Development and Design of Software-Based Methods to Promote Motivation of Patients in Cognitive Rehabilitation

DISSERTATION

zur Erlangung des akademischen Grades

Doktoringenieurin (Dr.-Ing.)

angenommen durch die Fakultät für Informatik
der Otto-von-Guericke-Universität Magdeburg

von Mareike Gabele (M.A.)
geb. am 11.05.1988 in Peine

Gutachter
Prof. Dr. Christian Hansen
Prof. Dr. Lennart Nacke
Prof. Dr.-Ing. Matthias Rötting

Betreuung
Prof. Dr. Christian Hansen
Prof. Steffi Hußlein

Datum der Einreichung: Magdeburg, den 23.08.2022
Datum der Verteidigung: Magdeburg, den 10.01.2023

*Rehabilitation is constantly being improved both conceptually and functionally.
But over time and optimizing functionality, we have forgotten who it is all about:
the human being.*

- analogously, from a talk at the GNP Conference 2017 -

Ehrenerklärung

Ich versichere hiermit, dass ich die vorliegende Arbeit ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe; verwendete fremde und eigene Quellen sind als solche kenntlich gemacht. Insbesondere habe ich nicht die Hilfe eines kommerziellen Promotionsberaters in Anspruch genommen. Dritte haben von mir weder unmittelbar noch mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen.

Ich habe insbesondere nicht wissentlich:

- Ergebnisse erfunden oder widersprüchliche Ergebnisse verschwiegen,
- statistische Verfahren absichtlich missbraucht, um Daten in ungerechtfertigter Weise zu interpretieren,
- fremde Ergebnisse oder Veröffentlichungen plagiiert,
- fremde Forschungsergebnisse verzerrt wiedergegeben.

Mir ist bekannt, dass Verstöße gegen das Urheberrecht Unterlassungs- und Schadensersatzansprüche des Urhebers sowie eine strafrechtliche Ahndung durch die Strafverfolgungsbehörden begründen kann. Die Arbeit wurde bisher weder im Inland noch im Ausland in gleicher oder ähnlicher Form als Dissertation eingereicht und ist als Ganzes auch noch nicht veröffentlicht.

Magdeburg, den 23.08.2022

____
Mareike Gabele

Abstract

This work was funded by the European Regional Development Fund, operation number ZS/2016/04/78123 and ZS/2017/01/83843 as part of the initiative 'Sachsen-Anhalt WISSENSCHAFT Schwerpunkte' , the BMWi, ZIM-Kooperationsprojekte, operation number FKZ: ZF 4028204TS9 and the European Social Fund (ESF) of Saxony-Anhalt, operation number CCI 2014DE05SFOP013 as part of the initiative 'Sachsen-Anhalt WISSENSCHAFT Chancengleichheit' with the program title 'FEMPower'.

Zusammenfassung

Softwarebasierte kognitive Trainings werden effektiv bei Patienten mit erworbenen Hirnschädigungen in der kognitiven Rehabilitation eingesetzt. Jedoch können besonders in der selbstständigen Nutzung zuhause sowohl Motivationsprobleme als auch eine ungenügende Durchführung des Trainings auftreten.

Die Motivation und Durchführung kann durch Ansätze wie Gamification oder unterschiedliche Nutzungs- und Erinnerungsmechanismen angesprochen werden. Für eine nutzerorientierte Umsetzung im spezifischen Kontext der kognitiven Rehabilitation werden detaillierte Kenntnisse zu Design, Entwicklung und Effekten benötigt.
Dafür werden in dieser Arbeit zur Erweiterung bestehender softwarebasierter kognitiver Trainings drei Schritte unterteilt:

1. Zuerst wird die Art betrachtet, wie Gamification Elemente für Patienten motivierend ausgewählt, entworfen und entwickelt werden können.
2. Als zweites wird betrachtet, welche Effekte sich bei der Implementierung von (angepasster) Gamification auf die Motivation in Wahrnehmung und Emotionen, sowie der Trainingsdauer ergeben.
3. Abschließend werden Möglichkeiten zur externen Ergänzung des Trainings am Computer betrachtet.

In der Art der Implementierung zeigen die Ergebnisse anhand von Interactive Storytelling und Quest initial die potentielle Eignung der Implementierung von Gamification und das Interesse der Patienten an der Nutzung ohne zusätzlich zu erschöpfen. Es zeigt sich in der Machbarkeit, dass die ergänzende Gamification unabhängig von der kognitiven Trainingsaufgabe entwickelt und umgesetzt werden kann ohne diese zu verändern. Vertiefend wird eine Orientierung für die Umsetzung eines Nicht-Spieler Charakters zur Begleitung von Patienten in softwarebasierten kognitiven Trainings präsentiert.
Übergreifend wird die Nachfrage von Patienten nach verschiedenen Gamification Elementen in Verbindung mit dem Charaktertyp basierend auf Marczewski's Player and User Types Hexad analysiert. Dabei zeigen sich von allen Typen gefragte oder abgelehnte und individuell je nach Typ gemischt betrachtete Elemente. Besonders gefragt ist die Kategorien Progression, aber auch die Assistance, welche für Patienten relevanter als für gesunde Spieler ist. Das gefragteste Element ist 'Meaning/Purpose'. Am wenigstens gefragt ist die Kategorie Socialisation.

Zur Unterstützung für die Auswahl von Gamification und Umsetzung in der Praxis werden folgende Ansätze vorgestellt:
- Eine visuelle Aufbereitung der Verbindung in der Nachfrage zwischen Charaktertyp der Nutzer und Elementen.
- Ein Tool-Prototyp für einen interaktiven 'Gamification Guide', der die Auswahl angepasster Elemente entsprechend einer individuell definierten Zielgruppe ermöglicht und einen Wissenstransfer zwischen Forschung und Praxis unterstützen kann.
- Die Anwendung einer Methode zur Zusammenfassung von Nutzereigenschaften im Mittel zur Zuweisung zu bestehenden Gamification Umsetzungen oder Auswahl von geeigneten Elementen.

Als Effekt von (angepasster) Gamification ergibt sich in der Arbeit in der Gesamtbetrachtung in der Trainingsdauer kein signifikanter Unterschied zwischen gamifizierten und nicht gamifizierten Trainings. Jedoch zeigten sich Hinweise auf die Hypothese, dass in den mittleren Trainingszeiten angepasste Gamification zu einer höheren Trainingsdauer führen könnte. Zudem zeigen sich in der vertiefenden Betrachtung teilweise signifikante Unterschiede je nach (nicht) primären Charaktereigenschaften der Nutzer.
In der Wahrnehmung weisen die Ergebnisse in der Nutzung von browserbasierten gamifizierten Trainings auf unterschiedliche mögliche Effekte hin, wie: Teilweise höherer Spaß oder höhere Kompetenz in Abhängigkeit des einzelnen Nutzertypen oder einen höheren Glauben an den Effekt von Trainings am Computer und Smartphones.

In der externen Software-Ergänzung wird die Ergänzung des (gamifizierten) Trainings am Computer durch eine Serious Game Smartphone App und die Weiterentwicklung eines Smart Home Reminder-Feedbackobjekts betrachtet. Es zeigt sich durch die hohe Varianz der Nutzungsbedürfnisse die Relevanz des Angebots angepasster Nutzungsvariationen. Nach der Anbindung des Feedbackobjekts an den Trainingsserver zur selbstständigen Nutzung werden Möglichkeiten zur Anpassung an den Charaktertyp vorgestellt, die das durch Nutzer als primär relevant beschriebene Feedback unterstützen sollen.

Basierend auf den Ergebnissen der Arbeit wird für zukünftige Methoden zur Betrachtung vorgeschlagen, als Basis generell gefragte Elemente einzusetzen und darauf aufbauend gezielt Elemente auf Effekt und Typ ausgerichtet zu ergänzen. Dadurch soll ein Kompromiss zwischen Entwicklungsaufwand in der Praxis und der Höhe des Effekts angestrebt werden.

Die Arbeit trägt Methoden und Vertiefung des Wissens zur Unterstützung von Design und Entwicklung zur Anwendung softwarebasierter motivationsfördernder Elemente in kognitiven Trainings bei. Sie bietet, erweitert und vertieft dabei die Möglichkeiten zur gezielten Auswahl in der Entwicklung zur Unterstützung der Motivation, Emotionen und Adhärenz der Nutzer.

Abstract

Software-based cognitive training is used effectively for patients with acquired brain damage in cognitive rehabilitation. However, especially in the independent use at home, both motivation problems as well as an insufficient conduct of the training can occur.

Motivation and conduct can be addressed by methods such as gamification or different usage and reminder mechanisms. For a user-centered implementation in the specific context of cognitive rehabilitation, detailed knowledge about design, development and effects is needed.
For this purpose, three steps are presented in this work to complement existing software-based cognitive training:

1. First, the way gamification elements can be selected, designed and developed in a motivating way for patients will be considered.
2. Secondly, the effects of the implementation of (tailored) gamification on the motivation in perception and emotions, as well as on the training duration will be considered.
3. Finally, ways to externally complement training on the computer are considered.

In regards to implementation, the results using Interactive Storytelling and Quest initially show the potential suitability of implementing gamification and patient interest in using it without additional exhaustion. Regarding feasibility, it is shown that complementary gamification can be developed and implemented independently from the cognitive training task without changing it.
In depth, an orientation for the implementation of a Non-Player Character to accompany patients in software-based cognitive training is presented.

Comprehensively, the request of patients for different gamification elements is analyzed in connection with the character type based on Marczewski's Player and User Types Hexad. This shows elements requested or rejected by all types, or considered mixed, depending on the type. Particularly requested are categories Progression, but also Assistance, which is more relevant for patients than for healthy players. The most requested element is 'Meaning/Purpose'. The least requested category is Socialization.

To support the selection of gamification and implementation in practice, the following methods are presented:

- A visual presentation of the connection in request between user type and elements.
- A tool prototype for an interactive 'Gamification Guide' that allows the selection of tailored elements according to an individually defined target group and can support a knowledge transfer between research and industry.
- The application of a method to group user characteristics in the mean for the assignment to existing gamification implementations or selection of appropriate elements.

In regards to the effect of (tailored) gamification, there is no significant difference between gamified and non-gamified trainings in the overall training duration. However, there were indications for the hypothesis that in the middle training durations, grouped tailored gamification might lead to a higher training duration. In addition, a more in-depth analysis revealed significant differences depending on the (non-)primary characteristics of the users.

In regards to the perception, the results in the use of browser-based gamified training indicate different possible effects, such as: Partially higher fun or higher competence depending on the individual user type, or a higher belief in the effect of trainings on computers and smartphones.

In regards to the external software complement, the addition of a serious game smartphone app to the (gamified) training on the coputer and the further development of a smart home reminder feedback object are considered. The high variance of usage needs shows the relevance of offering tailored usage variations.
After connecting the feedback object to the training server for independent use, possibilities for tailoring to the user type are presented to support the feedback, which is described by users as primarily relevant.

Based on the results of this work, future methods should consider using generally requested elements as a basis, and expanding additional elements targeted to effect and user type. This is intended to achieve a compromise between development effort in practice and the level of effect.

The work contributes methods and deepening knowledge to support design and development for the application of software-based motivation-enhancing elements in cognitive training. Thereby, it provides, broadens and deepens possibilities for targeted selection in development to support users' motivation, emotions and adherence.

Summary of Key Results

Methods for development and design to promote motivation in the conduct of software-based cognitive training were considered. Key results of this work indicate for the individual thesis research questions (TRQ):

TRQ 1: Implementation of Elements

Feasibility of the integration and deepening of specific elements:

- The integration of interactive storytelling shows, on the one hand, the feasibility of the method of wrapping training tasks through gamification over several sessions, and on the other hand, the interest of patients in using gamification and the usage without exhaustion and without subjectively perceived high distraction from training.
- A Non-Player Character (NPC) as a method to accompany in the browser-based training is requested in the type male and young or female and middle-aged and should be emotional and friendly, but also competent and taking the leading role. For the rehabilitation, different classical roles are included, like friend and mentor, but also aspects of the therapist.

Comparison of requests for elements:

- The differentiation of user types shows elements that are requested, mixed and not requested by all types. This indicates elements that might be used in general, but also elements that should be tailored to the target group resp. their subgroups for use.
- The primary requested element by patients in cognitive rehabilitation is 'Meaning/Purpose', which includes a meaningful goal. The primary requested element categories are Progression, followed by Assistance. The least requested element is Anchor Juxtaposition (do the training task or pay money to level up) and least requested category is Socialization.

Methods for assistance in the development, design and application in practice:

- The visualization as assistance for choosing appropriate elements for all types, or individually. resulting from the request for elements related to the user type.
- A proposed prototype for the browser-based tool 'Gamification Guide'. According to an individual definition for the target group, the 'Gamifiction Guide' is intended to visually present research results on gamification elements, whereby the user gets the competence to select appropriate elements for the application in practice. Furthermore, it is intended to support the interconnection of research and industry and the presentation of research results.
- The method of grouping parts of the scores of user characteristics based on player and user types hexad in mean allows for the assignment to existing gamification approaches based on the suitability for the user and potentially a simplification of the development.

TRQ 2: Effects

Gamified training can create effects in perception, such as

- A higher perceived fun or competence, emerging differently for different user types or implementations.
- Within grouped user types in mean a higher belief in the positive effects on personal skills, the effect of a training using a computer and subsequently complementary a smartphone, but not of playing a game.
- There are indications that need to be considered further that A) the level of responsibility conferred by the complementary methods should be integrated with caution and B) complementary goals can be integrated through motivational methods.

(Tailored) Gamified training shows for behavior in training duration:

- There are no overall differences between gamified and non-gamified training, but there are differences in the details:
  - In consideration of the user characteristic, in a combination of socialization and progression elements, partial differences in the duration of training were found within gamified training.
  - Indications emerge for the hypothesis that training duration can be increased in the medium range through the integration of gamification.

TRQ 3: Complementing Browser-Based Training on the Computer

- In the combination of browser-based (gamified) training and smartphone game app, the presumed most reasonable use (combined use) and the presumed personal use (increase of individual possibilities) differ from each other. A high need for individual selection of the version to be used becomes apparent.
- Feedback as a complementary object can be implemented as a smart home system for independent use and connected with the server for browser-based training to be able to react directly to the user's interaction with the training, depending on the personal training plan.
- Further, a meaningful integration tailored to the user types and a possible evaluation are proposed.

Contents

Contents

Ehrenerklärung ... 5

Abstract
Zusammenfassung ... 8
Abstract ... 10
Summary of Key Results ... 12
TRQ 1: Implementation of Elements ... 12
TRQ 2: Effects ... 13
TRQ 3: Complementing Browser-Based Training on the Computer ... 13

Contents
Contents ... 16
Notes ... 20
List of Abbreviations ... 21

1 Introduction
1.1 Situation of Patients in Cognitive Rehabilitation and Problem ... 24
1.2 Focus and Contribution ... 26
1.2.1 Focus ... 26
1.2.2 Goal and Main Contribution ... 28
1.3 Challenges, Restrictions and Requirements ... 29
1.4 Structure ... 31

2 Background
2.1 Medical Background ... 34
2.1.1 Anatomy ... 34
2.1.2 Acquired Brain Damage ... 34
2.1.3 Rehabilitation and Cognitive Therapy ... 35
2.2 Software: Clinical Practice in HCI in Software-Based Training, Software and Development ... 38
2.2.1 Software-Based Solutions ... 38
2.2.1 Software Development ... 41
2.3 Motivation and Gamification (in Rehabilitation) ... 43
2.3.1 Motivation - Fundamentals and Rehabilitation ... 43
2.3.2 Gamification and Tailoring ... 45
2.3.3 Motivation and Gamified Software-Based Training in Rehabilitation ... 50

3 Game Elements in Cognitive Rehabilitation Software Training
3.1 Focus and Purpose ... 60
3.2 Game Elements to Complement Cognitive Training ... 61
3.2.1 Complementarity, Effects and Deepening in the Use of Interactive Storytelling and Quest ... 61
3.2.2 In-Depth Design and Development of Accompanying Non-PlayerCharacters ... 71
3.3 User Requests, Effects and Ways of Tailored Gamification in Software-Based Training ... 81
3.3.1 Focus and Purpose ... 81
3.3.2 Research Questions and Background ... 82
3.3.3 Steps and Method ... 84
3.3.4 Results ... 89
3.3.5 Discussion and Conclusion ... 94
3.4 Outlook: Potentials of a Web-based Gamification Guide for Knowledge Transfer between Research and Industry - A Method to Support Design and Development ... 100
3.4.1 Focus and Purpose ... 100
3.4.2 Background and Related Work ... 101
3.4.3 Method ... 103
3.4.4 Concept Consideration and Prototypes ... 104
3.4.5 Results ... 107
3.4.6 Discussion and Conclusion ... 109
3.5 Discussion ... 113
3.5.1 Thesis Research Question 1 ... 113
3.5.2 Thesis Research Question 2 ... 115
3.5.3 Overall: Thesis Research Question 1 and 2 ... 115
3.6. Summary ... 117

4 Complement of Browser-Based Training: Grouped Gamification, Mobile App Game and Smart Home Device - Tailoring and Combination
4.1 Focus and Purpose ... 122
4.2 Effects of a Tailoring Method and Combined Browser-Based and Mobile Cognitive Software Training ... 123
4.2.1 Focus and Purpose ... 123
4.2.2 Background and Related Work ... 124
4.2.3 Feasibility of a Serious Game Approach ... 126
4.2.4 Effects and Combination of Tailored Browser-Based and Mobile Cognitive Software Training: Concept and Implementation of the Prototypes ... 128
4.3 Outlook: Smart Home Feedback Object - Further Development, Implementation for Independent Use and Tailoring of Gamification ... 138
4.3.1 Focus and Purpose ... 138
4.3.2 Background and Related Work ... 139
4.3.3 Pre-existing Approach ... 142
4.3.4 Further Development ... 143
4.3.5 Evaluation: Feasibility Study ... 145
4.3.6 Discussion, Further Concept and Conclusion ... 149
4.4 Discussion ... 154
4.4.1 Thesis Research Questions ... 154
4.4.2 Limitations and Future Work ... 155
4.5 Summary ... 157

5 Summary, Discussion and Implications of Contributions
5.1 Challenges and Summary of Contributions 160
5.2 Discussion 162
5.2.1 Thesis Research Question 1 - Implementation of Elements to Support Motivation 162
5.2.2 Thesis Research Question 2 - Effects in Perception and Training Duration 165
5.2.3 Thesis Research Question 3 - Training Complement 166
5.2.4 General Discussion 168
5.3. Limitations 172

6 Conclusion
6.1 Conclusion 176
6.1.1 Thesis Research Question 1 - Implementation of Elements to Support Motivation 176
6.1.2 Thesis Research Question 2 - Effects in Perception and Training Duration 177
6.1.3 Thesis Research Question 3 - Training Complement 177
6.1.4 Overall 178
6.2 Future Work: Research Agenda 179

Appendix
I Further Notes 182
II List of own Publications 184
III Bibliography 186
IV Questionnaires and Graphics 216

In PDF: See digital version of the attached questionnaires following page 223
Print: See the attached questionnaires on attached storage medium

Notes

- For ethical reasons, 1) the training in the studies in this work use, are based on or inspired by medically confirmed software used in practice and / or use further developed approaches based on this and 2) in studies with patients, elements that are considered as promising for use and assumed positive effects are implemented.
- Gender note: Care has been taken in this work to use neutral wording as often as possible when referring to gender. This includes all genders (female, male, trans*, non-binary, undefined, or other forms of self-identification) unless explicitly stated otherwise. Section 3.2.2 differentiates between female and male due to relevance to the research question.
- Parts of this work are based on the previous master thesis of the author [129], deepening and extending it.
- This work includes, in addition to the author's own publications, parts of the thesis proposal and the presentation at the 'Doktorandentag' at the faculty of computer science at the Otto von Guericke University of Magdeburg. Contents and formulations of the already published papers are integrated. An overview can be found at the end of the work in the appendix in the list of own publications. Some of the formulations and content in the own publications were adapted, shortened or expanded for this thesis.
- This work was realized within a cooperation with HASOMED GmbH and the Tagesklinik für Kognitive Neurologie of the Universitätsklinik Leipzig. Parts of the emerging results are integrated.
- Through the cooperation with the company HASOMED GmbH and the use of the RehaCom software they developed, they have partially supported the software development and the integration into existing training modules / web training, or realized parts.
- For this work, the german rehabilitation system is considered. Procedures in other countries may differ.

List of Abbreviations

Abbreviation	Explanation
eHealth	Electronic Health
FBO	Feedback Object
GUI	Graphical User Interface
HCI	Human-Computer-Interaction
IoT	Internet of Things
IoMT	Internet of Medical Things
LED	Light-Emitting Diode
mHealth	Mobile Health
NPC	Non-Player Character
RQ	Research Question
TRQ	Thesis Research Question
TUI	Tangible User Interface
WHO	World Health Organization

1 Introduction

1.1 Situation of Patients in Cognitive Rehabilitation and Problem
1.2 Focus and Contribution
1.3 Challenges, Restrictions and Requirements
1.4 Structure

This chapter introduces the focus and purpose of this work, its contents and main contribution.
It introduces the challenges, restrictions and requirements and gives an overview of the structure.

This section contains texts from the author's own publications (see 'List of own publications' in the appendix).

1.1 Situation of Patients in Cognitive Rehabilitation and Problem

Acquired brain damage can lead to various deficits, such as limitations to, or loss of, cognitive abilities. However, neither survival nor complete recovery of lost abilities can be ensured [312]. With the higher age of the patients, the need for treatment in clinics also increases [67, 352]. Neurological deficits can have a high impact on the patient's life and restrictions on activity and participation [175]. Following acute hospitalization, software-based cognitive training is used effectively [402, 416] in inpatient or outpatient treatment, and plans are created, which are tailored to patients and their deficits [181].

For improvement to the skills, various factors such as the repetitions, number or intensity of the training are relevant [182, 214, 403]. If motivation is low, there is only a small probability of successful therapy [276, 294]. The conduct of the training can be controlled extrinsically by the supervisors on-site. However, training tasks are sometimes perceived as boring [392]. In complementary or subsequent training at home, lower motivation [361], lack of direct guidance or control by therapists is a problem [178]. Patients tend to neglect their at-home training [178]. In electronic health (eHealth), it is also a problem to drop out too early before the goal has been reached [120]. An observational study in cognitive home training indicates that more than half of the patients do not train sufficiently [217].

Methods are needed to address motivation in software-based training, especially in independent use. Different possibilities are available for this, such as external control, reminders or support of the user's interest. In this work, two approaches are considered, which can be used individually or complementarily, depending on the patient and situation.

In health care [7, 192, 219, 379, 282] and specifically in cognitive training [329, 361, 392], to address perception, behavior or behavior change [329] and motivation, the use of elements from games [228] is promising in cognitive rehabilitation [106]. They can maintain engagement with the tool, increase compliance with health interventions, and convey positive emotions [329]. This is of interest to both research and industry [180, 405]. In practice, however, the context of use is crucial [156, 160, 388]. A transfer of results between different application areas is not guaranteed.

Research results in the field of gamification often range between mixed and positive [219], but negative side effects may also arise [54, 334, 392]. In use, the goal should be to strengthen positive effects and avoid negative effects [199, 281, 320], which is particularly relevant for patients and the conduct of training.

In rehabilitation, a challenging and meaningful approach is particularly relevant [60]. However, the use of different game elements is differently appropriate for different types of users. Thus, not only general use is important, but also a tailored approach [372, 284], especially for addressing the long process of rehabilitation [379].

Gamification frameworks therefore require knowledge about the user, their characteristics and needs as a basis for the development of gamification solutions [258, 262]. The therapeutic elements are an additional relevant factor for the use in cognitive impairments [228]. However, in the general research on gamification, but also in gamification in computerized cognitive training, the lack of theoretical foundations and approaches, empirical studies and issues is evident [329, 392]. In computerized cognitive training, there is also a lack of consideration to individual, group, and more broadly ranged elements and tailoring [392].

One goal of the research is to transfer solutions and effects into practical applications. However, the use of gamification is challenging, and poor design can result in missing the target [293]. Thus, further methods are needed to create easy access to the results for the industry and to support the applicability of the research results.

The motivation for training can be addressed through direct integration within the software, such as through gamification on the one hand, but also outside the computer on the other [129].
In practice, software-based cognitive training is offered for different devices, such as personal computer / laptop, browser-based or mobile devices [181]. According to Jokela et al. different devices are used for different purposes and situations, and based on different preferences [194]. Smart objects can provide additional support at home in everyday life [381, 393]. For the use in cognitive therapy, therefore, not only the suitability of developments for individual devices within the training, but also the effects of their combination and complementation possibilities of the basic training are relevant to deepen understanding and to address the tailoring to the usage scenario.

Therefore, this work focuses on motivational and meaningful methods for the user. This includes the way of implementing gamification and effects within the training and complementing the training software through connected devices. In this context, ways and methods for application and to support design and development for use in practice are presented.

1.2 Focus and Contribution

1.2.1 Focus
1.2.2. Goal and Main Contribution

1.2.1 Focus

In rehabilitation, a differentiation is made between cognitive and motor impairment [361]. This work focuses on motivational methods for a target group of adult users in the specific context of independently used software-based training for cognitive abilities after acquired brain damage. The target group is already undergoing outpatient therapy and can perform supplementary or sole home training. Thus, training situations in outpatient training or home training are considered.

According to Ferreira-Brito et al., commercial as well as adjusted and specially developed games are used in trainings [123]. Games for entertainment used for therapy, well-being e.g., brain training games for healthy users for fun, training for motor functions, as well as for brain damage existing from birth are not considered in depth.

For the personalization of gamified eHealth youth mental healthcare, van Dooren suggests examining the overall system as well as individual effects [388]. According to them, it is relevant to focus research on how a gamified eHealth application can support both patients and therapists.

In the field of common mental disorders and well-being, Brown et al. describe various approaches, such as persuasive technology, personalized reminders, tracking, interaction, or social networks, for use in web-based health interventions to promote adherence [56]. These are used to address motivation in this work for application in cognitive rehabilitation on the basis of gamification.

The focus is on motivation through gamification, and complementary methods, as well as the complementation of existing training, but not on the novel development of serious games.
Measuring motivation is a typical factor in considering the impact of gamification [379]. In this work, user requests, perceived emotions, and behaviors such as self-selected training duration are considered as indicators of user motivation. Important aspects are underlying meaningfulness [60], the possibility of tailoring to the user [372, 284] and the personal situation. The results are intended to serve as guidance in design, development, and implementation and are aimed at practical application.

De la Hera Conde-Pumpido proposes different strategies of persuasiveness in games, which include exocentric strategies, or those which change attitudes outside of the game, and endocentric strategies, which attempt to keep the player playing [94]. The goal of rehabilitation is exocentric outside the conduct of the software-based training to maintain or regain skills. The goal of gamification and motivation used in this work is an endocentric one for conducting the training. The focus of this work is therefore in the endocentric domain. For this purpose, an existing training software [162] was expanded in different training modules and complemented with gamification and external elements. Neither existing software-based training concepts nor sessions with the therapist are to be replaced.

Training and motivational methods are considered as two different components. This is to ensure that a) the effectiveness of the existing training, or training based on it, is maintained, b) the motivational methods can also be used flexibly for other training, and c) training and motivational components can be connected in the development but considered independently of each other. Based on this, the following Thesis Research Questions (TRQ) are considered. They are intended to consider the basis for motivation in the further development of software-based training to strengthen perceived emotions, behavior and long-term training adherence.

1. **How can gamification elements be implemented in the development and design of software-based cognitive training on the computer in a motivationally supportive way for patients with acquired brain damage?**

2. **What are the effects of implementing (tailored) gamification on motivation in terms of perception and usage behavior in self-selected training duration?**

3. **How can motivation-supporting elements complement browser-based training tailored to the user?**

TRQ 1 includes the initial consideration of the feasibility and suitability of combining gamification elements and software-based cognitive training. For this, the elements 'Interactive storytelling' combined with 'Quests' and 'Non-Player Characters' (NPCs) were considered in depth. For broader possibilities of implementation, the request for different elements were considered in general and in dependence of the character traits of patients. This offers an orientation for the selection of appropriate elements. To further support the design and development, a browser-based gamification knowledge transfer tool between research and industry is proposed, which supports the selection of possible elements tailored to the user group. Moreover, the grouping of different character traits of a user for the assignment to existing gamification options is considered.

For TRQ 2, (tailored) gamification scenarios created within the work, which were combined with existing [162, 168] or based on existing training, were evaluated in their use. Effects on perception and training behavior in the duration of training were considered.
TRQ 3 includes the consideration of different complements for training in different usage scenarios for combinations and devices. The basis for this is browser-based training on the computer. In addition, the difference of gamified or non-gamified training and the (complementary) use of a serious game on a smartphone were considered. Furthermore, the further development of an existing smart home feedback object, which was developed prior to this work [129, 135], software-based connection to an existing training server and the possibility for a meaningful tailoring were considered.
Based on Vermeir et al. [392], this work uses both qualitative and quantitative approaches to evaluate perception, behavior and tailoring to the target group.

1.2.2 Goal and Main Contribution

Successful rehabilitation is the long-term overarching goal, which is to be addressed by supporting patients' motivation to perform cognitive training independently. By addressing the TRQs and steps described above, this work contributes methods and implementations to support design and development of software-based training in cognitive rehabilitation and make research results applicable in practice. Therefore, the elements in this work are implemented in the context of cognitive training for practical use. This work thereby deepens the knowledge about the selection, implementation and effects and in the application of motivational software-based methods in cognitive training. For this purpose, specific application purposes are examined in depth on the one hand, and elements are compared in an overarching view on the other hand. The results contribute to the selection of motivational methods in the specific context of cognitive rehabilitation, specifically tailoring to the user and the intended effect [202, 373], and to integrate them into the training software.
The work offers concluding implications of the results and possibilities for applying the results in practice for integration into existing software-based therapies.

1.3 Challenges, Restrictions and Requirements

There are several challenges, restrictions and requirements for this work.

With regard to design-based research in the development of cognitive training for elderly, Lu et al. point out that the development of research approaches requires interdisciplinary collaboration and the integration of, among others, interaction designers, engineering scientists, mechanism experts, and stakeholders [235]. Khaleghi et al. also point out the relevance of interdisciplinary teams in their framework for the development of cognitive training [211]. For Parkinson's disease, van de Weijer et al. also point out the need for collaboration between researchers, health professionals, patients, and the industry in the development of training [387]. Regarding the development of mobile training, Dicianno et al. point out the relevance of including rehabilitation professionals to serve standards of rehabilitation in these technologies [102].
Since an interdisciplinary perspective is necessary [301], interaction and game backgrounds are included into the development in addition to the application and implementation in computer science. For the suitability for therapy, neuropsychologists from the field of cognitive rehabilitation are involved, as well as experts from the development of training software from the industry for the implementation. This is complemented by the inclusion of patients from cognitive rehabilitation and participants for the use of the home training for the user-centered approach and to address motivation.

Tamayo-Serrano et al. point out the problem that systems for in-home use are sometimes only tested in the laboratory or at the hospital [361]. Van Dooren points out the relevance of aligning studies with the context of use [388]. By considering the outpatient phase respectively primarily the home training, the target group should primarily carry out the training independently. This results in the requirement to develop prototypes and evaluation scenarios in this work, which are close to the real application purpose and technically usable by participants independently.
Sardi et al. point out in a review in eHealth that in the use of game methods the selection and suitability for the situation of use and the target group is challenging [329]. Transferring or using game metaphors in a different context can be difficult, thus easily understandable elements that do not require prior knowledge should be used. Furthermore, they point out that gamification should not only prolong tasks, but also add meaningful and entertaining value for longer user engagement. Gamification, however, may not be perceived as meaningful in terms of serving the health purpose in some cases. Partly, the user adaptation is missing or the interest in the elements decreases over time. Vermeir et al. point out that the game features used in complex systems must be well thought out to achieve the intended outcomes [392]. Therefore, the selection of the elements should be oriented towards their effect suitable for the user [201, 202].

This results in the challenge of supporting development, as well as the requirement of designing long-term motivational approaches due to the longer training duration and meaningful scenarios.

Further requirements for development are maintaining the effectiveness and conveying this to the user [329]. Existing effective training designed for therapeutic purposes in rehabilitation, or versions based on them, are to

be integrated into the motivational settings to be developed in this work.
The cognitive resources required for the motivation elements should be kept low. This should reduce the risk of increased difficulty [392] or overwhelming and enable a high training performance. Patients require cost-effective systems and preferably standard hardware for home training [178]. Furthermore, the results should be supporting and applicable in the software development of rehabilitation tools in the future.

1.4 Structure

After the introduction, the work is divided into the following sections:

- **Chapter 2**: Fundamentals of medical background, software background in cognitive training, motivation and gamification in rehabilitation and usage of software.
- **Chapter 3**: Focus on gamification within the computer-based training. Implementation and usage of game elements in combination with cognitive training in rehabilitation: In-depth and overarching integration, its tailoring and effect on patients, as well as a proposed tool-prototype to foster knowledge transfer between industry and research to support the design and development in practice.
- **Chapter 4:** Focus on gamification integration and motivation in combined multiple training settings to complement the computer-based training externally: The application of a method of integrating (grouped) gamification within the software. Also, the effect and combination of (tailored) browser-based training and a subsequent mobile serious game. Furthermore, the implementation, software-based interconnection with a cognitive training and possible tailoring of a training feedback object as a reminder in home environment.
- **Chapter 5**: Summary of this work, discussion of the thesis research questions and approaches, implications and pointing out limitations.
- **Chapter 6**: Conclusion of this work and research agenda for future work.

Chapters 2 and 3, after the individual studies, provide a concluding summary in take-away information of the respective key aspects. This work is complemented by implications of the results also for use in practice, which can be found in chapter 5. A list of the author's own publications, the bibliography, further notes on this work and parts of the questionnaires and graphics can be found in the appendix. Further questionnaires can be found on the attached storage medium.

2 Background

2.1 Medical Background
2.2 Software: Clinical Practice in HCI in Software-Based Training, Software and Development
2.3 Motivation and Gamification (in Rehabilitation)

Following the first surgical openings of the skull more than 10,000 years ago and continued research, it was possible to assign functions to the individual brain regions [204]. To regain abilities after brain damage, therapies were developed that can be carried out analogously and later on also software-based. To motivate patients in their therapy, various approaches exist, such as the use of tokens as positive reinforcement and rewards for desired behavior in behavior therapy.
In 2002, the term gamification was coined and game elements were used to address motivation. This has been used, researched and tailored to users in a wide range of fields, also in software-based cognitive rehabilitation training for patients.

This chapter describes the fundamentals and background for this work. Different specialist areas are included. First, an overview of anatomical fundamentals, acquired brain damage, and neurological rehabilitation is provided. This is secondly followed by an overview of clinical practice, Human-Computer-Interaction (HCI) in software-based training, training software and its implementation. Thirdly, it is extended by fundamentals of motivation, use of gamification and its tailoring to users. Lastly, their combination is considered, the use of gamification in rehabilitation and software used.

This section contains texts from the author's own publications (see 'List of own publications' in the appendix).

2.1 Medical Background

2.1.1 Anatomy
2.1.2 Acquired Brain Damage
2.1.3 Rehabilitation and Cognitive Therapy

2.1.1 Anatomy

The central nervous system controls cognitive and action processes and includes the spinal cord and the brain (anatomically: encephalon) [36]. It is embedded in liquor to protect it from shocks [36]. Viewed from the outside, the brain is divided into two connected cerebral hemispheres [38, 302]. A folded structure increases the size of the surface. The structure of the brain can be divided into different areas, such as the midbrain, cerebellum, diencephalon and cerebrum [37, 38]. The large area of the cerebral cortex can be divided into frontal lobe, temporal lobe, parietal lobe and occipital lobe.

The blood and oxygen supply to the brain is provided by the main arteries and the vessels branching off from them [400]. These supply different areas, so that in diagnostics, a suspicion can be drawn from the patient's symptoms which area is affected by damage. Imaging techniques can be used to diagnose and localize problems, for example CT (computed tomography), angio-CT (angio-computed tomography; examination of the blood vessels, often with the use of contrast medium) or MRI (magnetic resonance imaging) [147]. However, due to the faster availability of results and time-critical treatments, CT-based procedures are used more frequently. For example, lysis, a treatment for blood clots, should be performed within 3-6 hours, but this requires the exclusion of a cerebral hemorrhage.

An interruption of the blood supply in the brain of already 2-3 minutes can lead to a permanent damage of brain tissue and nerve cells [302].

2.1.2 Acquired Brain Damage

Acquired brain damage can have various causes, such as [74, 204]: Traumatic Brain injury (sudden traumatic injury, such as from an accident), infections (e.g., of the brain or meninges), tumors, strokes (ischemic (lack of blood flow to the brain / occlusion of vessels) or hemorrhagic (bleeding in the brain)), aneurysm (bulging of the vessel wall) or anoxia (lack of oxygen). The definition does not include developmental disorders or diseases that gradually damage the brain [376].
Beginning at the age of 45, the risk of suffering a stroke doubles every year [208]. Accidents can also cause injuries at an earlier age. Causes such as strokes [208] or traumatic brain injuries [65] are reasons for long-term disability, morbidity or death.
Acquired brain damage can result in various cognitive deficits in addition to, for example, physical deficits, such as in the areas of [162, 376]: Attention, speed of processing, memory, executive functions or language skills. In diagnostics, cognitive functions should be considered in the context of other cognitive functions, behavior and psyche [368]. The following describes in detail the deficits for which trainings are integrated into the concepts and prototypes in this work:

- Divided attention: Divided attention is the ability to simultaneously perceive different information and/or perform different tasks, for which one or more senses can be used [20]. Attention is divided into different channels, where practice is required and skills can be developed [346]. In this regard, training studies for executive functions with older adults in dual-task performance showed to be successful [127]. Patients with these deficits in divided attention describe difficulty accomplishing multiple things simultaneously [358]. The ability of divided attention is needed in various situations and tasks in the management of everyday life [127]. In the diagnosis of deficits in attention, computer-assisted procedures have proven to be useful, as they allow exact time measurements and thus an estimation of the user's processing speed, which is related to attentional performance [358]. In computer-assisted therapy for attention, specific training situations similar to everyday life are shown to be suitable.
- Verbal memory: Verbal memory enables the ability to retrieve learned spoken or written information [23]. For this deficit, various tasks exist in which patients are asked to learn items such as word lists, stories, or word pairs that are to be reproduced immediately afterward or with a delay [365]. For patients with mild to moderate memory impairment, training should be oriented toward function- or strategy-oriented tasks [368]. Smartphones or other digital tools can be used in everyday life as compensation and support for memory.
- Logical thinking: Logical thinking involves drawing logical conclusions from existing information [216]. In neurological reports abstract-logical thinking can be considered as a partial aspect of intelligence [268]. Problem solving requires various sub-areas such as skills in attention and memory, as well as presence of the action goal and self-control, among others [165].
- Calculation skills: Everyday life involves various demands for which arithmetic skills are required at different levels of complexity. These can be from different areas, such as number concepts and quantities, arithmetic operations, or connections between mathematical relationships and reality [163]. For understanding and implementing abstract calculation processes, the understanding of basic relationships such as quantity and size relationships (large / small, equal / unequal) is relevant [163]. Furthermore, the handling of money, time, lengths or weights is critical [204].

2.1.3 Rehabilitation and Cognitive Therapy

Considering various causes overall, almost two million people in Germany were in preventive care or rehabilitation facilities in 2016 [351]. With a higher average age, the number of rehabilitations increases [99]. Especially from the age of 45, patients are more often in preventive care and rehabilitation facilities [352]. In 2018, the average age of women in medical rehabilitation in Germany was 53.5 years and 53.4 years for men [99]. Chan et al. indicate that among older adults, hospitalization increased with age [67]. The same applies to the percentage requiring subsequent (long-term) care. The highest bed occupancy rates in preventive care or rehabilitation facilities (88% in each case) in 2016 were in the specialist departments 'Neurology' and 'Psychiatry and Psychology' [351]. If there are disorders in the function of cognitive and/ or emotional functions, if these are to be expected or if necessary within the overall assessment, neuropsychological reports are prepared to ascertain the extent of possible disorders in the central nervous system [268]. The goal of rehabilitation is to regain or maintain abilities as far as possible and to enable independence and participation [175]. Worldwide, there are no uniform conversions or classifications for rehabilitation. According to the system used in Germany (based on Verband Deutscher Rentenversicherungsträger (VDR) and Bundesarbeitsgemeinschaft für Rehabilitation (BAR)), rehabilitation is subdivided and described according to the phase model of neurological rehabilitation as described in Table 1 [98, 175].

Table 1. Description of the phases of neurological rehabilitation [98, 175]

Acute phase
A) Acute treatment: medical treatment of the acute medical condition
Phases of treatment/rehabilitation:
B) Provision of intensive medical care: Acute treatment is completed, further medical care for severely affected patients without the possibility of cooperation, with stable cardiovascular and respiratory systems. The aim is, among other things, the improvement of the state of consciousness, beginning mobilization, assessment of rehabilitation potential with corresponding further planning
C) Curative medical care (high level of care): Partially mobilized, patients who are predominantly able to interact, with the possibility of participating in therapies (30 min. daily). The aim is, among other things, the restoration of basic functions and consideration of the long-term process.
D) After completion of early mobilization: Ability to be independent in daily life and participate in therapies (4-6 hours daily).
E) Follow-up and vocational rehabilitation: Vocational reintegration and further existing rehabilitation potential.
F) Permanent support and / or maintenance of the condition: Need for permanent care / assistance

Within this interlocking system, patients pass through the different phases according to their limitations and abilities. On the one hand, it allows a uniform and structured process, and on the other hand, the flexibility to skip or downgrade phases according to the patient's situation.

When patients are able to learn, learning strategies for detouring or re-learning functions are strategies for therapy in neurological rehabilitation to address impaired abilities in mental processing [19, 175]. Due to neuronal plasticity, the brain is able to change and compensate for lost structures [17]. This supports new learning and relearning in the context of rehabilitation. Through targeted training of the working memory, its capacity can be increased, and there is potential for transfer effects and general cognitive enhancement [261]. The duration of rehabilitation depends on the individual patient, can last from months to years, and cannot always be fully completed [74].

In cognitive therapy of patients, software-based training is effectively used for rehabilitation of skills in acquired cognitive impairment [122, 402, 416]. Considering the effectiveness of the training, a high number of training sessions has a high effect on it [403]. Considering, for example, working memory, the recommended number of trainings for effectiveness is at least 10 trainings [368]. With respect to attention deficit disorders, Sturm et al. point out that in addition to the number required, their close temporal proximity is also relevant for positive outcomes [358]. Training can be carried out in the clinic as an inpatient or as a substitute or subsequently on an outpatient basis [98]. This may depend on the individual situation of the patient. Another option is the use of training as home training [171]. In an observational study of patients in outpatient neuropsychology and supervised home training, three groups emerged in terms of duration of use [217]:

- High performers (>50 hours / 2.5 hours per week): 28.17%.
- Middle usage (30-49 hours / 1.5 hours per week) : 12.68%.
- Low usage (<30 hours / 0.45 hours per week): 59.15%.

For the conduct of the training, the cooperation and motivation of the patient is relevant, which is a main problem in the training at home. Trainings are often conducted face-to-face in the presence of the therapist [105]. Computer-based cognitive training can be used to increase the flexibility of conduction [105]. If training in clinics can still be supervised and externally encouraged, the patient is responsible for it at home. In the eHealth sector, early drop-out or inadequate training is a problem [120].

Colzato and Hommel also point out that a 'one-size-fits-all' approach is often used in cognitive training, but they suggest that training that is tailored to the user and their needs and abilities may be more effective [79]. Lentferink et al. point out that in eHealth in combined self-tracking and persuasive eCoaching for healthy lifestyle support, among other things, personalization in development is a key component [230].

2.2 Software: Clinical Practice in HCI in Software-Based Training, Software and Development

2.2.1 Software-Based Solutions
2.2.2 Software Development

2.2.1 Software-Based Solutions

Mainly paper-pencil tasks or computer-based tests are used in the study of cognitive functions [368]. In the development of trainings to enable greater dissemination and accessibility of the trainings, audio and video recordings have been used as alternatives [307]. Further development of software-based practices show, among other things, the use of virtual reality [368].

Software-based training has been shown to be beneficial in mild cognitive impairment in a systematic review of older adults by Hill et al. [174]. According to Jaeggi et al. in a study with children using a video game-like working memory task, cognitive training is effective and long-lasting, but there are limiting factors such as type and differences in training performance [182]. In a review, Bogdanova et al. point to the improvement of cognitive functions through computer-assisted training after acquired brain damage [48]. In people with dementia, García-Casal et al. have shown that they benefit more from computer-assisted than non-computer-assisted cognitive interventions [141]. In a software-based training setting in a three-dimensional city (Reh@City), Faria et al. show significantly higher global cognitive functions, attention and executive functions in stroke patients compared to conventional therapy [121]. Ge et al.'s review of the use of technology-based cognitive training, including computer-assisted software, tablets, game consoles, and virtual reality, among others, points to promising but mixed results and the need for more standardized methods for comparison [143].

In a review of patients with traumatic brain damage, for cognitive and cognitive-communication skills, Politis and Norman point to inconsistent results on the efficacy of computer-based cognitive rehabilitation, but also to a range of limitations in the studies [299].

For interaction, mouse and keyboard or touch screens are frequently used as input devices [181]. When using mobile devices, such as tablets, care should be taken to simplify implementation for older people, especially those with cognitive or physical impairments, such as few icons or flat hierarchies in the app structure [265]. Patients often perceive tasks on tablets as more attractive than on paper [105].

The term digital health encompasses the use of digital technologies to improve health and includes not only electronic health (eHealth) but also mobile health (mHealth) [409].
eHealth describes the use of information and communication technologies in the treatment of patients or prevention of diseases [58]. Telemedicine is a field of eHealth and describes the medical care (e.g., consultation, diagnosis, therapy, etc.) of a patient by specialists at a distance [409] and corresponding communication channels such as telephone or internet. This can also be used for teletherapy or telerehabilitation [171]. Advantages are the bridging of spatial distances, availability of different offers, the possibility for more frequent and / or long-term training and individual motivation approaches within the software. However, the technical knowledge and requirements must be available or affordable for the users [171].
However, How et al. point out that the effect of telerehabilitation depends on both the content of the intervention and the technology modalities, which may also produce different results according to the literature [178].
Furthermore, the need for technical support or further explanations may arise [80, 217]. At the same time, problems can arise, such as not being able to intervene adequately when there are motivational problems or low usage [217]. Also, challenges can arise in the implementation in clinics and practices [171].

mHealth specifies the use of medical interventions via mobile and wireless technologies [246]. In a review of adherence to online and mobile technologies for people with psychosis, Killikelly et al. described a drop-out rate of 11.4% and found no associations in the majority of studies, but in some studies indications of individual predictors of drop-outs, such as 'symptom severity' or 'male' / 'younger age' [212]. Furthermore, adherence was higher in the first week than in the second week.

For the future use of cognitive telerehabilitation, How et al. point out the adaptability of pervasive technologies to the user's life situation, physical, cognitive, and emotional situation, and changes in rehabilitation [178].

Telerehabilitation can be used for different fields, such as motor or cognitive training for patients with stroke [220]. Web-based cognitive training has been shown to be feasible and positively evaluated by patients, with high interest in performing the tasks at home [80]. In their review of patients with traumatic brain damage, Politis and Norman point to inconsistent results for cognitive and cognitive-communication skills with regard to the effectiveness of computer-based cognitive rehabilitation, but also to a range of limitations in the studies [299]. In a literature review on telerehabilitation after stroke, Sarfo et al. also point to different results in the measured significance, but also conclude that telerehabilitation has equivalent or better effects than conventional therapy with face-to-face contact [330]. For example, the software 'Rehability' offers an interlocking system that connects the training between clinic and home and can be used at home on the pc, tv or mobile [308].

In this work, a training that can be conducted independently at home is also referred to as 'home training'.

Various software-based solutions are available for software-based training in inpatient treatment in clinics, outpatient treatment, and in some cases also as home training. They address various restrictions and possible uses, such as extended use of the software in home training or on mobile devices. These can often be tailored by the therapist to the needs of use [181]. Table 2 shows an excerpt of various software for cognitive therapy and training. The focus is on software that is used with the supervision of a therapist or within the therapy. The contents of Table 2 are based on a web search and are extended by review results of Irazoki et al. [181].

Table 2. Therapy software and functionalities: Excerpt of various software for cognitive therapy and training, including parts of Irazoki et al. [181]. (Note: Description based on information from distributors / websites; no guarantee of completeness; yes = available according to the distributor; - = no or no further information found)

Name	Description	Game/ Gamification (full / partly)	Complementary Home / Remote training	Mobile devices
RehaCom [162]	Modular cognitive therapy with targeted training, usable for all phases of rehabilitation	yes (partly)	yes	partly
CogniPlus [337]	Training set for cognitive functions with linking of diagnosis, training and evaluation	-	-	-
Fresh Minder [128]	Training using different exercises to address a wide range of mental skills for all ages	-	yes	yes
Cogpack [245]	Cognitive training with different exercise programs and task variations	-	yes	-
MyBrain-Training [269]	Online based cognitive training for clinic and teletherapy for different fields of application	yes	yes	yes
Rehability [308]	Game based tele-rehabilitation with cognitive and physical games	yes	yes	yes
HeadApp [172]	Various therapy modules for use in different phases of rehabilitation	yes (partly)	yes	yes
Cogmed [76]	Cognitive training with integrated reward-based incentive system to motivate users	yes	yes	yes
KoCo [218]	Cognitive training for different skills with games implemented in an appropriate way for adults	yes (partly)	yes (practice or single)	-
Brainer [52]	Cognitive training with various exercises and presentation of results	-	yes	yes
Captain's Log MindPower Builder [53]	Cognitive training with the preparation of a training plan and games	yes	yes	-
CogniFit [77]	Cognitive training with different exercises, games and result presentation	yes	yes	yes

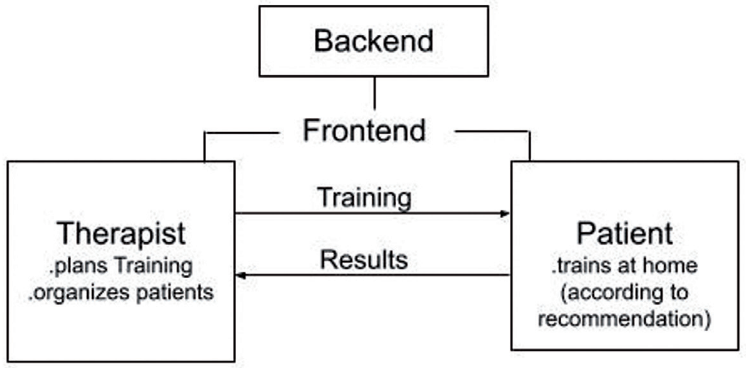


Figure 1. Exemplary structure for training software with connected use of therapist and patient area, also described as gamified version by Jung et al. [196] or Oliver et al. [278]

The software included can be used on the computer, some of them web-based and / or mobile. Most of them can be individualized in the tasks and present the results.
Among other things, everyday situations are used for skills training (e.g., Rehacom [162], Rehability [308], Cogniplus [337]). In this way, training environments are used that are both familiar to the patients and illustrate the use and relevance for the tasks to be trained.

2.2.1 Software Development

In the implementation of the software, different usage scenarios with different focus can be considered: 1) use on computers / hardware in inpatient or outpatient therapy on hardware of the facility/therapist, 2) independent conduction at home as a complement to therapy based on supervision by therapists, 3) independent training with optional therapeutic supervision. Offered software can address one or more usage scenarios.

In independent use linked to therapy, as in scenario 2, the training is supervised and managed by therapists and often used in combination with patient and therapist accounts. As described in Rehability's Hometraining process [308], a connection to the clinic's / therapist's system enables direct data exchange. Web-based telerehabilitation uses a cloud- or server-based architecture for this purpose, for example [379]. In the backend, system data and databases are provided. In the web frontend, the structure of the software, such as in the 'Cogmed' [76] or 'MyBrainTraining' [269], can be divided into two sections, one for patients and one for therapists. An exemplary schematic structure is shown in Figure 1. The areas enable different functions:

- Administration area for therapists: This area allows therapists to create and organize patients, e.g., create individual training plans, times or difficulties, define functions for training monitoring or view results and statistics
- Training area for patients: Personal training interface for the patient, accessible through personal login data. Here, training sessions assigned by the therapist or other training sessions can be accessed. In some cases, results are displayed and/ or transmitted to the supervising therapist to whose account the patient's training is linked.

Jung et al. propose a web-based ubiquitous gamification framework as an extension of this system [196]. This demonstrates the personalization via a rehab central server based on data and behavior of the patients and connection through web-services, whereby challengeable levels can be provided. Patients can give input via a Local Rehab Hub connected to the central server via control devices and receive feedback/rewards as output. In smart home systems, Bennett et al. describe the central hub as a key component in telerehabilitation systems for collecting, distributing, and making decisions in the processing of data [40]. In cloud-based solutions, they point out the problem of higher latencies when time-critical decisions are required. Different devices or sensors can be connected.
For decentralized processing, in physical rehabilitation, Calvaresi et al. propose a decentralized multi-agent architecture [63]. They enable autonomous coordination and planning with data between each other in real time. In this context, sensors are regarded as autonomous agents.

Dynamic adjustments can allow for automated alignment to the user's needs and abilities in difficulty and level, among other things [269]. However, according to Perry et al., the best approach is a balance between dynamic adjustment generated by the system and manual adjustment generated by the therapist [294].

However, medical support is not only screen-based, but also supported by objects networked in software. Technologies from the Internet of Things (IoT) are also being used with a special focus in the healthcare sector, which is described by the Internet of Medical Things (IoMT). A typical use case is monitoring based on biomedical data collected by sensors [393]. The data of patients at home can be collected, sent to a central server and monitored remotely or cloud-based from the clinic, for example.

To enable this in cognitive telerehabilitation, Oliver et al. describe the extension of the patient application by sensor systems for stress detection, motion capturing or haptic stimulus [278]. They add a viewer that allows the therapist to monitor videos recorded during training and stored in the cloud.

The server connection to the training thus enables the implementation of mobile and smart systems.

2.3 Motivation and Gamification (in Rehabilitation)

2.3.1 Motivation - Fundamentals and Rehabilitation
2.3.2 Gamification and Tailoring
2.3.3 Motivation and Gamified Software-Based Training in Rehabilitation

2.3.1 Motivation - Fundamentals and Rehabilitation

In the process of motivation and behavior, various approaches and theories exist in psychology, which consider the reasons, goals and criteria. According to the principles of Epikur, actions have a hedonistic basis and aim to achieve positive states and prevent negative ones [199, 281, 320]. According to the basic model of 'classical' motivation psychology by Rheinberg, motivation is influenced by both the motives of a person and the potential incentives in a situation [311]. A person's behavior results from the resulting motivation.

Motives describe characteristics of a situation for the expected achieving or failing to achieve a goal [111]. Sociogenic motives include, for example, the achievement motive, the affiliation motive, the power motive, or the curiosity motive. The needs expressed in the motives can be stimulated by incentives. Based on the expectation-value principle, the action option that is subjectively expected to have the highest value is selected. According to Rheinberg, motivation can be addressed, for example, by 'pressure' (drive stimulus/lack) or 'pull' (satisfaction possibility/goal) [311]. The Rubicon model of action phases describes the development of desires through to realization in the four phases of consideration (1), concrete planning (2), execution (3) and evaluation (4) [1]. Thereby the first and fourth phase are based on motivation and the second and third on volition (determined by the will). Volitionally chosen actions contain as characteristics of motivated actions the possibility of choice between action alternatives, possibility of latency, variability of intensity, as well as duration over a certain period of time [320].

According to goal-setting theory, human behavior is influenced by individual goals [227, 233]. Assuming that the appropriate skills are available, performance is related to the difficulty of the goal and goal commitment, whereby specific goals have a positive influence on performance [227]. Latham and Locke state that both the setting of distant goals or an overarching vision and near and concrete goals are relevant [227].

McClelland distinguishes between implicit and self-attributed/explicit motives in motivation [249]. Implicit motives are affectively controlled and can maintain behavior over a longer period of time, e.g., through perceived pleasure. Self-attributed motives are based on cognitively developed constructions. They represent a self-generated image and can deviate from the motives that actually underlie the action [349]. Discrepancies between the two can lead to motivational conflicts and a high level of self-regulation required. Based on research findings in the area of physical activity, a five-week rehabilitation program showed that implicit attitudes increased, were

associated with post-rehabilitation behavior, and should be targeted in the future [72]. Rawolle et al. found no correlation of personal goals commitments with implicit motives, but a substantial positive correlation of personal goals with self-attributed motives [306].
In the development of motivation, a distinction can also be made between extrinsic and intrinsic motivation. Extrinsic motivation arises from an external incentive that reinforces a behavior [21, 320]. This can be, for example, a reward given by others or oneself. Intrinsic motivation arises from the enjoyment of an activity itself [22]. Emotions can thus be an important basis for developing motivation. Thus, motivation can arise both from goal orientation, but also from enjoyment of an action, which is felt in the action itself, on the way to a goal, or when the goal is reached [320]. Therefore, it is assumed that emotions and motivation are closely linked.

Deci and Ryan's Self-Determination Theory [88, 321] is a relevant basis for considering behavior in the health sector [192] and is based on three basic principles for the development of intrinsic motivation: perceived competence (useful skills and the opportunity to use them effectively), relatedness (connectedness / belonging between others and oneself) and autonomy (determine one's behavior / voluntariness). In cognitive behavioral therapy, Dwyer et al. show in anxious and depressed patients that higher satisfaction of autonomy is associated with better outcomes in therapy [112].

The meaning of events and the development of perceived meaningfulness are important aspects for the development of intrinsic motivation [322]. However, it should be taken into account that an existing intrinsic motivation can be weakened by extrinsic reinforcement, which is referred to as the overjustification effect or crowding effect [110]. This is also pointed out by Schmidt-Kraepelin et al. in their review for the use of gamification for health behavior change [334].
Such an effect can occur, for example, through tangible expected rewards associated to the task (e.g., material gifts or symbolic awards on paper) [87, 271]. However, a negative influence by verbal, unexpected or task-independent rewards has not emerged. A subsequent absence of extrinsic reinforcement can lead to a negative effect and absence or decrease in comparison to the previous behavior [110, 334]. Therefore, instead of using rewards as an incentive, the development of intrinsic motivation can be supported instead [87].

Motivation in Rehabilitation

According to Nübling et al., patient motivation is a relevant aspect of therapy [276]. Therapy motivation describes an active cooperative behavior of the patient directed towards a certain goal, compliance describes the adherence to the instructions in the therapy. Approximately half of the patients in the rehabilitative setting show a lack of perseverance. They differentiate different motivational factors in motivation: 'Experience of illness', 'General expectations of and attitudes towards therapy', 'Consequence expectations' 'Attribution of causes', 'Experience of competence' and 'External influences' [276].
A basis of motivation in rehabilitation is the need for change of the current state, whereby empathy with the patient, strengthening the patient's sense of self-efficacy and setting and continuously specifying the patient's own goals are relevant in the course of rehabilitation [190]. Goals should not be too high and should be adapted to the patient [417].
How et al. also show that setting personal goals is relevant [178]. Furthermore, they point to a required meaningfulness and that every small success should be positively acknowledged, as development involves both progress and regression. However, they also point out that supporting motivation is not just rewarding success, but technological support involves empathy for the patient's developmental journey.
Yoshida et al. show that patient motivation in the clinic is primarily based on extrinsic factors such as personal factors (Patients' Goals, Experiences of Success and Failure, Physical Condition and Cognitive Function, Resilience) and social relationship factors (Influence of Rehabilitation Professionals, Relationships Between Patients, Patients' Supporters) [417]. However, there was no focus on intrinsic motivation such as enjoyment in therapy. Comprehensively, high motivation is associated with increased activity.
The health belief model describes a person's preventive health behavior, which is influenced by the perceived threat and the level of expectation of the preventive method [109]. According to the trans-theoretical model, motivation changes in different phases during the course of rehabilitation: 1. intentionlessness / precontemplation (being at the mercy of others and experiencing low self-efficacy), 2. intention formation / contemplation (understanding the personal efficacy), 3. action / cooperation, 4. maintenance and termination [75, 190, 300]. According to Nübling et al. questionnaires do exist, but motivational diagnostics are neither adequately carried out nor included in the therapy [276]. Eysenbach suggests several possible reasons for dropouts in eHealth studies, such as lack of push factor (e.g., reminders and resulting sense of obligation), lack of positive feedback/encouragement or personal contact, positive/negative sense of community, barriers to entry, ease to drop out, and usability/interface problems [120]. A three-phase drop-out model is proposed by Eysenbach in which users first perform the task out of curiosity, followed by a high drop out rate, and finally the highly motivated users remain.

2.3.2 Gamification and Tailoring

The term 'Gamification' was coined by Nick Pelling in 2002, as he states [291]. According to Deterding's definition, gamification is the use of elements of games in different, non-game contexts [97]. Inspired by games, motivation and commitment are to be addressed [219]. To include the academic and practitioner perspective, Werbach describes gamification as a process that approximates activities to games [406]. It is pointed out that the mere use of individual elements, such as points in school, does not constitute gamification. Within the process, the aspects of the game can be deepened instead. Huotari and Hamari extend the process to support the creation of value and the user's experience in a service while creating a gameful experience [180]. The focus is not on the method or the element, but on the goal, and the results are psychological outcomes and emotions, and thus behavioral patterns. According to them, a gameful experience is based on the fact that it is, among other things, voluntary and intrinsically driven.
Landers et al. use the example of gamified learning to show that this is based on different theoretical principles, how game elements can be used to address these theories, and how different outcomes can be stimulated through the use of specific elements [225].
Kaptein et al. show that it can be beneficial for compliance to involve the user personally in the selection of strategies [201].
According to Tuah et al., the challenge for successful integration is to develop a balance of gameful experience, interaction, and design to create a game-like experience rather than just integrating individual elements [379].
In contrast to gamification, serious games are complete games which do not only use individual elements and which have a goal beyond the classic playful characteristics and fun of the game [97, 254, 359, 392], such as therapy [61]. However, the border between the two categories is blurred [193, 392]. Serious games can improve the effectiveness of conventional training, as has been shown, for example, in motor rehabilitation [366].
In a review, Krath et al. highlight the various theories on the effects of gamification and how it addresses motivation, behavior and learning [221]. From this, they derive different ways in which gamification works, e.g., relevant or individual goals, feedback, positive reinforcement, adaption, simplification or social aspects.

Elements

According to Bostan and Marsh, there is a wide range of interaction possibilities in games: with the system (objects, second self, environment), with other users (players, virtual agents or communities, social groups) or with the content (participatory design, interactive storytelling) [49]. For the implementation of gamification, different elements can be used and clustered into e.g., categories, mechanics or goals [372, 407]. For example, in the Octalysis Framework, Chou shows the subdivision of eight Core Drives (e.g., epic meaning or social influence) which are addressed by associated subordinate elements (e.g., narrative or mentorship) [73]. According to Robson et al., mechanics are created by designers, the behavior of the players within the mechanics is reflected in the dynamics, and emotions are generated by the influence of both aspects [313].

To address motivation, Sailer et al. propose the following system, according to which different aspects can be linked to the use of gamification from different perspectives of motivation research [325]:

1. Trait (achievement (achievement, success and progress), power (status, control and competition), affiliation (membership), e.g., badges, leaderboards),
2. Behaviorist learning (immediate feedback (positive/negative reinforcement), rewards, e.g., points),
3. Cognitive (clear and achievable goals and resulting consequences, relevance of personal action, gamification supports achievement of goals, e.g., badges, progress bars /performance graphs, quests),
4. Self-determination (competence, autonomy, social relatedness, e.g., badges, leaderboards, meaningful stories, avatars / profile development)
5. Interest (situational context, flow by feedback, goal and adequate difficulty, e.g., points, badges, progress bars / performance graphs, quests, meaningful stories, avatars / profile development),
6. Emotion (negative/positive feelings, e.g., meaningful stories).

According to Muangsrinoon and Boonbrahm, leaderboards, levels and points are used particularly frequently in gamification research [264]. According to McGonigal a differentiation can be made between extrinsic gamification elements (points, levels, leaderboards, achievements, badges) and intrinsic reward oriented gameful design (positive emotions, relationships, meaning, accomplishments) [250]. According to Nicholson, external rewards (BLAP Gamification (Badges, Levels / Leaderboards, Achievements, and Points [272])) may be appropriate for onboarding, lack of or inability to develop intrinsic motivation, or short-term engagement [271]. For interaction with virtual rewards, communication and goal setting are relevant aspects [154]. Virtual rewards can trigger pleasure, achievement and pride or set alternative goals [154]. However, Ha et al. also point to problems such as lack of alignment with personal health goals, novelty effects, and poor design [154]. In the use of fitness trackers, they show that a large proportion of users do not share rewards because tracking is a personal matter. They are valuable to the user when they are challenging to achieve or validate the effort made. They suggest a meaningful implementation of virtual rewards, such as the integration of health-related information or personalization to the user.

Nicholson points out that gamification should be meaningful and rewarding for the user even without external rewards. To create a reward that is not external but meaningful for the user, elements adapted to the type of user are suggested [272]. For this, the inclusion of the user's goals is relevant. Therefore, instead of using rewards as an incentive, the development of intrinsic motivation can be supported instead [87].

According to Nicholson, meaningful elements that provide intrinsic motivation (e.g., play, exposure, choice, information, engagement, reflection) should be used to develop long-term motivation [271]. This is particularly relevant when intrinsic motivation already exists, as it can otherwise be replaced by extrinsic motivation [89]. The development of meaningful gamification should be user-centered, should focus on play rather than scoring elements, and should be tailorable to the different needs of the users [271, 272]. According to Yang and Chen, gamification and game elements should support the perception and value, which support motivation and promotes the intended goal behavior [414]. Gamification, however, also requires the integration of an end to strive for changes in long-term and to promote interaction with the real world and release them into it [271].

Effects on Motivation

For the motivation and effects of gamification, different aspects, such as behavior or perceived emotions, can be considered [239, 323, 329, 379]. Various effects and interrelationships can be observed, as the following examples show.
Groening and Binnewies show, based on cognitive tasks, that achievements can increase performance and only partially increase motivation (persistance, but not enjoyment and self-reports) [152]. For effectiveness, they recommend high difficulty and low quantity. In comparison to goal setting, they indicate a higher increase in performance for achievements.
According to Mazarakis and Bräuer, using the example of how many quiz questions were answered, it is shown that the use of individual gamification elements supports motivation, but is particularly increased in a combination of feedback with progressibility [247]. Darzi et al. show for the perceived enjoyment in affective games among others the relation to current speed (of the example games), learning goal and in-game score [83]. Ryan et al. show the connection of Self-Determination Theory to emotions perceived in the game [323]. Thus, based on the consideration of short-term effects in pre- and post-tests, perceived competence, autonomy, and social relatedness are independently related to perceived enjoyment and future game play. Van Roy and Zamen point to the addressing of the Self-Determination Theory through the integration of gamification elements, such as for autonomy through meaningful options or feedback, competence through achievable goals [318], and relatedness through social interactions. These aspects will be taken up within this work. According to Werbach and Hunter, individual elements can also be assigned to the three components, e.g., achievements and points to competence or level and quest to all three [407].

De Vries et al. show that high intrinsic motivation also results from different mechanics [100]. Relevant was among others visual and positive feedback to increase drive to perform and variance e.g., to stay focused. For elderly people, they point out the relevance to adjustments, e.g., in the speed of the game.
Sailer et al. show that badges, leaderboards, and performance graphs affect competence and task meaningfulness, while avatars, meaningful stories, and teammates affect social relatedness, suggesting that gamification is not generally effective, but that different elements have different effects [325, 326]. Hallifax et al. also show that there are different effects on motivation depending on the type of implementation of an element [156].

According to Bostan and Marsh, individual actions can be based on several needs, combine them or contradict each other [49]. Sailer et al. point out that while individual elements may be linked to different effects, their combination can lead to complex and varying motivational effects [325]. According to Pereira, gamification is a process and interaction of, among others, several mechanics to get an effective solution, so it can be more useful to combine several elements instead of using a single one [292].

Negative Effects on Motivation

When considering e-learning, Rapti points out that gamification can generate a variety of emotions, both positive and negative, such as disappointment or sorrow [304]. Vermeir et al. point out, among other things, possible distractions [392]. Bräuer and Mazarakis show that the use of gamification can also have negative side effects, such as reduced perception of competence or social relatedness in the use of leaderboards [54]. However, in the context of Self-Determination Theory [321], both are the basis for the emergence of intrinsic motivation. In health behavior change, Schmidt-Kraepelin et al. analyze five categories with different emerging side effects, which can for instance adversely affect motivation or weaken morale [334].
In addition, Bräuer and Mazarakis point to different effects of the elements between perceived emotions and performance [54].
In a comparison, Boendermaker et al. find indicators that gamified training is less easy to use than non-gamified training [44]. Lopez and Tucker point out a possibly negative impact of a main task on performance through

the implementation of an indirect task such as game features [234].
Kaptein et al. point out that the integration of multiple strategies can also be a disadvantage compared to an appropriate strategy [201].

Other works point out that in addition to addressing positive aspects, the use of gamification should also include the avoidance of negative effects [199, 281, 320].

Tailoring Gamification

Not only the individualization of cognitive training programs [79], but also that of gamification [158, 215, 290, 294, 309, 388] is relevant to support users and achieve the intended effect [373]. According to Hamari et al, the effect of gamification is highly linked to the user [160]. In the use of gamification, the higher suitability of tailored systems, rather than a one-size-fits-all approach, is pointed out [79, 234]. In the adaptivity of systems, different levels between partially adaptive and fully adaptive are used according to Böckle et al. [43].

According to Klock et al., tailoring most frequently involves user models and associated game elements, personalization (individual tailoring of content by the system within the use model), adaptation (individualized interaction within a context), and individualized recommendations [215]. They refer to automated personalization, not customization chosen by users themselves. According to them, frequently considered aspects of the user profile as a basis for tailored gamification are player preferences, gender, and personality traits. Factors such as these, including, for example, context [43, 156, 160, 388], user type [372], age [243] or gender [215], may influence perception, impact and/or preferences.
For motivation, Klock et al. also describe a different view of goal orientation in connection with game elements and a focus on mastery or performance [215].
Altmeyer proposes a framework for the selection of gamification elements based on personal factors and the context with the corresponding needs [12]. Utomo and Santoso propose to tailor based on performance/activities [385]. Using the example of student learners, they suggest encouragement in activities for low scorers and the possibility for high scorers to offer personal social support. It is shown that different determinants and game elements are perceived differently by users with different character-derived user types [281, 372].
There are various examples and further developments for taxonomies, approaches and models and their use. Malone has identified several categories of motivation in games (challenge, fantasy, and curiosity) and developed the theory of intrinsically motivating instruction [241]. Bartle defined a model for types of players based on their behavior and what they enjoy [34]. Yee et al. created a typology for players in massively multiplayer online role-playing games [415]. The 'BrainHex' by Nacke et al. connects playing preferences in games with neurobiological insights to define user types [266]. Tondello et al. address in their model the problem that players can have different traits and record the preferences in a player profile [371]. Upshall points out in his work that gamification should be developed based on the psychological needs of users. The work also shows pairs for combining elements derived from user suggestions, such as Avatar and Adaptability [384].
For the design of gamification, Marczewski defines in the 'Player and User Types Hexad' a framework which includes six types with different motivational aspects: philanthropist (meaning and purpose / altruism), free spirit (autonomy and self-expression), achiever (mastery / competence), socialiser (relatedness), player (rewards), and disruptor (change) [244, 371, 372, 374]. However, the percentage distribution of the types is not equal [374]. In addition, the proportion of philanthropists increases with age, whereas the proportion of players decreases [243].
Tondello and Nacke show within the example of an image tagging task a relation of the hexad user type and the self-selected game elements [373]. However, the subsequent evaluation deviates from this, so they suspect further influencing factors. They also show that personalized gamification results in higher performance in terms of the number of images and higher experience than in the generic system.

However, Klock et al. point out that there is a lack of recommendations for tailoring game elements for older people (over 30) [215]. Studies on the Player and User Types Hexad have shown that the percentage of philantropists increases with age [12, 243]. In a study by Altmeyer et al., collaboration and virtual characters were rated positively by older people, customization and progress bars in the middle range, and points, badges and competition negatively [12].
Altmeyer et al. have developed gameful applications through which the types in the Player and User Types Hexad can be analyzed by a selection system or interaction with the elements instead of by a questionnaire [16]. Preferences in categories of game elements can be assigned to the individual types [215, 372, 374]. Lopez and Tucker show, using the example of physical activity with a Kinect, that the use of reward-customization strategies results in different performance of the user types in this system [234].
Santos et al. show that the user type is dynamic and can change in primary and subscales over the course of six months, thus no static assignment should be used in the implementation, but continuous adjustment is relevant [328].
According to Hallifax et al., the Player and User Types Hexad is best suited for tailoring gamification [156]. In the Hexad model, Lopez and Tucker show that gamification adapted to the user's type leads to higher performance, while unsuitable gamification leads to lower performance [234].
In the example of youth mental healthcare in eHealth, van Dooren points out the relevance of involving stakeholders in the development process for tailoring [388]. Among other things, they also point out the possibility of using the ‚Player and User Types Hexad' [244]. Further, they point out the relevance of the possibility to set goals and the adaptation to the context of use [388].
Furthermore, effects and results are dependent on the context in which gamification is used [156, 160, 325, 388], also in rehabilitation [301]. Hallifax et al. also point out that it is not sufficient to consider the dominant user type, but to consider the player profile as a combination of the types [156]. In the use of the elements they point out badges and schedules as suitable for all types. Progress elements appear to be more motivating to them, whereas socializing elements are perceived as less motivating (with the exception of the socialiser type). Lentferink et al. point out that even if it is viewed rather negatively, it is more likely to be accepted through friends or family [230].
In a review, Hallifax et al. point out the different results in duration: long term studies show mixed results more often than short term studies. They suspect a weakening of the novelty effect as reason [155]. They assume the emergence of mixed results in use is due to the complexity of learner preferences and point to the need for better adjustment to learner profiles, as well as dynamic tailoring. Lavoué et al. differentiate in terms of motivation between achievement-oriented engagement for high achiever or initially intrinsically motivated and for low achievers with perfection-oriented engagement [229]. To enable dynamic tailoring, they point out the relevance of tracking different factors of engaged behavior due to the different engagement and purpose of gamification. In another work by Hallifax et al., in the application for learners, they show a positive effect on motivation and engaged behavior in tailoring by learner model and initial motivation. Furthermore, they show that in comparison to individual tailoring, tailoring to both user type and motivation profiles can increase intrinsic motivation [158].
Loria et al. show with the use of the PEAS framework a possibility to use the behavior within the game and to enable adaptation, consideration of the effect and dynamic handling [235].

Studies show various applications for the use of tailored gamification, such as:
Zhao et al. use a fitness recommender system for permanent use, which provides dynamic personalized recommendations and gamified content [418]. They show long-term positive effects for gamification and personalization on increasing user motivation.
Altmeyer et al. use a booking system for fitness courses and integrate different game elements (activity points, level, badges, social competition / leaderboard) and relate the users to the ‚Player and User Types Hexad'. [15].

They show that users book more when they receive elements that are suitable for their type than without or with unsuitable gamification. This indicates the effect of tailored gamification.

Passalacqua et al. implemented gamification in a warehouse management setting. They mapped users to the Player and User Types Hexad, compared performance time and errors, and found that the effect of personalized gamification was higher than non-personalized gamification [290].

Behavior Change

Beyond the effect during use, gamification is an effective strategy to support behavioral changes, for which, to address e.g., healthy living, different strategies such as goalsetting, feedback, reinforcements/rewards, progress or social elements are implemented [82, 283]. Hervas et al. propose a taxonomy for the application of gamification for behavior change [173]. They assign different gamification elements to different mechanic categories (goals, status, randomness, appointment, scoring, immersion) as subcategories.
Further, the relevance of tailoring persuasive strategies to the user is shown: in the big five personality model, e.g., competition is suitable for open people, goal setting and suggestion for conscientious people, many different elements for extraversion, but none for neuroticism [283]. For physical activity, Adams et al. show that user-adapted goals lead to significantly higher performance relative to the baseline [3].
For the Player and User Types Hexad, the different tendencies and influenceability of the different character types are confirmed: while socialisers are addressed by all strategies included, achievers are not addressed by any of them in the work of Orji et al. [284]. Altmeyer et al. confirm the influenceability in physical activity, but found differences in the addressability of the types [14].

Physical Gamification

Gamification is primarily used as a digital construct based entirely on software, but it can also be translated into physical elements.
Degraen et al. transfer gamification elements to a Japanese mini garden [92]. Points and progress are represented by water elements and badges and unlockables by nature elements. In terms of persuasiveness, however, the implementation was not perceived to be better than the digital version. In the evaluation, a digital gamified version was preferred, with reasons given including greater accuracy, simplicity and ubiquitous availability. Reasons for choosing the garden included its physical implementation, aesthetics, and relaxing effect.
Altmeyer et al. developed a physical prototype in which points and leaderboard are represented by marbles [13]. They use the riding of a stationary bicycle as a basic task and showed a higher persuasiveness and meaningfulness of the physical implementation than in the digital presentation of the elements when gamification was added in comparison.

2.3.3 Motivation and Gamified Software-Based Training in Rehabilitation

Application, Advantages and Challenges

Maintaining motivation and engagement over time is a core challenge in rehabilitation according to Perry et al. [294]. Due to the different causes, the development of motivation and varies a lot between different people, which should also be taken into account in the offer of games in rehabilitation. They point out that if motivation is not maintained, rehabilitation will fail due to insufficient training.

An advantage of games in therapy is motivational support [294]. Games can be a successful therapeutic tool [32]. Health gamification, according to Johnson et al., aims to support specific experience and behavior [192]. They describe the combination of persuasive technologies (addressing behavior), serious games (supporting intrinsic motivation) and personal informatics (individual behavior: integration and tracking). In the health sector, three categories are usually differentiated for the use of gamification: physical health, cognitive and well-being [234].

Various goals can be addressed through the use of gamification, such as behavioral change or motivation [192, 282]. However, Boendermaker et al. point out that the use of gamification targets the motivation to train, which is different from the motivation to change [47]. De la Hera Conde-Pumpido differentiates here between different persuasive strategies [94]. In contrast to exocentric persuasive goals, which seek to change attitudes outside of play, endocentric ones support continuing play [94], which is in line with the conduct of the training.

Hung et al. identified advantages and disadvantages of in-clinic and home training and the use of gamification [178]. Stroke patients see advantages of in-clinic delivery in e.g., detailed therapists' instructions and better facility modalities, whereas advantages of home-based training are, e.g., flexible schedule and more comfortable. However, home-based training can also be less motivating and less focused and lead to neglect training. They perceive the use of game-based rehabilitation training as novel and fun and more effective, but criticize the limited choice on games in the conducted training version and that it is easy to get bored. They would like additional and more games, customized for home rehabilitation and that they are more related to real life.

In eHealth, according to Sardi et al., gamification is often studied in chronic disease management / rehabilitation [329]. According to Tuah et al., gamification is mostly considered in physical rehabilitation, customization, outcomes (motivation/engagement, individual behavior and health outcomes) and integration of external devices. Proposed solutions are frequently considered in research on gamification in eHealth, but a lack of empirical evaluation is apparent [379]. According to Klock et al., tailored gamification is the third most frequently studied area in health after education and generic, but only accounts for 7.1% in their review [215].

Frequently used in cognitive rehabilitation are serious-game based and web-based applications [379]. According to Lumsden et al., the reasons for the use in cognitive training are an increase in motivation, usability/ intuitiveness, long-term engagement, suitability for the target disorder and ecological validity to investigate the effects and brain stimulation [239]. Advantages of using gamification in eHealth include maintaining engagement, addressing extrinsic and intrinsic motivation, supporting fun, enjoyment and comprehension, and healthy behavior and behavior change [329]. Gamification is also used to reduce the drop-out rate [239, 388]. Gerling et al. point to potentials for older people, but also the challenges of the target group's lack of game experience and the need to complement daily tasks with entertaining and meaningful tasks for long-term engagement [146]. Low complexity solutions should be offered to enable use despite cognitive or physical limitations [145]. For use in training, it is challenging to go beyond initial motivation to address and maintain motivation over the longer term for the long duration of rehabilitation [47, 379], for which appropriate mechanisms should be included [329]. In addition to generating motivation, adjustments may be needed to maintain it, also user customization is lacking and rewards may sometimes be considered as irrelevant [329].

For patients, important selection criteria when choosing games in rehabilitation include intuitive use and that they are recommended by therapists [178]. Perry et al. point out the specific principles for using games for elderly and stroke patients, such as that they are often unable to see or understand complicated text and instructions, and when elderly people are not familiar with games, games should incorporate familiar content from daily life, and further that collaborative rather than competitive approaches should be preferred [294].

Table 3. Description of an excerpt of gamification elements relevant in rehabilitation

Element	Description	Example of use in Rehabilitation
Rewards	Rewards are benefits obtained through actions [234], e.g., Polak et al. give points for correct results in the interaction with objects [298]	RehaCom (Working Memory) [167]
Level	Levels indicate progress [215 234, 263] and intermediate goals [392] and include progressively increasing levels of difficulty [379] and visualization of progress [215]. Adjusting the difficulty in levels addresses both performance and motivation in rehabilitation [294].	RehaCom [162], Cogmed [76]
Feedback (loops)	Feedback provides the user with relevant information and can also be described as self-monitoring or a game state overview [215]. It enables the user to draw conclusions about e.g., personal performance [379] and encourages them to observe the personal behavior and outcomes [82]. It enables the adjustment of personal behavior through the information received [392]. Feedback can be given as a direct reaction to a behavior or as an overview afterwards, as in the interface, by digital characters or therapists [379]. The presentation of feedback on the training, e.g., based on graphs, is relevant both for the patient for information and support and for the therapist for therapy planning and patient assistance [361]. It should always have a meaning for the patient [361].	RehaCom [162]
Progression	Progression highlights the current situation and the progress in a task [379, 392]. It allows the user to adapt his behavior so that the progress can be enhanced [379]. Progress can be represented in different ways, such as progress bars [329] or progressing in increasing levels and/or difficulties [379].	City Builder Game [45], HeadApp [172]
Theme / Narrative / Story	Themes are real or fictional [372]. Stories / Themes can address the interests of patients, but also the learning from real world [379]. Themes are often combined with other elements, but can also be applied individually [409]. Stories allow the user to participate [372].	Meister Cody [253]
Points	Points can be awarded as a reward [372, 379]. They can be collected and used for other goals [379].	HeadApp [172]
Socialization	Socialization describes the possibility of direct or indirect interaction with other individuals. There is a wide range of possibilities, such as the use of comparisons, e.g., through leaderboards, communication, e.g., via direct messages, or the integration of social media [329]. It enables social influence [82].	City Builder Game [45], Cogmed [76]

However, using the example of attention training, Navarro et al. show that competition can increase effectiveness and enjoyment without increasing pressure [267]. Competition is, however, less suitable for older adults [258].

Furthermore, Perry et al. suggest using aspects such as appropriate challenge (motor and cognitive), simple interfaces, social elements, new learnings, promotion of cognitive skills and consideration of limitations such as slowed reactions [294]. In the process, they should be geared towards the development of intrinsic motivation.

For example, Boendermaker et al. warn that the term 'game' should be used with caution, as the perceived fun of training integration may not match the fun of an entertainment game, leading to disappointment and/or demotivation [47], which is also mentioned by Schmidt-Kraepelin et al. [334]. Similarly, the findings of Wiley et al. point to the emergence of disappointment created by the integration of a story into a task and the labeling and expectation of a game [409].
In another work, Boendermaker et al. suggest using elements for fun to support the maintenance of motivation rather than to generate it [44]. They also note that there is a risk that with longer-term training and decreasing fun, motivation could also drop below the level that would exist if no additional gamification elements were used [47]. In addition, it should be considered which elements can be used in a supportive manner and which ones should not be used in order to prevent a decrease in task performance. According to Sardi et al., when gamification or games are integrated, there is also a risk that training will be perceived less seriously, against which highlighting the effectiveness of training in medical use can be helpful [329].

Elements

For the depth of the implementation of game approaches, Boendermaker et al. describe six stages starting from the basic training task, ranging from extrinsic and intrinsic motivators to the development of a game shell to a complete game development [47]. According to Johnson et al. the integration of gamification into existing health systems offers an opportunity for faster and more cost-saving software developments as compared to serious games for health [192]. The integration of elements into existing training tasks is also termed 'game-up' [211]. Kapp et al. distinguish between structural gamification, the adaptation of structures outside the content such as points for completing a task, and content gamification, the adaptation of content for a game-like feeling such as a story [199]. They point out that instead of single uses, their combination has the most impact.

Gamification elements may have specific requirements for rehabilitation [60]. Burke et al. point out that the goal should be to encourage and reward engagement [60]. Thus, as described also by Jung et al., mistakes should not lead to game over and demotivation due to the missing skills as in a classic game, but to a positive reinforcement for the conduct of the rehabilitation [196]. Burke et al. also describe, in addition to common rewards, the possibility of rewarding rehabilitation-typical aspects such as playtime [60].
In behavioral therapy, even before the development of software-based gamification systems, physical tokens were used as elements for operant conditioning to a desired behavior [350]. In rehabilitation, rewards should be given when the patient has made an effort, rather than when a goal is reached [32]. Rewards are frequently used gamification elements in cognitive training, as well as feedback (loops) and story/themes [392].
However, Ferreira-Brito et al. point out that game elements for extrinsic motivation threaten adherence to interventions in the long run [123]. Intrinsic support, although more difficult to implement, has been shown to be better in the use of gamification, although the question is whether a combination of extrinsic and intrinsic approaches may be appropriate due to the different nature of the motivators [47]. Complementing intrinsic with extrinsic elements can be helpful in rehabilitation when the intrinsic elements cannot be adequately understood cognitively [32].

According to a review by Brown et al. in the area of common mental disorders and well-being, elements from the category 'Story/Theme' in web-based interventions are used particularly frequently [56]. Alexiou et al. show for serious games in learning that narrative and aesthetics have positive effects on flow and perceived learning [7].

Another relevant aspect is the possible need for assistance. Tran et al. demonstrate the assistance of an avatar within a serious game for performing movements in front of a screen [377].

For cognitive tasks, Wiley et al. confirmed the different effects of different elements in healthy participants [409]. Their work shows an increased reaction time but also error rate. However, this was not shown with the integration of a theme. In the perception, fun de-

creased from before to after the task. With the integration of a theme, fun was higher during the task in relation to the basic control task and lower after the task. With points, the effect was the opposite.
Considering the use of gamification in general in rehabilitation, Caliskan et al. show that quest, level, story, or points are often used, in descending order of importance [62]. Social elements or leaderboards, in contrast, are less used.

Tamayo-Serrano et al. point out in the implementation for stroke rehabilitation that in the consideration of motivational rewards, primarily points systems are used and approaches beyond that are very few [361]. In general consideration of rehabilitation, besides feedback, the frequent use of, among others, level, progression and leaderboards is pointed out [379]. Social interaction is a relevant motivational aspect in rehabilitation [361], but social elements are rarely used in cognitive training [392] and are less requested by users in eHealth and eCoaching interventions [230]. Social interaction can occur, for example, between player and player or between player and Non-Player Character (NPC) [49]. The description of these elements is shown in Table 3 with reference to practical examples. Relevant in the area of health is the addressing of various aspects such as meaningful interaction/play, purposeful goals [137, 237, 361], variety, appropriate challenges and difficulty [32], and visual feedback [206] on personal progress [230]. To address long-term goals and long-term motivation, gamification goals are often set over a series of trainings [239].

Burke et al. describe it as relevant for use in rehabilitation to integrate aspects of meaningful play and challenges [60]. To support the perception of meaningful play, feedback on individual actions, performance and progress and their relation to the larger context is relevant, as well as the setting of short and long term goals [32] and the advantages and disadvantages of personal actions [361]. Negative feedback is important to present, but it should be presented in an encouraging way so as not to demotivate [361].

Tuah et al. propose a grouping of elements into blocks based on the following techniques for rehabilitation [379]: Motivational Narratives, Goal-Oriented Tasks, Responsive Feedback, Rewards, Fantasy, Personalization, Personal Informatics, Visual Feedback, Iterative Feedback. According to Cugelman, different gamification strategies show different validated effects on behavior change [82].

Effects

Gamified cognitive training shows e.g., effects on perception like higher engagement/motivation, enjoyment, effort or higher demand/difficulty [45, 239, 256, 392], but also healthy behavior, possible behavioral changes [329] and adherence in therapy [361]. In use, according to Koivisto and Hamari in general [219] and Vermeir et al. in cognitive rehabilitation [392], there is a high degree of heterogeneity and mixed results, in addition to many positive ones.
In a review for the application of gamification for health and wellbeing, Johnson et al. indicate rather positive results in terms of health behavior and rather mixed results for cognitive outcomes [192]. Also, Lumsden et al. indicate a highly engaging effect for cognitive training, but mixed results in task performance [239]. Vermeir et al. report a lack of differences in cognitive performance due to gamification and a lack of significant correlation between the number of gamification elements and the number of training sessions on motivation/engagement. Here a deeper consideration of the reasons and effects is necessary [392].
Välimäki et al. found no significant difference in rehabilitation effect between 'Rehabilitation Gaming', 'Entertainment Gaming' and 'No Gamining' in people with traumatic brain injury [386]. Katz et al. indicate a lack of positive effects in performance when integrating various gamification elements and combinations after a three-day training session [205]. They point out that especially in the initial phase additional elements could be distracting. According to them, a balance should be found between avoiding elements that are distracting and implementing motivating elements.
Lumsden et al. also found no increase in performance when gamelike features (points, cowboy setting) were integrated into cognitive tests [239]. Despite having fun in a cowboy theme setting, participants instead showed decreased performance in behavior compared to the control task. At the same time, they indicate that the non-gamified version is perceived as more boring, less entertaining and less stimulating compared to the integration of game elements. Lumsden et al. suggest that points may be particularly appropriate for cognitive testing, because the data is not affected and engagement is still addressed [239].
Ninaus et al., in contrast, show that when game elements (progress bar, level indicator, and a thematic setting) are used in a working memory task, their integration leads to increased performance in higher scores and reaches closer to the maximum performance [275]. Similarly, Boendermaker et al. showed a longer training duration in a working memory training with added game elements [45]. Higher performance was also found by Mohammed et al. but a difference was only apparent starting on the fourth training session [256]. They also indicate that gamification may be beneficial only for longer interventions. However, they still point to a lack of difference in the training effect for higher performance.

Development

For the implementation of gamification, the weighing of costs and benefits is relevant [292]. Gamification can be added to existing software as a complementary element to the main task [256]. Besides increasing complexity in carrying out, Lopez and Tucker also point to increasing complexity in implementation, for which time and resources are needed for development [234]. Van Dooren questions how high the personalization can be while maintaining a balance between cost and effect [388]. Lopez and Tucker propose a compromise between development and impact on motivation and, for this purpose, a method for the selection of elements based on evaluation of the complexity of the implementation in physically-interactive gamified applications.

In the development it is relevant to know the needs of the patients to be able to apply appropriate game elements for motivation [379]. However, it requires guidance in the development of gamification for rehabilitation [379].
According to Calvaresi et al., games for rehabilitation include professional expertise and motivational aspects for rehabilitation and therefore include more complex variables in the development than normal games [63]. Furthermore, they need to address aspects such as compliance and progress in rehabilitation. For the design of cognitive training games for older people, Lu et al. propose principles such as multisensory implementation, closeness to daily life, different tasks and exercises, integration of feedback, and the involvement of users and stakeholders [235].
Van de Weijer et al. propose various factors as a basis for the development of gamified cognitive training, using the example of Parkinson's disease, as for the gameplay (e.g., increasing complexity in levels, (long-term) goals, clear interfaces, personalization to needs in real-time, dynamic adjustment of the difficulty, fun factors, integration of positive feedback and avoidance of negative feedback), the development (e.g., Integration of validated (motivation) theories), the procedure (e.g., Guidance, cross-platform availability, or the methodology (e.g., comparisons, measurements, feasibility, adherence) [387].

Khaleghi et al. propose a framework for developing cognitive assessment and cognitive training [211]. It includes typical user-centered design and development steps such as user analysis, idea development, and implementation, but also the analysis of appropriate implementation options for the context and techniques such as game-up and mapping. They point to the relevance of subsequent monitoring to identify potential adaptations to maintain intrinsic motivation for long-term use.
Shapi'i et al. propose a framework for designing games for cognitive rehabilitation [339]. This involves tailoring tools for the therapist for the game characteristics and rehabilitation objectives. The adjusted games are provided to the patient individually. In the use, a game cycle is created to support engagement and cognitive and affective outcomes. Outcomes

can be used for monitoring and readjustment. Afyouni et al. present a framework through which, based on different input modalities, a serious game can be adapted to hand rehabilitation [4].
Tuah et al. propose a classification of gamification in rehabilitation that includes the domains of physiotherapy, neurology, and psychology, as well as gamification techniques and commonly used elements [379]. When using gamification in rehabilitation, they point out that the connection to the rehabilitation process and procedure, as well as the requirements and effectiveness, have to be considered [379]. Lau and Agius propose a framework in the development of serious games for mild cognitive impairments that incorporates four different aspects for development: the mild cognitive impairment player profile (capabilities of a player), core gaming elements, therapeutic elements, and motivational elements [228].

Technology

In the technical consideration of platforms, Caliskan et al. point for use of gamification in general rehabilitation to a frequent use of smartphones and tablets in studies, followed by computers [62]. However, in studies on gamified cognitive training, computer-based systems are used most frequently, followed by tablets and only to a very small extent smartphones [392]. In practice, the use of all three platforms is sometimes offered, e.g., by 'Cogmed' [76]. Due to the positive results of gamification on the pc, it should also be considered in mobile versions in the future [44]. Lumsden et al. point out the potential for using gamification to support engagement in studies conducted on pc or mobile devices rather than in the laboratory [239]. Lugmayr et al. also point out the suitability of smartphone apps to address patient self-management. In addition to web-based applications, mobile applications are being used more and more frequently in rehabilitation [237]. This is also reflected in the analysis of offers from practice (see Table 2). They show potential in health and wellbeing due to broad accessibility and appeal in mobile systems, among other things [192]. Boendermaker et al. point out that with increased use in the future, there should be no difference in training effects compared to the computer [44]. However, the use of smartphones offers only a small available screen and in the environment potentially distracting stimuli [76].
Dobosz et al. have developed 'RehaMob', an app for adapting rehabilitation exercises to tablets and enabling the practice of cognitive tasks despite motor problems, and have shown that tablets can be successfully used in cognitive therapy [103, 105]. Schlosser et al. developed 'PRIME', an app designed to support motivation and quality of life in schizophrenia, which was shown to be feasible to develop and acceptable to the target group [333].
White et al. point out that devices are often used for different purposes, but also show the cloud-based combined usage for multi-device usage using the example of a tablet and a smart speaker as an assistance tool [408].

Gamified Software-Based Training resp. Training Software

In practical implementation, the use of games and gamification is widespread. Various developments can be found in the use of software-based cognitive training in commercial use, research or commercial games used for training [32, 123, 379]. Off-the-shelf games, however, sometimes require too fast reactions, which are partly limited in patients [361]. In addition, required interactions can lead to higher difficulty in use due to physical limitations [303]. Therefore, user-driven approaches may be more appropriate [361]. For location flexible use or home training for rehabilitation, e.g., websites or web apps can be used [196].

In the following, examples of gamified cognitive training or training games are described. In commercial applications, Table 2 shows the use of gamification in various tools.
The web-based training for working memory 'Cogmed' [76], for example, has an integrated reward-based incentive system. In the training, gold and jewels can be collected as rewards, through a world builder, in which a unique personal world can be created, the progress is visualized.
'RehaCom's working memory training uses a card game for training tasks. Among other things, it includes a level system integrated into increasing leagues with trophies, rewards through bonus games or jokers, and performance feedback [167].
The tool 'Rehability' offers different training games to address motivation and adherence, besides physical training there is a prototype for cognitive training in the area of 'Rehability cogni' for android tablets [308].
'Meister Cody' offers training in math and German for children with weaknesses or dyscalculia or dyslexia [253]. In these learning games, exercises are integrated into the course of a story. 'EndeavorRx' [115] / 'Project Evo' [84] offers as a serious game a racer for training children with ADHD. On different race courses, for example, objects or markers are collected or avoided on the track. Among other things, new worlds and characters can be unlocked in the game. For older users and for training multitasking, the game 'Neuroracer' is used [24].
Also for older adults, but for the maintenance of cognitive skills and in the case of dementia, Mora et al. designed a web-based gamified training with a collaborative crowdsourcing approach, adjusted to the characteristics of the target group [258].
In research, different implementations of gamified software-based cognitive training are emerging. For example, in 'RehabCity' [396] / 'Reh@City' [121] (implemented in Unity 3D [383]), a three-dimensional city is presented where the user navigates through and performs various exercise tasks at different locations. This is intended to adapt the tasks to real-life situations and environments in a simulation instead of on paper.
'Rehamob' was extended as an existing mobile training app with various gamification elements, including levels, awards and achievements, time measuring, hints and tips, and collecting and storing statistics [104, 105]. In the 'City Builder Game', a working memory capacity training is conducted. Within this training the users receive points which can be exchanged between the training blocks as game money. To build up a virtual world, different objects such as houses or trees can be bought [45].

Prior Approach

In a previous work of the author, first concepts for an interlocking approach to integrate gamification and complementing elements into software-based training were created with the focus on visual neglect [129]. Initial prototypes and first qualitative evaluations indicate a potential suitability for addressing motivation. However, the prior step lacks further development, implementation in existing software-based training, deepening, and substantial evaluation.
The prior findings encourage the next steps and new approaches in this work to use gamification in a tailored and targeted way and further to provide support for design and development in practice.

Game Elements in Cognitive Rehabilitation Software Training

3.1 Focus and Purpose
3.2 Game Elements to Complement Cognitive Training
3.3 User Requests, Effects and Ways of Tailored Gamification in Software-Based Training
3.4 Outlook: Potentials of a Web-based Gamification Guide for Knowledge Transfer between Research and Industry - A Method to Support Design and Development
3.5 Discussion
3.6 Summary

Gamification is often used to address motivation, emotions or desired behavior [192, 329]. When implementing gamification, due to the dependency on context [156, 160, 325], the use of gamification in the specific context of software-based cognitive rehabilitation is considered in this chapter. The possibility and way of software-based use, the implementation of individual elements and element combinations is examined in depth, and effects are considered. Overarching the request for various elements and possibilities for tailoring are analyzed, and the possibility of support in the development of the training software in the implementation of tailored gamification in practice are considered.

This section contains texts from the author's own publications (see 'List of own publications' in the appendix) and partially extends prior work. The chapter is based primarily on the following publications:

Section 3.2.1 (Interactive Storytelling / Quest)
- P. 16: Gabele et al. (GamiFIN 2019)

Section 3.2.2 (NPC)
- P. 15: Gabele et al. (GamiFIN 2019)

Section 3.3 (Implementation: Effects & Ways)
- P. 4: Weicker et al. (Jahrestagung GNP 2020): Clinical part of the study by J. Weicker. Extension and in-depth consideration of gamification by M. Gabele. Line chart by S. Wagner. Implementation, training software and web interface by HASOMED GmbH.
- P. 3: Gabele et al. (UMAP 2021), based on and deepens P.4
- P. 8: Gabele et al. (IEEE EMBS ISC 2019)

Section 3.4 (Gamification Guidance)
- P. 2: Gabele and Fischer et al. (UMAP 2021): Joint primary authorship: Idea and supervision by M. Gabele. Design and implementation within a team project by V. Fischer, M. Steinbrügge and D. Thiemke (Fischer et al. [124])

3.1 Focus and Purpose

Software-based training is frequently used in the rehabilitation of acquired cognitive impairments. For a positive effect in therapy, its frequent conduct is relevant [368, 403], for which, however, a high level of motivation is required [361], which can be addressed through gamification [44, 239, 361, 392]. Here, a requirement is to create a long-term support based on meaningfulness and purposeful goals [32, 146, 237].
However, research regarding the use of gamification in cognitive training needs further in-depth analysis [392] and consideration of the factors that influence adherence [212]. In their review, Vermeir et al. suggest examining individual elements for the individual effects, but also combinations, as these are more closely oriented to real-life use [392]. However, a one-size-fits-all approach [290, 372] is not advisable, because individual approaches and knowledge of the target group are relevant for supporting the effects by tailoring [258, 262, 388]. However, for the transfer of research results to the practical implementation of gamification in cognitive therapy tools, support for knowledge transfer is needed [379]. Therefore, the following aspects are considered in this chapter:

1. Feasibility and way of using gamification elements in software-based cognitive training by:
   a. The general potential of integration and interaction in cognitive training software, using the example of the elements 'Interactive Storytelling' and 'Quest'.
   b. In-depth analysis of the requirements for an accompanying Non-Player Character (NPC) and thereby targeted digital social support and resulting recommendations for the development.
   c. Requests for game elements in training depending on patient's character for an overarching comparison as a basis for tailored implementation.
   d. The usage of a gamification scenario in cognitive training over several weeks.
   e. A knowledge transfer tool prototype for gamification between research and industry to support the selection of appropriate gamification elements in practice.

2. Effects of the training methods in the use of gamification through
   a. Perception of the gamified training in the elements 'interactive storytelling and quest' generally or in the possibility of influencing the content through interaction,
   b. Effects in perception and training behavior through gamification in training in general and depending on the character of the patients.

The focus is on supporting and optimizing the implementation of (tailored) gamification in the development of cognit129 trai1129 software. Thus, in this step, the overall questions TRQ 1 (Implementation of elements) and TRQ 2 (Effects in perception and training duration) are addressed, which is intended to further support the addressing of the motivation of patients.

3.2 Game Elements to Complement Cognitive Training

3.2.1 Complementarity, Effects and Deepening in the Use of Interactive Storytelling and Quest
3.2.2. In-Depth Designs and Development of Accompanying Non-Player Characters

3.2.1 Complementarity, Effects and Deepening in the Use of Interactive Storytelling and Quest

Stories are a typical element used in games and can support meaningfulness. Quests address the basis for the development of intrinsic motivation.
In this step, the initial effects and feasibility of combining an existing medically approved cognitive therapy software training and interactive storytelling and quests for patients with acquired brain damage in outpatient rehabilitation are considered. Based on the requirements (section 1.3), a practical combination is implemented and an exploratory study with patients was conducted. A subjectively perceived motivational tendency without exhausting or losing concentration due to extension has been shown. Patients stated interest in further use.
Lastly, the feasibility, potential, effect, and aspects for software development are discussed. The results lay a basis to implement gamification, influence motivation, further clinical evaluations, and show feasibility and importance for further research.

Focus and Purpose

The focus of this step is on the initial testing of the integration of gamification and involving the patient through personal interaction (here by means of interactive storytelling and a quest) in software-based therapy in cognitive rehabilitation. The focus is on application and interaction in the context of rehabilitation. The following research questions (RQ) will be considered:

- RQ 1: How can interactive storytelling and quest be implemented in concept and development to support motivation as a complement to cognitive training for patients?
- RQ2: How do patients in cognitive rehabilitation perceive the complementation of software-based cognitive training with interactive storytelling and quest?

Requirements for the use of gamification are to motivate patients without restricting their work during training. Therefore, the focus is on the method of implementation on the one hand, and on the perception by the patients including factors such as motivation, exhaustion and distraction on the other hand. The purpose of the chapter is to deepen the knowledge on the implementation and effect of the combination of interactive storytelling and quest. Thus, the use for patients in practice is to be facilitated.

Background and Related Work

According to Nicholson, the successful development of meaningful gamification and long-term motivation involves 'exposure' (here the integration of a story into a real setting) and 'choice' as relevant subconcepts [271]. Considering healthy players, 'Narrative or Story' and 'Meaningful choices' are rather requested gamification elements [372]. In the field of learning, Toda et al. point to the relevance of considering narrative and storytelling as possible elements in gamification, following a survey of experts [369]. Palomino et al. point out that for the use of narrative in education, aspects are relevant such as: an actor, choice, interactivity, events as sequences, as well as addressing motivation and user experience [288]. Zhou et al. show in their review that narrative game-based interventions have an effect on changing behavior, knowledge, self-efficacy, and enjoyment [419]. However, they point out that this is influenced by factors such as genre or age.
As a gamification element, stories are frequently linked to and wrapped around other tasks [325]. Based on this, in this step, an existing medically approved cognitive training software [164] is complemented with interactive storytelling to wrap it around the training task. Boendermaker describes a process that persists a task which is expanded with a game as a game shell [47]. Thus, the training task remains unchanged in this method [47, 388]. However, there is a connection between the content of the task and the additional game elements. In software-based training, gamification is used in various applications and implementations [392] (see Table 2).

Different interpretations of the term 'storytelling' can be found in several fields (e.g., as a therapeutic technique, narration or branding). In the following, it is used as mechanics for a fictional story, with the extension to interact and intervene in the storyline [347]. Authoring tools can assist in the development of structures such as complex non-linear stories, offering both new development and customizable templates [197], supported also by artificial intelligence to plan network structures [69].

According to a review by Vermeir et al., stories / themes are frequently used gamification elements for computer-based cognitive training in research [392]. The selection of the theme is partly based on its suitability for addressing the target group. The basis of immersion is described as potentially supporting intrinsic motivation, especially in relation to autonomy and Self-Determination Theory.

By integrating serious storytelling, for example, meaningful interaction and purposeful goals can be addressed, as Lugmayr et al. suggest for health and wellbeing [237]. This is also suggested by Day for long-term motivation and fun rather than competition and performance-enhancing goals within fitness apps [85]. Storytelling is used, for example, in the fitness apps 'The Walk' [341] or 'Zombies, Run' [343] for adults to support long-term performance of sporting activity. In 'Zombies, Run' a story is experienced in real time and combined with real running training and current goals. In healthcare, for example, the serious game Re-Mission 2 [177] is used, in which children in cancer therapy control an avatar that fights cancer cells through a body.

Storytelling is also implemented in cognitive training. Dörrenbacher et al. complements a cognitive-control training for children with a story of an astronaut who lands on a planet and has to train the creatures Watermons living there to repair his damaged spaceship [107]. They increased intrinsic motivation through the complementation of game elements.

The dyscalculia training for children 'Meister Cody' includes different tasks, whose execution is in the foreground in terms of time, but are embedded in a background story to address the motivation [253]. Gellner and Buchem let elderly people recreate lost health data in 'Find & Fill the Golden Record' [144].

The description and / or integration of settings also appears in cognitive training for adults, which can be seen, for example, in realistic but fictitious scenarios. Executive functions are trained in 'RehaCom' [162] by planning processes during a vacation [169], or for example in a shopping scenario [28]. In 'HAPPYneuron' [331], cocktails are mixed and recipes are memorized to train verbal memory, visual analysis and concentration [332]. In the approach 'RehabCity', the user moves through a three-dimensional city in which various real-world training tasks have to be solved [396]. Stories are read and memorized for verbal memory training in 'RehaCom' [170].

As a game element, stories can be assigned to the category 'Immersion' according to Tondello et al. [372]. They have the potential to create the feeling of emotional immersion [237]. They can arouse the interest of users and promote positive feelings [325]. According to McGonigal, positive emotions, along with meaningfulness, are aspects of intrinsic rewards and gameful design [250].
The use of narrative architectures can be found in many games in different ways [188]. It incorporates a pre-designed story, but also includes integration of the player and enables freedom of interaction during the action. It involves engagement and decisions in narrative progression [237]. Within four weeks, the example of various physical-activity games that highlight the physical activity showed a decrease in usage and a perception of boredom [28]. Here, the lack of a story is suggested as a possible reason. The perceived meaning and interaction with the system are related in interactive storytelling to a feeling of presence in the situation presented [49].

In a prior work [129], a cognitive training was modified with stories that can be selected by patients out of four themes. The training was adapted within the training task according to the selected theme. An initial qualitative evaluation of the click prototype showed its potential suitability for supporting motivation, which encourages further in-depth investigation in this work.

Beyond the integration of stories, interactivity can likely support the feeling of the personal contribution to the result [28]. Gong et al. have analyzed eleven factors that are relevant for the successful development of game storytelling [149]. These include 'Engage & Explore', and 'Autonomy', among others. 'Choice' can give users choices in engagement with the system and thus a sense of autonomy [271]. Although autonomy and decision freedom are associated with each other, a lack of effect in practice could be due to the fact that a game process is not or too little influenced, and a possible effect may therefore also depend on the consequences of the decision [326].

By implementing quests, tasks can be integrated for the user. They offer motivational mechanisms such as the possibility to clearly define the goal of the user's action, as well as showing the relevance, but also the consequences of one's own actions [325]. The smaller incremental tasks and interactions within build up to the larger and long-term goal of solving the game [49]. According to Muangsrinoon et al., quests address all three dimensions of the Self-Determination Theory [263]. Through the selection options, the player has the possibility and responsibility to control the game. Thereby it is in the result partly tailored to the preferences of the user [49].

Concept and Prototype Development

An existing medically approved software for cognitive training of divided attention in rehabilitation was used as a basis [164]. According to the developer, it is a frequently used training program due to its relation to the everyday life of patients. The task is to drive a car on the screen (Figure 2c) and to react correctly to visual and acoustic environmental stimuli. A connection between existing training in the form of a simulation (car drive) and gamification (interactive storytelling / quest) results in a single-player game and interaction with Non-Player Characters (NPC). NPCs can, for example, enable communication and social interaction or provide support during quests [49]. The approach is intended to address the various dimensions of Self-Determination Theory [263, 318].
Important for concept design is that the training should be motivating over several training sessions [129]. Thus, two car rides were integrated exemplary. Dividing the story into short sections can be used to adjust the duration of the training individually for each patient [239].

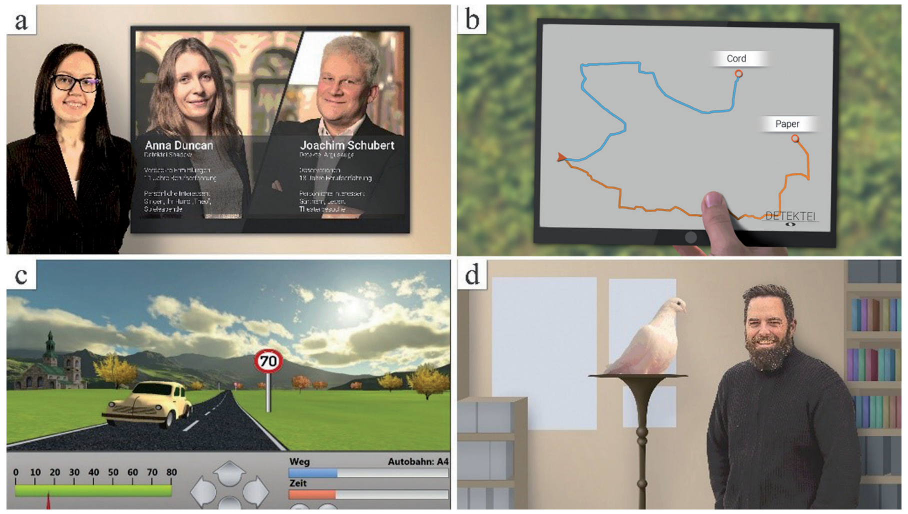


Figure 2. Story and quest in which cognitive training is integrated: a) Selection of the detective to work with. On screen: Left: female, Right: male. b) Selection of the route to be driven. c) Task for cognitive training of divided attention by the means of a car ride. d) Resolution of the story. Figure from Gabele et al. [131].

To complement the car rides, a criminal cases setting was chosen. Since the group of patients includes both gamers and non-gamers, the selection for this is based on books in daily live, in which the genres 'Thriller' and 'Crime' are read the most [348, 356]. It allows to integrate a fictional main story with shorter quests and to justify the car trips. This wraps the story around the main task of training [47, 253, 311]. Thus, the training task is not modified compared to the previous approach [129] in order to maintain its effect.
In the overall concept, patients can support and solve several cases in the course of therapy. Each criminal case is intended to have its own main story and quests and they do not build on each other. The prototype exemplarily shows one criminal case to be solved. Here, the patient takes the role of a new employee in a detective agency and supports a senior detective (selectable between female or male, Figure 2a). In the game, the quest giver, a woman, calls the patient and tells about a mysterious note found on the doorstep. The patient selects one of two possible routes and drives with the car to the woman. The woman gives some clues to solve the case. One of two possible clues can be selected (Figure 2b) and thus the patient chooses the route to follow with the car (Figure 2c).
The story ends with a visit to a carrier pigeon breeder (Figure 2d) whose pigeon has lost the note. In the end, the case turns out to be more humorous than expected. Finally, a hint about the next case is given. This is intended to arouse interest for the next session.

Since 'scriptwriting' is an important factor for successful game storytelling [149], the suitability of the overall story was evaluated in a preliminary study based on a questionnaire / structured interview with seven patients with acquired brain damage (average age: 65, age range: 56-74 years) in outpatient rehabilitation. All patients stated to have understood the story content and to want to get to know more cases. According to the German school grading system (1: very good - 6: poor) the story was rated by 71% with '2' and 29% with '3'. The story was rated as rather exciting (yes: 57%, no, 29%, no answer: 14%) and the solution as rather amusing (yes: 57%, no: 14%, don't know: 29%). This implies that the story is predominantly appropriate for the target group, and an evaluation through a prototype is reasonable.

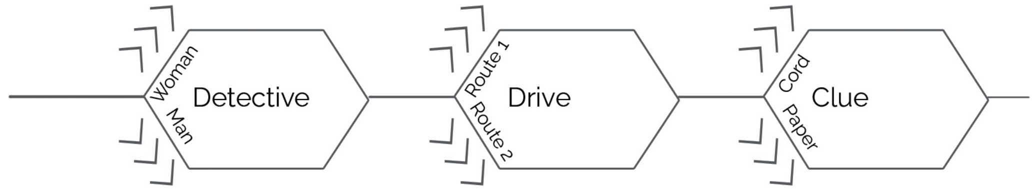


Figure 3. Decision tree of the detective story, based on a simple fake choice architecture.

For the design and development of the prototype, the interactive story was created as one story with a simple fake choice architecture (Figure 3).

The case is always resolved in the same way based on a linear main story, but can be solved by variation at different branches. The decision tree for the prototype was limited to three decisions, each with two options: the selection of the detective to work with, the route to the woman who called and the hint to follow. The structure of the story is based on a classical drama with exposition, climax and resolution (Figure 4). In game design, level structures and stories based on these are also used [197].

A flat 2D visualization with low complexity and focus on the story elements was chosen due to the limited cognitive abilities of the patients. For this, a low level of detail of the background and a higher level of the persons, objects and interactive elements that are important for telling the story was used.
The detectives were selected by three experts (clinical, technical and interaction / game background) based on a resolute but friendly appearance and photopgraphed and integrated in different poses in the story.

Technically, the prototype uses an existing Unity 3D [383] based version of the training for divided attention. Through wrappers it is linked to a low fidelity click prototype for the integration of the story, with which the patient can interact. The story is enhanced with audio files for speakers and background sound. Keyboard and mouse are used as input devices, which are familiar and probably do not influence the effect of the prototype.

Explorative Study

Method

Note: Since the thesis focuses on the use of gamification for training in outpatient clinics or at home, the method / results of patients that are undergoing this cognitive rehabilitation are considered, who used the training with gamification extension. Respective parts of the method are described below. Those of healthy participants or patients from other rehabilitation phases and those without gamification are not integrated further in this work.

In an explorative study, trends of possible effects (positive, negative and feedback) on cognitive performance and perception and perception of interactive storytelling and quests of patients are considered. In the consideration of patients and the use of gamified cognitive training, patients in an outpatient clinic for cognitive neurology in Germany with heterogeneous causes of cognitive impairment (stroke, craniocerebral trauma, cerebral hemorrhage) are considered. Due to the qualitative exploratory character of the conducted study, a small sample was chosen, which may provide starting points for further research.
The prototype was used in overall approx. 30-minute training sessions, divided into two sections, which were carried out one after the other by the patients (Figure 4).

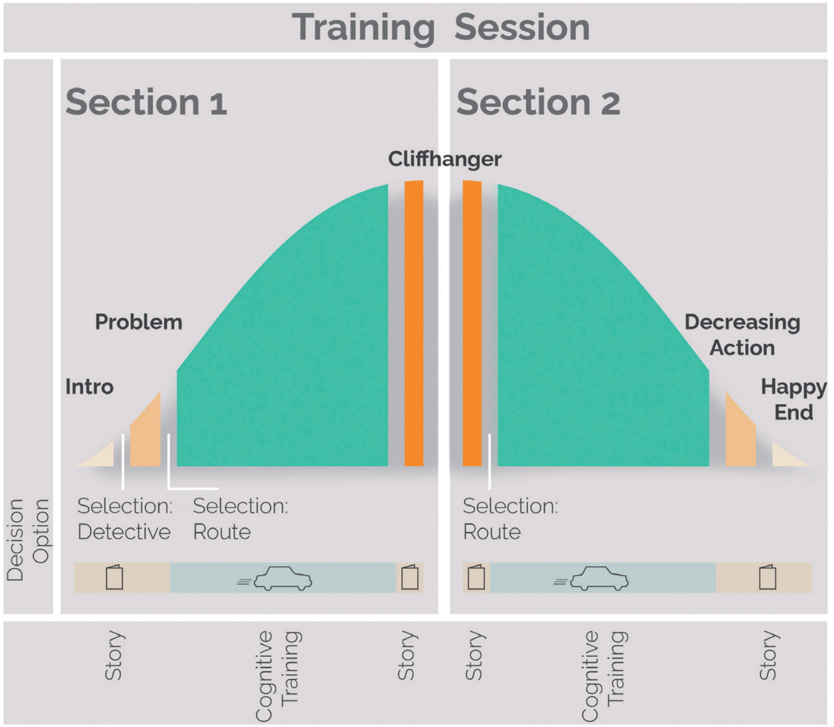


Figure 4. Procedure of one training session with two sections based on the presented prototype and based on the combination of a cognitive training for divided attention, interactive storytelling and quest. Figure oriented to Gabele et al. [131] and extended.

This allows an additional measuring point between the sections and a future connection of the content for conduction on different days [239]. The cliffhanger between is generated when the caller shows the note she has found.

The structure was as follows:
a) After an explanation of the study, the participants gave their written consent, b) Demographic data, prior experience and disease-related data were collected, c) Participants stated how motivated and exhausted they were before, between the sections and after the training session (5-point Likert scale: 1=not at all - 5=very), extended by a first perception after both sections (closed questions), d) After the training session, the outcomes regarding perception of the interaction and combination of story and training, effects and interest in use were evaluated (closed questions), e) Participants were asked to describe aspects such as the goal of the section, the goal they had in mind during the training, or positive aspects, criticism or comments (open questions).

The questions on a 5-point Likert scale allow a comparison between the answers. It provides the opportunity to give neutral answers, whereby ratings out of the neutral range can be considered more relevant. The possible answers are mainly divided into 1 (not at all), 2 (hardly), 3 (a bit), 4 (predominantly), 5 (very). Additionally, open qualitative questions were asked about the subjective experience of the training session. Thus, reasons for rating and feedback for optimization can be obtained without influencing the respondent with given answers. For interest in further usage, three choices were offered: 1 (no), 2 (maybe), 3 (yes). The core results of the study are summarized and presented in excerpts in the following.

Table 4. Demographic data of the patients. Table from Gabele et al. [131].

ID	Age	Gender	Education	Using computers in everyday life	Experience with system RehaCom	Experience with training 'Divided Attention'
P1	52	female	Secondary School	(almost) daily	yes	no
P2	51	male	Secondary School	rare	yes	yes
P3	31	male	Grammar School	(almost) never	yes	yes
P4	44	female	Secondary School	rare	yes	no

Table 5. Subjective perception of physical and mental condition before, in the middle and after the training session. Items were rated on a 5-point Likert scale (1=not at all, 5 = very). Table from Gabele et al. [131].

	Training		
Questions	Before	Middle	After
How motivated are you currently?	3.75	4.25	4.25
How exhausted are you currently?	3	3	3
Was it possible for you to concentrate and stay focused?	-	4.25	4.25

Results

Four patients with cognitive impairment, around phase D, based on the German rehabilitation system, participated in the study (related to b), Table 4). The average age was 44.5 years and the age range 31-52 years. They suffered from cognitive impairments, were in cognitive rehabilitation and participated in addition to their standard therapy.

They were from European cultures, took part voluntarily in the study and were not rewarded. In order not to influence their perception, they were not previously integrated into the design process. In the following, relevant results are presented in excerpts.

Table 5 shows in relation to c) the progression of perception from before the training, between the sections and after the training. Figure 5 shows excerpts of the results of the closed questions d). Furthermore, conspicuous aspects of the data are described in detail. Aspects from the open questions are described subsequently in relation to e).

Further usage at home (1 (no), 2 (maybe), 3 (yes)), was rather desired (2.75) (P1, P2, P4: yes / P3: maybe). On average, the responsibility transferred to the patient was assessed as rather not unpleasant (2.25). In detail, however, large differences are shown: While P2, P3 (1) and P4 (2) perceived it to be less unpleasant, it was very unpleasant for P1 (5).
Based on open questions e), being attentive (P2, P4) and working on the detective case (P1, P3) were described as the task. The goal in mind during the session was described as driving correctly (P1), solving the detective case (P3) and achieving all the required things (P4).
The combination of driving and other things / story was rated positively (P1, P2, P4). P3 would like to have an increased difficulty, also in the story quest.

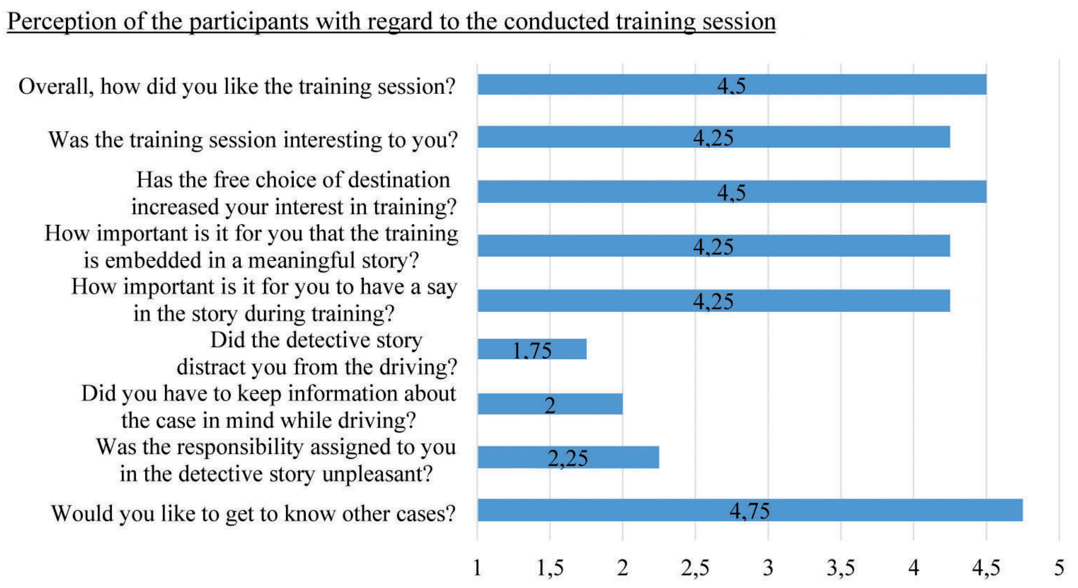


Figure 5. Results of the questions after the explorative study with patients and control group (1 (not at all) - 5 (very)). Figure based on Gabele et al. [131].

P1 rated the prototype as less boring and reported from experiences in the personal environment that patients have lost their interest in training after several training sessions. P1 expects that the story will be very motivating to stay longer at the training.

Discussion and Conclusion

In this step, a practical combination of an existing computer-based cognitive training for divided attention and interactive storytelling and quest in a prototypical gamified training with high driving content was implemented. This was evaluated qualitatively in an exploratory study, focused on the subjectively perceived effect to initially consider the connection between gamification, interaction and cognitive training in rehabilitation.
According to RQ 1, in line with other work [325] and the previous developments in research and practice, the feasibility of wrapping a task [47] is confirmed, here by complementing the cognitive training with interaction storytelling and quest. The implementation combines the existing training without changing the basic principles and therapeutic training concept. By the structure, goals could be achieved over several sessions as suggested by Lumsden et al. to address long-term motivation [239]. An overarching story is also used, for example, in 'Master Cody' for children [253]. In this way, the story can be extended to several training sessions by adding more content, or it can be divided into short quests depending on the patient's abilities. However, it is still questionable how in-depth a retrospective summary needs to be for patients with cognitive impairments, as there are potential memory problems. Thus, it should be considered whether stories and quests for specific patients need to be implemented in a particular way, e.g., for patients with limitations in memory by supplementing long-term with more short-term gamification [271] or retrospection, such as in TV or game series.

In development, training and interactive story and quest, although meaningfully connected, the areas can be treated independently of each other through the game shell [47]. This supports the creation of a game shell, as in other software-based eHealth trainings and domains, such as van Dooren's [388].
The use of a wrapper in the development of the prototype in this step points to the advantage that in independent development, e.g., different teams may be involved or interactive behaviors, stories or quests may be replaced or changed independently of training. In the long run, this might support a dynamic tailoring to the player and their needs to, e.g., genre or to their character traits, e.g., in user types [49, 129, 284, 374]. Possible individualizations and adaptations to the patients needs in the situation of rehabilitation should be considered to further develop the user-centered approach [49].

However, the development of video games [28] or gamification takes a lot of time, which is often not available in practice [234, 292]. Moreover, the duration of using the software is extended by the addition of the story. The longer overall duration per training session may be problematic for use in (outpatient) clinics, since there are mainly predefined training schedules with corresponding limited time frames. However, this probably influences home training less.

Currently, the session is designed not to be repeated. However, this can be enabled by a more complex subdivision of the decision tree and branches and different endings. Here, the question is whether a positive dissolution of the training session is necessary for motivating patients or not.
The developed story is currently primarily focused on its motivation and entertainment value. The results show that it is rather important for patients that the training is embedded in a meaningful story, what supports the relevance of the integration of meaningfulness [60].

In further developments, and to support health-related desired behavior, the content of the story could be more oriented to the real subject matter of the situation [28], for example, by making personal meaningful choices or mirroring reality, as well as through analogies [271, 379]. Further it is shown by Shen et al., that in health communication narrative messages in digital formats (audio/video) have the potential to address persuasive effects [340]. Besides the scriptwriting of the story [149], the integrated characters can also have an influencing effect [191, 285, 326, 378]. Thus, it should be further considered which characteristics of digital characters are relevant for patients in gamified software-based training. This is considered in the next step in section 3.2.2.
According to RQ 2, the results and effects indicate that interactive storytelling and quests may have the potential to support motivation for adult patients with acquired brain damage in rehabilitation. Thus, they support the intended motivational approach in training [253].
The results are in line with the system proposed by Sailer et al. for connecting motivation research and gamification, which associates meaningful stories with interest and emotions [325]. The positive highlighting of the combination and the slight increase of motivation perceived in the course of the training might be due to the interest in it, but also result from a comparison with the basic or other training known to patients which may be considered as less interesting. Although there is no significant increase in perceived motivation here, there is a preservation of motivation, as suggested by Boendermaker et al. [44]. The fact, that neither perceived exhaustion nor concentration decreased, indicates that there is no cognitive overload in cognitive abilities required for therapy, which is also reflected in the perceived low distraction from training, which addresses the requirements defined (section 1.3). De Vries et al. further point out that staying focused is supported by variation [100], which might also be addressed by interactive storytelling.

Both the cognitive task and the detective task were mentioned for the goal of the training and for the goal that was kept in mind during the training. This indicates, that with the solving of the detective quest, a new goal has been integrated [325]. The different distribution and partial change of objectives between the questions suggests that there could be a different degree of individual goals [227, 233] and focus on the goals or also incentives. The integration of additional goals based on a tailored concept according to the character of the users is further considered in section 4.3.

Interest in getting to know further cases confirms interest in this scenario, but leaves open whether interest in other scenarios or thematic areas would be higher or lower. Additionally, the effect should be critically investigated that in the interaction, transferred responsibility can also be perceived as very unpleasant. For corresponding patients, this may result from an overload of choices [271]. In this context, factors that foster this could be considered further such as the degree of interactivity and control [49] or degree of impairment.

Some limitations of the study are to be mentioned. Due to the small number of participants, the results should be considered as a trend and not be generalized. The results show starting points for further research focused on individual aspects.
For comparability, the effect should be further evaluated quantitatively with a higher number of patients, a control group and more standardized questionnaires. The results refer to patients with limitations in divided attention in rehabilitation phases around D.
For other limitations and other phases, they may differ. The study was conducted in Germany and can thus not be directly transferred to other countries or cultural groups. Likewise, a different method of implementation may lead to different results [156].

In the prototype the difficulty of training and quest was set to a low level in order not to overstrain and thereby falsify the effect. In a further approach, as is common in software-based training, this should be adapted to the patient's abilities based on the assessment of therapists to enable flow [81].

Overall, for patients with acquired brain damage in cognitive rehabilitation, the overall approach of the presented concept and prototype has been shown to be rather appropriate. The potential for motivational support and also the desire to use this kind of training at home supports the intended use. This step contributes to the feasibility and deeper understanding in the application of gamification in the combination of interactive storytelling and quest in cognitive rehabilitation.
It supports the deepening of the implementation of gamification for cognitive training in the next steps of this work.

Take-away & Key aspects

- *Wrapping of cognitive training by storytelling and quest as gamification elements is possible without changing the training*
- *In development, training and story can be developed and handled independently and connected with a wrapper*
- *Patients show interest in current and future use of training at home with complementation of meaningful interactive storytelling and quest*
- *Neither the subjectively perceived motivation and concentration decreased nor the exhaustion increased in the course of the training due to the complementation*
- *Through the story, another goal, besides the training task, can be created*
- *The level of responsibility transferred by involving the user in interactive storytelling and questing should be taken into account and handled with caution*

3.2.2 In-Depth Design and Development of Accompanying Non-Player Characters

Existing social cognitive functions can be affected by brain injuries and can lead to seclude oneself [207]. Social isolation is a risk for poor rehabilitation outcomes [119, 148], or higher mortality rate [318]. Existing social contacts can be reduced considerably by the stay in the clinic, the temporary or complete leaving of the workplace, and motor and cognitive restrictions. Therefore, fostering consistent social contacts is relevant and human needs for consistency and motivational social relatedness and support are to be addressed. This is intended by the integration of a Non-Player Character (NPC, also called digital / virtual agent) as a companion. In this step, possible representations based on required characteristics, age and gender will be considered. These were set in relation to age and gender of the user. Three female and three male companions in three age groups were created and subsequently tested in an explorative feasibility study with 40 participants. 50% preferred a female middle-aged companion, 25% a younger male. Older companions were chosen only by women. Preferred characteristics include friendly, empathetic and motivating, but also competent and authoritative behavior. The results present an orientation for developing NPCs as companions in software-based training for cognitive rehabilitation.

Focus and Purpose

The NPC integrated into the software-based training should neither replace the therapist nor real social interaction, but offer a stable companion. In examining the relationship between therapist and patient, effectiveness factors such as the therapist's empathy or appreciation [295, 314], are often considered. Similar characteristics may be assumed for a companion. However, the requirements for the characteristics of a companion and how it is perceived may vary, due to the large demographic differences between patients. Therefore, different questions regarding this are considered in the following:

1. Which characteristics are desired for a companion?
2. Which age of the companion is preferred and why?
3. Which gender of the companion is preferred and why?
4. Does the reason for the selection match the previously desired characteristics?
5. What are the characteristics of the choice of a companion in terms of the age and gender of the participants?

There are various aspects available for the realization of an NPC (e.g., appearance and behavior), but the effect of an NPC evolves from the entirety of its individual aspects [324]. Therefore, it is relevant to consider the goal and the characteristics more in detail to align the designs to it.
The purpose of this step is to analyze which characteristics are required for a companion in cognitive rehabilitation therapy, and to which age and gender of NPCs these characteristics are attributed to, by which participants. If there is a trend, it can be used in development to support the patient's behavior positively in the use of the software-based training.

Background and Related work

Social relatedness, along with autonomy and competence, is one of the central factors of Self-Determination Theory, which describes the psychological needs for intrinsic motivation [88] (see section 2.3). Social relatedness describes the human need for integration into a social environment and belongingness [90]. Reinforcing this feeling results in feeling more involved and encourages people to become more involved themselves [39]. Common goals [326] and appropriately used game elements can support this motivation mechanism [325].

According to Yoshida et al., social relatedness factors are relevant extrinsic factors for supporting patients' motivation in the clinic in rehabilitation [417]. Coleman proposes the use of multi-player games for cognitive rehabilitation and a corresponding framework and approach [78].
Contact with the therapist is a relevant aspect of rehabilitation and can, among other things, provide motivational support on the way to the goal through feedback [301]. When considering social support, Lentferink et al. point out that in eHealth and eCoaching interventions, strategies such as face-to-face instructions are relevant to health outcomes and usability [230]. Despite the motivational relevance [361], they are rarely used in cognitive training [392].
Social structures can arise on interpersonal contacts in the real or virtual world, but also on contact with non-realistic characters [326]. Digital characters are used in rehabilitation to give feedback, for example [301]. The cooperation with teammates (for example NPCs) successfully affects the sense of social relatedness [326]. Different game elements are included in the area of socialization, such as social comparison, competition or networks, guilds or teams [372]. They are particularly preferred by male users, albeit character traits such as extraversion are also associated with the tendency to socialization and can explain this [372]. Digital characters are frequently used in rehabilitation and can have various tasks [379].
Avatars are successfully used in current software-based training for self-representation. Agopyan et al., for example, have used them for patients to mirror a virtually improved version to increased the individual movement [5]. In cognitive trainings, avatars are used, for example, for children with attention deficit hyperactivity disorder (ADHD) in serious games as in 'Harvest Challenge' as player-character [42].

However, digital characters can also be NPCs that don't represent the user. For this they can have different tasks [33] and roles as for example according to Warpefelt in functions, adversaries, friends and providers [398]. Manavalan and Bulitko point out the relevance of believability of NPCs and propose an algorithm that automatically generates emotional responses from NPCs [242]. Social companions can, according to Nijholt, e.g., motivate or provide social and mental support [274].
In hand motor rehabilitation, Gago et al. suggest the use of a digital agent to motivate and provide verbal and nonverbal feedback to patients during home training [138].
Based on a review, Tropea et al. point out that in motor rehabilitation, virtual coaches promote physical activity [378], but this cannot be compared to real-life training. At the same time, they also pointed out the potential for continuity in long-term care and for improving rehabilitation and treatment adherence.

Ortiz et al. have shown for elderly people that a digital character can help to follow instructions better [285]. Emotions shown on the face could be recognized both by people with and without cognitive impairments. Tran et al. show in a cognitive concentration game for the elderly, that there is no loss of performance with a digital agent compared to a therapist [377]. In the dyscalculia therapy game for kids 'Meister Cody - Talasia', users join NPCs through the game and help them save their world [253]. Here, users immerse themselves in the story of the world with the characters. According to Bartle, the level of immersion describes the degree to which the player considers themself to be part of the virtual world and is a relevant contribution to the experience [33]. The relationship between player and NPC can support this [33]. Johansson proposes the consideration of 'social immersion', which can arise in the interaction of players with NPCs in the game [191].
In an initial qualitative evaluation, a previous approach indicates the potential suitability of a digital trainer to accompany the patient during the process of rehabilitation [129]. However, guidelines for design and implementation are needed.

Believability is a relevant aspect in the development of NPCs [398] and can be addressed by different aspects in the realization [191]. It is reinforced by the fulfillment of the user's expectations, which are related, among other things, on the NPC's visible appearance aspects such as age or gender [114, 398].

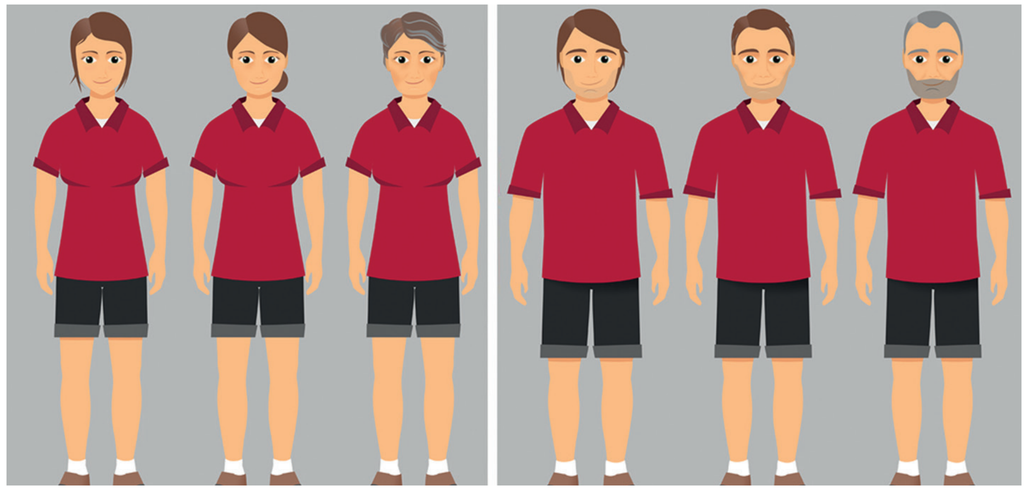


Figure 6. Visualization of the six different companions used in the study, A-C Female (age young to old), D - F Male (age young to old). Figure from Gabele et al. [132].

The roles of an NPC can be identified by users through its representation, which is supported by the environment and placement in the digital world [398, 399]. Besides the visual representation, the interactive component, such as reactions and the expression of emotions, is also relevant for the development of an NPC [225, 398]. Bostan and Marsh point out that digital characters can also be seen as having human characteristics by the players [49]. An emotional connection to the NPC is considered important by players, which can create the feeling of not being alone in single-player games [114]. If expectations and NPC do not match, this can lead to a negative perception [114].
Therefore in this step of the work, it is analyzed whether there is a trend for expectations on the characteristics, age and gender of an NPC that can act as a digital companion in software-based cognitive rehabilitation. The behavior model of the NPC is intended to base in the programming on the principle that they do not independently remain stationary in one place or a specific area or path, but move along with the player, e.g., to a certain destination [187]. To accompany or assist the player is one role that NPCs can take. There are several categories for this, for example according to Warpefelt for friends the subdivisions into sidekick, ally, companion, pet and minion [398] and furthermore roles like tutors, goal-givers or mentor [114, 316]. For example, they can be used when something is too difficult for a single player or designed as too difficult to foster interactions [49].

Pedagogical agents support the user by providing guidance. Schroeder et al. suggest that in learning, the use of pedagogical agents can make systems more effective [335].
Regarding the use of educational agents in a learning environment, Baylor and PALS show that different role models are perceived differently [35].
While a motivator was perceived as engaging and an expert was perceived as credible, a mentor combines both and leads to better learning transfer. This indicates that several characteristics can be relevant.

In line with Emmerich et al., a companion is defined in this work as a character that accompanies and supports the player throughout the game, but does not need to be controlled by the player [114].
The behavior of an NPC should be aligned with the player's expectation of him / her and provide support in achieving the player's goal [114, 153]. In computer games, companions are expected to have the basic attributes skilled, helpful, nice, attractive and naive [316]. Bouquet et al. indicate that NPCs could take on leading roles beyond an accompanying

role [50]. The way of realizing NPCs for patients in cognitive rehabilitation will therefore be considered in the following.

Explorative Feasibility Study

In this part, the focus is on the excerpts regarding aspects of characteristics, age and gender representation, which are considered according to the research question. Due to the explorative procedure, considerations of different graphic styles are not taken into account.

Design of the Appearance in Age and Gender

Social interaction is intended to address relatedness in the long term [318]. In this step, the design of age and gender of different NPCs is considered. For this, the visual representations of three female and three male companions (Figure 6) were designed: One companion each in the range under 35 years (young), 35 - 49 years (middle aged) and over 50 years (older). These were developed iteratively in collaboration of a psychologist and a project manager from the field of cognitive rehabilitation, and a designer.
A consistent style and clothing is used to minimize further influences by personal preferences, e.g., in the color or clothing style and a thereby possible bias. The choice of the skin color of the NPC is based on the reason that the study was carried out in Germany and that the participants are most accustomed to it in their everyday life. Primarily the head is modified by the change of the age and age-appropriate representation of the hair, secondarily the age- and gender-appropriate body form.

Method

An explorative feasibility study was conducted based on a structured interview. First, the participants were informed about the voluntary participation, goals and background of the study. As a theme, the metaphor of a long hike with the possibility of taking a companion was described. Closed questions were asked about representations to bring about a decision. Open questions on characteristics and the reasons for the selection were asked. With regard to the research questions the following items and results are considered:

Characteristics (RQ 1):
a) Which characteristics a companion needs to have in order to take the companion on the long rehabilitation trail (open)

Age (RQ 2) and Gender (RQ 3):
b) Selection of one of three possible female avatars as companions (A, B, C) based on pictures (closed) and the reason for the selection (open)
c) Selection of one of three possible male avatars as companions (D, E, F) based on pictures (closed) and the reasons for the selection (open)
d) Selection between the two avatars previously selected in b) and c) as final selection and the reasons for the selection (open) (RQ3 and in discussion RQ4)

Relation of the selection to the age and gender of the participants (RQ 5):
e) Demographic data: age group (<20, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, >80), gender and existence of acquired brain damage (RQ5)

With regard to the open questions, similar answers were summarized, the frequency of naming was counted and the answers were sorted based on this. Afterwards, for a), similar characteristics were clustered. Concerning b), c) and d), the occurrence for conspicuities with regard to age and gender of the participants were analyzed.

Participants

The study was conducted at the Open Day of a German University Hospital with attached outpatients clinic for cognitive neurology in September 2018. 40 participants took part in the study (female: 24; male: 16). They are composed of patients in cognitive rehabilitation (n=5) and persons with professional or personal knowledge and connection to the topic and / or interest in (n=35).

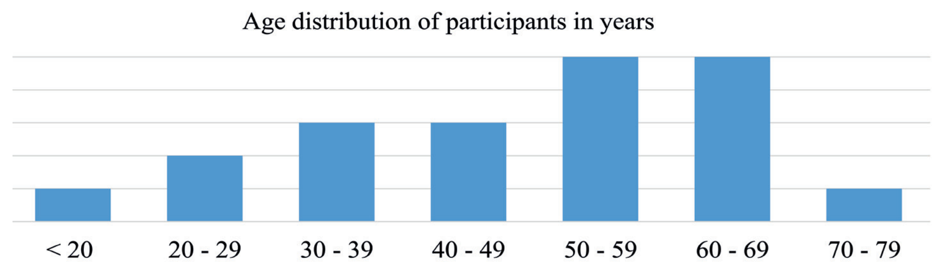


Figure 7. Age distribution of participants in the study. Figure from Gabele et al. [132].

Table 6. Sorted and clustered answers for requested characteristics for a companion on the (hiking) path of rehabilitation. The number in brackets shows the frequency of naming by all participants. Characteristics without brackets were mentioned once. Table from Gabele et al. [132].

Character (44): friendly (4), authoritative (4), empathetic (4), relaxed (3), patient (3), clear (3), charismatic (smile / be positive) (2), open-natured (2), demanding (2), serious (2), nice, considerate, understanding, uncomplicated, not too soft, energetic, assertive, distinct, strict, resolute, not so serious but funny sometimes as well, also sometimes sarcastic / black humor, objective, helpful, honest
Type / Optical (4): beeing able to walk well, sporty, more dynamic than oneself, both feet on the ground
Behavior / Knowledge (23): competent (7), knows what the best way is especially for me (giving feedback) (5), knows the situation and knows what it is like and how to deal with the situation (2), someone who has gone through this himself, able to give expert advice, giving feedback even if it is negative, explain what makes sense / what doesn't, giving background information, open to questions, interested in the field, bringing the goals I have in line with the therapy, dealing with it individually
Interpersonal (27): motivating (6), when I don't feel like it / have a low point, motivate me to do it (3), must be able to talk to him (2), must be able and willing to listen (to one's own problems) (2), friend (2), relaxed atmosphere, person in a position of trust, right chemistry, says what to do, takes the lead, pays attention if one does the tasks, supporting, doesn't force you, calming, provide security, able to catch me, get to know each other on a neutral basis

The age groups ranged in steps of ten from under 20 to over 70.
According to the experts with whom were collaborated during realization of this chapter, the age distribution curve reflects the approximate distribution of patients in cognitive rehabilitation and is shown in Figure 7.

The participants were personally asked about their interest in participating in the study. They were selected on the basis of their age, which fits approximately to this distribution, and otherwise without further selection criteria. All participants took part voluntarily in the study and were not rewarded.

Results, Clustering and Analytical Procedure

Table 6 shows the required characteristics for an NPC companion, clustered in Character, Type/Optical, Behavior/Knowledge and Interpersonal. Figure 8 shows the results for selection of female and male companions and the final selection. For female companions the middle-aged (B) is preferred. For male companions the younger male (D) is preferred. A final selection was made between the previously selected female and male companion. 50% of the participants preferred the middle-aged female companion B. Additionally, Figure 8 lists the reasons for the selection on

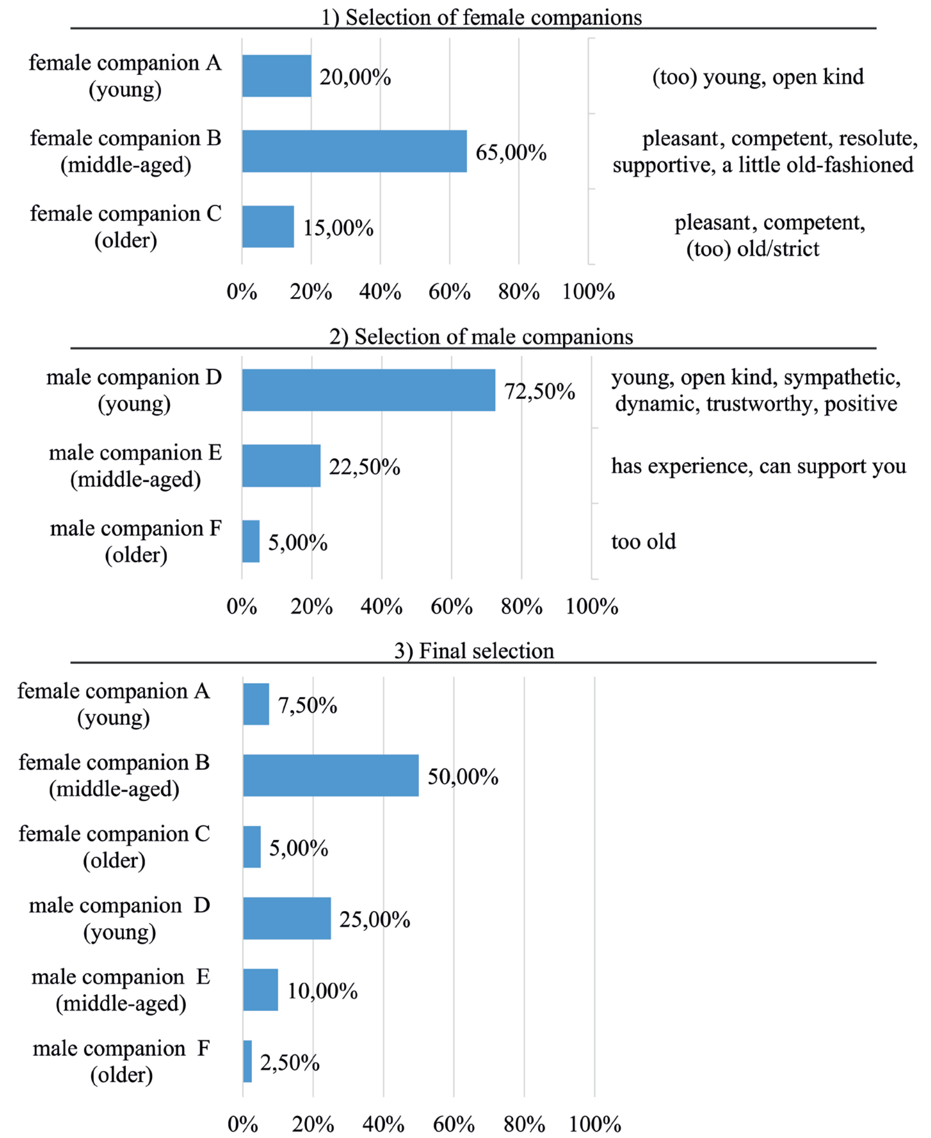


Figure 8. Percentwise 1) selection of female companion and reasons for selection, 2) selection of male companion and reasons for selection, 3) selection of the final companion. Figure from Gabele et al. [132].

the right axis, or below. The relations between the chosen companion and the age and gender of the participant are described in Table 7 and at the end of this section. The focus here is on conspicuities that emerged in the data analysis.

With regard to Figure 8.3, the reasons for selection after clustering by frequency of naming are as follows: sex (11), animating / supporting (6), competence (6), sympathy (6), empathy (5), sense of security (5), trust (4), assertiveness (4).

Table 7. Percentwise 7.1) selection of female and male companions based on age group of the participants, 7.2) selection of female and male companions based on gender of participants, 7.3) final selection based on age group of the participants, 7.4) final selection based on gender of participants. Table from Gabele et al. [132].

Chosen female and male companion								
Participants	female A	female B	female C		male D	male E	male F	
7.1) age								
Young (<30)	5%	7.5%	2.5%		12.5%	2.5%	0%	
middle aged (30-59)	7.5%	42.5%	5%		32.5%	17.5%	5%	
old (>60)	7.5%	15%	7.5%		27.5%	2.5%	0%	
Overall	20%	65%	15%		72.5%	22.5%	5%	
7.2) gender								
women	20.83%	54.17%	25%		83.33%	8.33%	8.33%	
men	18.75%	81.25%	0%		56.25%	43.75%	0%	
Chosen final companion								
Participants	female A	female B	female C	female overall	male D	male E	male F	male overall
7.3) age								
Young (<30)	0%	2.5%	0%		0%	2.5%	0%	
middle aged (30-59)	5%	32.5%	2.5%		15%	7.5%	2.5%	
Old (>60)	2.5%	15%	2.5%		10%	0%	0%	
Overall	7.5%	50%	5%		25%	10%	2.5%	
7.4) gender								
women	8.33%	45.83%	8.33%	62.5%	33.33%	0%	4.17%	37.5%
men	6.25%	56.25%	0%	62.5%	12.5%	25%	0%	37.5%

Taking account of the demographic data, only 7.5% prefer the oldest companion (female C and male F) in the final selection (Table 7.3). Of these, all were female in the age range between 40 and 69. The young female companion (A) was chosen by 7.5%, of whom 5% were female in the age range between 50 and 69 and 2.5% male in the age range between 20 and 29. The middle-aged male companion (E) was chosen in the final selection exclusively by men (Table 7.4), who were equally distributed between the age ranges from under 20 to the ages of 50 - 59. The older man (F) was chosen exclusively by women between the ages of 50 and 59.

Regarding only the participants with brain damage and cognitive rehabilitation, 60% chose the middle-aged female companion (B), 20% the younger female companion (A) and 20% the younger male companion (D). This results in 80% of the participants with brain damage who chose a female companion.

Discussion and Conclusion

In a subsequent review of this step for the general consideration of the implementation of an NPC by Wittmann and Morschheuser, various requirements for the attributes such as empathy and giving feedback were confirmed [410]. They further point out the relevance of appearance, as it can influence the user's behavior.

Previous research has shown the different expectations of the roles of NPCs]114, 316, 398]. In the presented study, the requested NPC is predominantly described as an empathetic friend and competent at the same time (RQ1). It has to be motivating, but also strict if necessary. This results in a combination of different characteristics, as described by Baylor et al. for the role of the mentor in Pedagogical Agents [35]. The requested characteristics and that being naive is no requirement, differs from the expectations of a classic companion in computer games [316]. Rather, a combination of companion and mentor is the result, which also includes behavioral aspects that are expected from therapists [295]. Moreover, the assumption of Bouquet et al. is supported, that companions can not only take on supporting roles, but also leading ones [50]. This may indicate a need for trust and guidance in a situation that cannot be assessed by the individual where necessary skills are lacking.

Thus, in the development of NPCs as companions in software-based cognitive rehabilitation, the characteristics shown should be in the foreground. And the role can be supported by appropriate realizations of appearance and behavior [114, 398].

A mentor is additionally described by Rogers et al. as wise and intelligent, but also old [316]. Regarding the age (RQ 2), this does not correspond to the expectations for a companion in rehabilitation. The selection of the younger to middle-aged companion might be based on a need for strength for long-term support. If older NPCs are chosen, patients frequently stated that the reason is due to the closeness to one's own age. This may indicate the need to bring up empathy for the personal situation.

Existing classifications [316, 398] are an important basis for comparing these systems with the needs of patients and possibly extending them.

Regarding gender (RQ3), the middle-aged (B) is preferred for the female companions and among others described as pleasant and competent. Among male companions, the younger one (D) is preferred and described as sympathetic and dynamic. However, in the overall selection in particular the woman was requested.

In learning, Shiban et al. found that a female virtual agent, who was rated as young and attractive, had a positive impact on participants' interest compared to the male agent presented [341]. Previous research on gender has shown gender expectation due to stereotypes and that selection criteria in learning are partly associated with the assignment of characteristics to a gender or individual gender [209]. Also in the presented study, desired characteristics, which were stated previously by each participant, were later often linked to the choice of gender when the reasons for the final selection were stated.

Compared to the previously stated requirements (RQ4), no gender-specific requirements were specified for the NPC. The final selected NPCs attributed comparable characteristics as requested for characteristics before. These were thus confirmed based on the representation of the companions. Furthermore, this may indicate that certain characteristics are requested on the one hand. On the other hand, it may indicate stereotypical expectations [316], rather than individual characteristics, for realization [367]. This is a relevant aspect, since the design of the appearance of a companion is relevant for the development of the expectation of its role and characteristics [114].

In the study, only two gender role models (male and female) with light skin color were tested. Further diverse gender roles, appearance, and interpretations should also be evaluated [129]. The resulting diversity of characters can be adapted to the diversity of players and their needs, as suggested by To et al. [367].
Moreover, Bouquet et al. point to other diverse ways of representing NPCs in addition to humans, such as animals or fantasy creatures, among others [50].

Regarding the choice of age and gender of participants (RQ5), it was found that women also chose the older characters, while men did not. Women were more likely to choose the younger male companion, men also the middle-aged. The younger female companion is preferred by older women and younger men. Here various aspects, such as the protective instinct of the older participants or the sexuality of the younger participants may be involved. Due to the low final selection of some of the companions, this can only be interpreted as an indication.

Some further limitations and further steps should be considered. An influence on the data can be assumed by the unequal distribution of the participants between men and women. However, if the percentual distribution of the final selection is compared between female and male participants, it is exactly the same. From this, it can be assumed that the gender of the participants does not influence the distribution of the selection of the gender according to the companion.
Both healthy and patients were included. The comparison of data between participants with and without brain damage shows that the distribution of the selection is similar. That is apparent in the trends in the selection of companions, both female and male, and the final selection. This indicates that the presence of brain damage does not change the needs in the presented situation, because all participants were asked about their personal preferences. However, the observed trend should be treated with caution in generalization due to the small sample of patients. Participants without acquired brain damage know the situation, but are not in the same emotional situation. The acquired brain damage and the resulting experience may lead to further effects in the use of NPCs. This should be examined more closely in further studies. The participants come exclusively from the European cultural area, so the results can only be related to this particular demographic. Due to the exploratory approach of the feasibility study, the results should be considered as trends. Deviations from the trend can arise due to individual personalities and resulting needs [231, 372]. Therefore, the results provide a basis for further studies to consider the conspicuous results found here in detail.

Overall, this step shows the requested aspects of an NPC in terms of character, age and gender to support patients in software-based cognitive rehabilitation. The results propose an approach for the use of companionship by NPCs in software-based cognitive training in rehabilitation. For further usage, this is intended to promote the feeling of social relatedness and intrinsic motivation [321] and support the patient mentally during the rehabilitation process in the long-term. Through an NPC as a partial aspect of the storytelling [49] (see section 3.2.1), a part of the autonomy [271, 321] in a metaphor might be addressed by extending interaction and decision possibilities to the integrated NPC.

Paradeda et al. use a robotic NPC and show that they can influence the decision of players [288]. However, NPCs with low assertiveness are perceived more positively in emotional re-

gard [288]. This indicates that the needs of the users should be considered as a basis and the implementation of the NPC in the intended effect should be directed to them.
Nijholt suggests using a social companion in augmented reality, which could also be tested for patient support and motivation in the next step [274].

The results provide a design basis for the further implementation of existing frameworks and further developments [50], or technical integrations, such as for personalization [4, 196] or Artificial Intelligence [49]. This enables a more individual tailoring to the characteristics of the user [288], which may result in different weightings in the various roles. The tailoring of various elements is addressed in the next step in section 3.3.

Due to the intended emotional impact, it is important that the NPC reacts according to the patient's behavior and needs. Beyond non- or hand-scripted implementations, e.g., Manavalan and Bulitko propose an algorithm for emotionally appropriate reactions of NPCs [242]. Appropriate behavior in an easy way for development should be further considered based on the characteristics analyzed in this step in the implementation of different responses suitable for the specific situation of rehabilitation.

In conclusion, the results show a trend to integrate a middle-aged female or a younger male companion. The relevant characteristics include emotional empathy as well as competence and authority, which implies that different characteristics should be included. This knowledge of the target group supports the development process of NPCs, which are intended to provide emotionally wanted support and are based on needs-oriented realization. The results also indicate the relevance of tailoring gamification elements in use to the needs of patients in the situation of rehabilitation. Thus, this step contributes to deepening and specifying the use of NPCs in cognitive rehabilitation and provides guidance for their development in practice.

Take-away & Key aspects

- *An NPC for rehabilitation combines various classic role models*
- *Middle-aged female or a younger male companion are preferred, in the overall selection rather a woman*
- *Emotional, friendly but also competence-oriented characteristics and taking the leading role are requested*
- *Requirements for characteristics are reflected in the selection of the offered NPCs*
- *As a result for an accompanying NPC, the connection of different roles, as friend, mentor and aspects of therapist is indicated*

3.3 User Requests, Effects and Ways of Tailored Gamification in Software-Based Training

3.3.1 Focus and Purpose
3.3.2 Research Questions and Background
3.3.3 Steps and Method
3.3.4 Results
3.3.5 Discussion and Conclusion

Note: This step is related to a larger clinical study [401] and includes only partial results of it as its exploratory extension and deepening

Motivation can be addressed beyond an one-size-fits-all approach through tailored gamification elements individualized to the user. To consider requests for elements and effects in cognitive training, a clinical study (N=83, with outpatients undergoing three weeks of cognitive training in their home environment) was deepened with questionnaires and further exploratory questions.
The use of gamification in relation to the patient's user type was explored in three steps. First, the individual user types and related requests for specific game elements were determined by means of questionnaires. Afterwards, the effect of gamified training based on a Non-Player Character and training progress within a metaphor was examined. Secondly the individual perception and emotional effect and thirdly the performance based on training duration were considered.
The results showed that 37 elements were requested by patients of all types, 18 elements were partially requested, and 4 elements were rejected. A comparison shows that the requests partly differ between healthy persons and patients. Overall, gamification was perceived positively and gamified training lead to an increase in enjoyment compared to non-gamified training. In detail, however, there were different effects on the individual user types: socialisers experienced more enjoyment while achievers perceived higher competence throughout gamified cognitive training. Also, differences in performance in training duration were found. Within gamified training, socialisers trained significantly more than patients not primarily assigned to this type. In contrast, no significant difference was found for achievers. This supports user-centered tailoring of game elements in the development of software-based cognitive training in rehabilitation and provides guidance for the selection and use of elements in practice.

3.3.1 Focus and Purpose

Gamification may lead to an increase in motivation [392], but effects and requests cannot be generalized for every element and user [15, 215, 281, 290, 325, 326, 372] (see section 2.3). For its integration, it is important to stimulate positive effects while avoiding negative effects [199, 281, 320]. At the same time, over-

loading the user by introducing too many aspects and strategies should be avoided [210], especially for clinical use. Thus, knowledge about requests and effects is relevant. Therefore, the focus in this step is on the consideration of individualization and tailoring of gamification for selection of elements for patients in cognitive therapy.
This is addressed by the consideration of user-centered individual requests for game elements as a supplement to software-based training in cognitive rehabilitation (RQ1), the subjectively perceived emotions and motivation (RQ2) and the behavior of two user types based on the performance in training duration (RQ 3).

The integration of a software-based progress map as a game element in cognitive therapy has initially shown to be promising in prior work [129]. Also, in the previous steps of this work (section 3.3.1 and 3.3.2), the use of the elements story, metaphor and NPC in software-based cognitive rehabilitation is examined. Corresponding aspects can be found in the following part and were developed further.
For this, for a low complex frame story, the hiking trail metaphor was used as a setting (see 3.3.2, and as further development of a prior concept [129]). Beside simulation of real-world settings, also, e.g., analogies to the real world can, according to Nicholson, contribute to the development of meaningfulness in stories [271]. They can assist the user in bringing the situation closer and integrating personal interests [379]. Lugmayr et al. propose the definition 'serious storytelling' for stories that are connected with a serious context outside entertainment [237]. Based on this, the designed metaphor is intended to create a mental model [273] of the rehabilitation path and goal, and support the development of a relationship and emotional and cognitive response. This basis is intended to support the motivation, goals set [227] and thereby reach the goal of rehabilitation [190, 276].

The results of this step contribute to a more targeted and tailored selection of gamification elements for implementation in the development of software-based cognitive rehabilitation and an understanding of their effects on patients. The research questions (RQ1-3) were investigated by expanding a clinical study [401] in patients with acquired brain damage that underwent three weeks of computer-based training with or without additional game elements.

3.3.2 Research Questions and Background

Tailoring Gamification in Health

Based on their character, users can be assigned to different user types [34, 241, 266, 415]. Different user types can be assigned to different game elements in terms of type and quantity [215]. Tailored elements can have a positive impact on perception, task performance and user engagement [280]. In health-related behavioral changes, tailored game elements depending on the players' character are ways to influence the effectiveness of training or, e.g., healthy eating [199, 281]. It is highly relevant to select specific elements suitable for the user to achieve the desired effects and compliance [202]. Therefore, knowing the target group, their characteristics, needs and behavior are essential for most gamification frameworks [258, 262]. In this vein, the context in which gamification is used is relevant for its effect on user motivation [156, 160]. To create a user-centred approach for patients in rehabilitation, the request for game elements in cognitive rehabilitation will be investigated in

- RQ 1: Which game elements are requested by patients in software-based training in cognitive rehabilitation depending on their user type?

For this the request for gamification elements depending on the patient's user type are recorded and compared in the average with the existing data of healthy persons.

Emotions and Behavior in Training

Visualization and positive feedback are, among others, mechanics and important for the drive to perform [100]. In sports, health programs and apps, usually the user's progress is visualized. In health apps, tracking and presentation of personal physical or performance data is used for self-improvement [85]. According to Tondello et al., regarding healthy players, progression and immersion are suitable to address self-efficacy and individual motivation [372]. Feedback on progress shows success in achieving the goal and can support repetition of a behavior [313]. User performance increases significantly by implementing the combination of progress bar and feedback [247]. Performance graphs as a game element measure and show among others performance development of players [325].
In a prior approach, the concept was introduced to illustrate step-by-step the level of performance within a visualized pathway [129]. An initial qualitative evaluation indicates the potential suitability to address motivation. However, both a goal and the implementation within a software-based cognitive training were lacking.
According to goal setting theory, the behavior is related to goals and the feedback given for them [118, 233]. Based on the received feedback, behavior can be regulated accordingly to foster progress towards this goal [198]. Research showed that progression is among others related to a meaningful goal [372]. According to Sailer et al., performance graphs as one component can help to increase the perception of competence need satisfaction and meaningfulness, as well as meaningful stories and teammates social relatedness [325, 326]. Also in eHealth, progression is a rather common element in gamified apps / serious games [329]. In current cognitive rehabilitation trainings for adults, progress is for example frequently visualized in classic charts, such as lines or bars [162]. Furthermore, in the style of games, stars are used, for example, to represent progress in levels [172]. Such visualizations represent past progress and partly further tasks based on the training software, but provide a limited basis for future steps in personal rehabilitation and thus a less meaningful user-oriented integration of the overall goal. Based on serious games, a case study suggests that seeing one's improvements may increase the motivation for training [6].
Within a story, the user can see connections between past, present and future [271]. Progress visualizations that enable to track one's improvements have been successfully realized by a metaphor (using a map or a path) and avatars or NPCs, who walk along such paths to illustrate the progress in various games. Similarly, the presentation of progress by a mountain [388] or a path through a landscape for use in software based cognitive therapy [129] are shown as a possibility promising potential. Furthermore, digital characters show the possibility of supporting behavioral changes through feedback [232]. In games, there are corresponding opportunities for use, such as giving the player hints, informing or helping [398]. For software based interventions, Schlosser et al. have shown, based on a mobile app for patients with schizophrenia, that frequent shorter communications with a coach can increase engagement (e.g., login, peer and coach interaction, active use rate) [333].
The requests for the characteristics of an NPC to accompany in cognitive rehabilitation were considered in section 3.3.2. However, it is unclear how an NPC and combined progression metaphors are perceived in clinical conditions during use by users with cognitive impairments. This leads to

- RQ 2: How is the integration of a gamified metaphor using a combined social NPC and progression in software-based training in cognitive rehabilitation a) perceived in its implementation and b) does it affect emotional or motivational perceptions depending on corresponding user type?

For this, as a basis the general perceived effect of the gamified training used and in detail on two user types is considered.

In learning, gamification led to significant increases in cognitive, motivational and behavioral outcomes [327]. In motoric rehabilitation in home training, indications are found that addressing motivation may have a positively affect on motivation, adherence and training results [125, 361]. In cognitive rehabilitation, positive effects are shown on motivation / engagement [392], and mixed results on cognitive outcomes [192] and task performance [239].

As described in section 2.1.3, a lot of cognitive training has a positive impact on effectiveness [368, 403]. Therefore, it is important to examine how the use of elements affects training behavior, depending on whether the integrated elements fit the patient's type. This may have both a positive but also a negative influence on the training duration. This leads to:

- RQ 3: Does the implementation of the gamification elements NPC and progress influence the training duration in software-based training in cognitive rehabilitation depending on user type?

For this, the effect of the gamified training on training duration on two user types is considered.

3.3.3 Steps and Method

Initially, with the integration of strategies, one aspect of the feasibility of the approach was considered. Extending this, a browser-based training approach, based on a training for verbal memory [170], was developed with, among other things, the implementation of gamification as a part of it. In a following clinical study, different aspects of effects, implementation and behavior were assessed. Based on this, a deeper analysis was conducted, which is in focus below. In it, parts of the clinical study are considered in more depth with regard to the effect and perception of gamification, which is wrapped around training tasks [325].

Feasibility of including strategies in training

One actual goal is to improve and use the personal skills in daily life [48]. For this, tips for everyday life can be obtained from other patients [129] or therapists, or strategies can be used. One approach in rehabilitation is relearning or retraining [19, 175]. In cognitive training for patients, strategy-oriented training and / or compensation strategies are recommended [368].
In the field of software-based cognitive behavioral therapy, in the mobile app 'MoodMission', strategies were implemented that patients receive when they feel low or anxious [26]. This partially increased mental well-being and addressed self-efficacy.
For the clinical study of the next step, in an initial feasibility study [133], it was considered how a strategy can be combined browser-based with an existing training for verbal memory [170] to transfer the training into the daily life of the patients.
In the training task, the patient read texts, memorized it and answered multiple-choice questions about the text. For the approach created, these were combined with the existing 'Visual Imagery' strategy [27] in a browser-based click prototype:
The patient imagines a picture of the elements in the text or information received. For usage in software, the strategy is explained in three steps: (1) at the beginning of the training the use of the strategy, (2) after half of training an extension of the strategy and (3) at the end how to train or use it in daily life. Between the steps, the strategy was practiced with examples.

In a qualitative evaluation (N=4 patients with acquired brain damage), it was shown that the strategy was understood and that there was interest in learning strategies and wanting to use them in everyday life. It was mentioned that the strategy is not helpful in all situations. However, the enjoyment in this way of training was described as higher than in current training. The division into three steps was perceived as meaningful.

The results initially indicate the feasibility and interest of integration into the training. This indicates the possibility for use in the next step.

Table 8. Study design of the clinical study. Table based on Weicker et al. [401].

		External to the training task via the web interface in the training account (metaphor 'rehabilitation as a hike').	
Within the training task (memory strategies and practical tips for everyday life)		No complement (in the following deepening part 'Group A')	With complement (in the following deepening part 'Group B')
	No complement	1	3
	With complement	2	4

Procedure and Method

Within the cooperative project, the approach was realized in an interdisciplinary team with different responsibilities and focus.

Clinical Study

The data presented below in this step were collected within a larger clinical study [401] targeting motivation in cognitive therapy after aquired brain damage. Initial results of the clinical study indicate that gamification does not seem to influence behavior in general. However, indications of motivational effects and differences in requests of motivational gamification elements were found.

Study Design of the Clinical Study

N=83 patients suffering from cognitive impairments after acquired brain damage gave written informed consent to participate in the study. They underwent outpatient cognitive rehabilitation and were able to conduct the study in terms of language, communication, cognitive and motor skills at home. They were in phase D to E based on the German rehabilitation system [388] and had mild to moderate cognitive impairments according to clinical and neuropsychological assessments (Montreal Cognitive Assessment [195]: M= 25.98, SD= 2.61; no significant differences between groups). Patients with severe deficits were not allowed to participate, as for them independent computer based training at home would not be reasonably possible. Participating patients were provided with access to a medically approved software-based training for three weeks. The number and duration of the training sessions were not fixed and could be chosen individually.
However, it was recommended to train for 15 minutes at least twice a week, preferably more often. 64 patients completed the training phase successfully.

The study included four phases (and parts of the data collected therein):

1. Information and written consent,
2. Pre-test and pre-survey (demographic data, disease-related data, abilities / disabilities, various character-related measurements incl. identifying user types, requested game elements),
3. Individual training phase (incl. interim survey with, among others, perception and (technical) execution, incentives / own motivation to conduct the training, perception and assessment of the NPC), and
4. Post-test and post-survey (abilities / disabilities, perception of execution, incentives / own motivation to conduct the training, requested elements / aspects in the training, perception of integrated training aspects (e.g., strategies), different aspects of possible / integrated gamification, intrinsic motivation, game experience, perception and assessment of the NPC, presentation of the training, usability, own behavior, professional situation, positive and negative aspects as well as study execution), and determining the effect of the gamification elements.

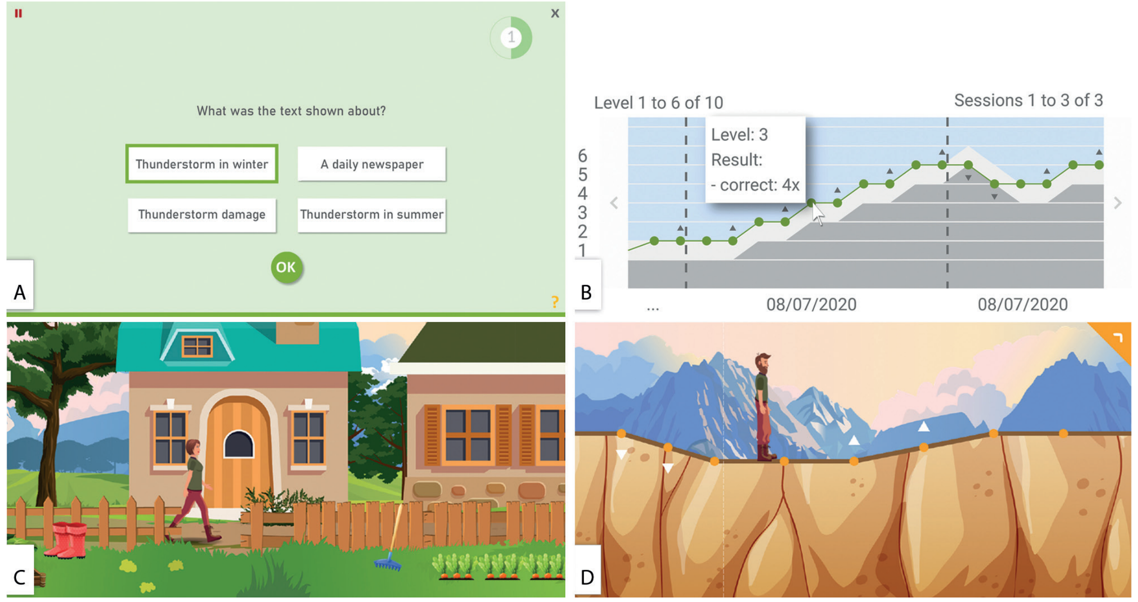


Figure 9. Training for verbal memory (A), line chart (B), mountain ridge (C) for progress visualization and hiking path (D). Figure from Gabele et al. [136].

The study was conducted multicentre and double-blind and was approved by the local ethics committee (297/19-ek). A follow-up survey was additionally conducted to determine which content was seen and perceived or remembered.

Based on the basic training, different elements in two areas (within the training and external across the training within the training account) were integrated and considered in the clinical study in four versions (Table 8).

Basic and Gamified Cognitive Training on the Online Platform in the Clinical Study

Within the clinical study, a basic training and different complements in four groups were used (Table 8). For a deeper insight and focus on the effect of the game elements used (required for RQ 1-3), two groups are differentiated for the following step: Patients who used cognitive training without (group A) and cognitive training complemented with game elements integrated in a metaphor (group B). Therefore, in this part the training implemented is described with a focus on these two components.

Both groups conducted during the training task the same training for verbal memory, based on an enhanced existing medically approved software training [170] as a web application (Figure 9 A). Within the training, texts were shown to the patient. The related information has to be memorized and reproduced in multiple-choice questions. Depending on the percentage of correct answers, the difficulty is adapted by adjusting the difficulty level from one to ten. The integrated concept complements the training and does not change the type of tasks. This is intended to ensure the therapeutic effectiveness of training.

As a possible additional element, memory strategies, and practical tips for everyday life among others were integrated. The feasibility of a similar approach has already been considered qualitatively earlier (see above). These elements were provided to parts of Group A and B (see Table 8).

Also, visualizations of their progress were shown to the patients. The requirement in the visualization of progress is based on a realistic, not embellished presentation to provide self-assessment. The information must not be presented in a too complicated way, not to overwhelm patients with cognitive impairments. As a basis and following current visualizations [162], a line chart (Figure 9 B) of training performance was used. The green dots show the results of a specific task and the green line shows the overall performance and the progress of the training level. The grey area marks the levels below the current performance level, the white area marks the level in which the patient is classified, and the blue area marks the levels above. This visualization was presented to both groups.

According to Hamari and Koivisto [159], the acceptance of gamification is influenced by both utilitarian and hedonic aspects. Based on the line visualization, and as further development of a prior concept [129], the gamified metaphor of a hiking path and NPC was chosen in several brainstorming sessions by a multidisciplinary team of psychologists, computer scientists, and interaction designer focusing on gamification. Reasons for deciding on this metaphor included the transferability to the rehabilitation process and the accessibility for a wide range of patients. Nature tourism, especially hiking, offers opportunities for different age groups and abilities. In addition, according to Hung et al., based on a survey among stroke patients regarding game-based rehabilitation systems, a connection to real life is requested [178]. To address both, with the hiking path, a setting between a simulation of everyday activities like in, e.g., RehabCity [396] and a fictional story like in 'Meister Cody' [253] or section 3.2.1 is chosen.

In an analogy [271], the metaphor of the hiking path illustrates the patient's situation in a pictorial language in a meaningful way through a path towards a goal, mountain peak and successful rehabilitation. In contrast to the prior approach [129], a goal is represented by the mountain peak. Van Dooren also uses this analogy of a mountain to be climbed step by step for gamifying and setting goals in everyday life in the mobile application ‚ReadySetGoals' for eHealth therapy in youth mental healthcare [388].

Thus meaningfulness is intended to be addressed, according to Barrett et al., by performance, progress and the relation to the overall context [361]. Within the therapy, the patient follows progress for which stamina, effort and small steps are necessary. As in rehabilitation, this involves setting a goal, but the process of achieving it is the largest part. A comparison between users or networking was not integrated because of data privacy and the different rehabilitation potentials. The metaphor uses the core game elements of progress, integrated feedback, goal setting and a supporting NPC. Thus, core domains of progression and digital socialization are used. The metaphor-gamified training was only used in group B. To implement the metaphor, the line of the chart described above (Figure 9 B) was transferred to a mountain ridge's corresponding setting (Figure 9 D). Both will be referred to in the following as the performance curve.

Setting a gamification goal to address long-term motivation over several sessions in line with other work [239] is thereby addressed in the form of the mountain peak as a goal. To reinforce the feedback, patients can see in a second visualization how the landscape changes as they progress (Figure 9 C). This is independent of performance and shown after each training session. Thus, despite the possibility of negative feedback in mountain ridge (Figure 9 D), according to the approach of Tamayo-Serrano et al., an encouraging component is integrated [361]. For positive influence through goal-setting, concrete, as well as the setting of overarching and close goals are relevant [227, 233]. Thus, in addition to the overarching goal of reaching the rehabilitation goal / mountain ridge, milestones can be achieved along the way. Some are set by the system (e.g., completion of the 10th training session), but patients can also set personal goals to allow for individual and personally meaningful tailoring. In contrast to the first, this second visualization is not performance-related. Each training session results in progress along the path. This addresses the point of view of Jung et al. [196] and Burke et al. [60], which is to reinforce the positive aspect of execution instead of highlighting a lack of abilities.

The visualization of ridge or path can be switched by using the orange arrow (Figure 9 D). The patient is accompanied by an NPC who walks along the path (Figure 9 C). The NPC does not represent the patient like an avatar, but is a person who accompanies

the patient (see section 3.2.2). The NPC is intended to help the patient to identify with the metaphor, support involvement in the training and to build up an emotional bond. With avatars, character identification has been shown to be related to the development of flow and openness to experience [345]. The concept of the NPC was based on desired characteristics of a digital companion in rehabilitation, such as 'competent', 'motivating' or 'empathic' (see previous results in section 3.2.2) [132]. Patients can choose a woman or a man. The NPC interacts with the patient, e.g., by greeting and commenting on performance. In training, step by step, the patient can select equipment for the NPC from various objects for the hike to reach the mountain peak, symbolizing successful rehabilitation. NPC and complementary elements are introduced step by step to avoid distraction or overload by too many elements, following Katz et al. [205].
The elements used are intended to address the aspects of the Self-Determination Theory [88, 321, 318]: competence (achievable goals), relatedness (interaction with the NPC), autonomy (positive feedback, immersion).

Methods RQ1 - RQ3

Based on indications found during the first examination of the results in the clinical study [401] on motivational effects and different requests for gamification elements, the question arises about possible individual effects. Therefore, a further exploratory approach was conducted to consider the individual requests, effects and possible tailoring of gamification elements, which considered different types of players. For this, only partial aspects and results of the clinical study are considered. Through this procedure, the focus is on addressing TRQ1 (Implementation of elements) and TRQ2 (Effects in perception and training duration) of this thesis.
In the following, the methods for RQ1 - RQ3 of this step are described. Due to drop-outs of patients at different points in the study (e.g., due to technical and medical reasons), different numbers of patients are included in the analysis of the research questions. The respective number of patients included is stated in the results section for each research question. Exclusions are mainly based on missing data or anomalies / schematic answers or technical problems.

RQ 1: User Types and Game Elements:
User types and requested game elements were identified during the pre-survey. The Gamification Player and User Types Hexad [244] and the corresponding existing questionnaire [374] (7-point Likert scale (1 (do not agree at all) - 7 (agree completely))) were used to identify the patient's user types. Although there are also classifications of gamification in rehabilitation, such as according to Tuah et al., this only includes the structuring of the rehab domain, application and elements [379]. Gamification Player and User Types Hexad allows for the classification of users into types, descriptions and linking to game elements and comparative data of healthy persons [372], a link to persuasive game strategies [284] and is particularly appropriate for gamification [156]. For the study, the questionnaire was translated into the language of the participants (German). Participants can be assigned to several types based on equivalent results of the highest propensity. The user types identified permit the classification of patients as follows:

- primary type (highest score is in this type),
- non-primary type (highest score is not in this type and instead between second highest and lowest score) and
- least suitable type (lowest score is in this type)

For distribution, primary and least suitable type were considered. For request of game elements, a version of the questionnaire on Elements of Gameful Design (59 items, 5-point Likert scale (1 (I do not like it at all) - 5 (I like it very much)) [372] was used as a basis. For this, a cluster of eight categories (Socialization, Assistance, Immersion, Risk/Reward, Customization, Progression, Altruism and Incentive) showed the correlation between user types and categories [372]. For usage in the study, the questionnaire was adapted to the context of rehabilitation because some items were difficult to understand for non-players. Three iterations assured the adaption quality with three middle-aged non-players and two cognitive rehabilitation experts to ensure comprehensibility and suitability. The changed items were compared to the original questionnaire to ensure that their meaning was preserved. One item (Social Competition) was transferred to the individual's performance (Self Competition).
For the rating of the elements depending on the user type, the primary user type was used. For each element, the average ratings of all user types are stated. Then it was examined how many elements were rated exclusively positive, mixed (positive, neutral or negative) or exclusively negative by the user types.
For the request in categories, the four top loading elements per category [372] were used. For 'Socialization', the fifth element (Social Status) was used due to the change of 'Social Competition' to 'Self Competition'. The average rating of the patients was compared with existing data of healthy persons [243, 372].

RQ2 - Emotions and Motivation
To determine the effect on the perception of individual user types of a gamified metaphor using a social NPC and progress visualization, ratings from parts of the questions in the post-survey were considered. All between-group comparisons were analyzed with the Mann-Whitney-U-test to detect significant differences (two-tailed, alpha = 0.05). The perception of the performance curves in comparison between group A and B in terms of comprehension, self-assessment and information content was collected. The effect of gamification is context- and realization-dependent [156]. Therefore, one of the items per and of different aspects describing emotional effect or the perception of the aspects relevant to the implementation of the metaphor were considered (one item per: Metaphor, Goal, Visualization, Progress, Milestone). As a basis, the impact of the elements in general was considered. In detail, two primary types were analyzed: socialiser (because one core element of the gamified metaphor is based on social interaction with the NPC and socialization elements correlate most with socialisers) and achiever (as it correlates with progression in healthy persons and is primarily motivated by competence perception [372]).
Collecting items or equipping an avatar or NPC are typical elements in games. In rehabilitation, however, the success of the patient is in the focus. Therefore and due to socialiser, it was considered whether supporting the NPC or receiving support was perceived as more positive by ratings in group B on a 5-point Likert scale (1=Not at all true, 5=Completely true). Based on collected elements orientated on the Intrinsic Motivation Inventory (IMI; 7-point Likert scale: 1=not at all true; 7=very true) [198], the perceived competence contained therein was considered due to achiever. Enjoyment and effort were considered in both groups in the training phase based on a 5-point Likert scale (1=none; 5=a lot).

RQ3 - Performance in Training Duration
To evaluate the effect of user-centered gamification on the behavioral level, the individual training duration was analyzed. For user types socialiser and achiever, the training duration for both, within and between group A and B was compared. For this, the primary user types were considered. The training duration is represented by median time spent with the cognitive training tasks. An unpaired t-test was used for significance analysis. The threshold for significance was set to 0.05.

3.3.4 Results

User Types and Game Elements

Results of Patient Data

68 patients completed the user type questionnaire according to the Gamification Player and User Types Hexad in the pre-survey (f (female)=29; m (male)=38; d (divers)=1, mean age=47 years, age range=18-78 years). Philanthropists are most (27.59%), and disruptors are least represented in primary type (1.38%). Regarding the least suitable type, the most are disruptors (53.33%) and the least is free spirits (1.11%). The distribution of all user types in patients is shown in Figure 10.
Data from 61 patients were analyzed regarding the adapted version of the questionnaire on Elements of Gameful Design (f=28, m=32, d=1, mean age=47 years, age range=18-78 years). The detailed results can be found in Figure 11.

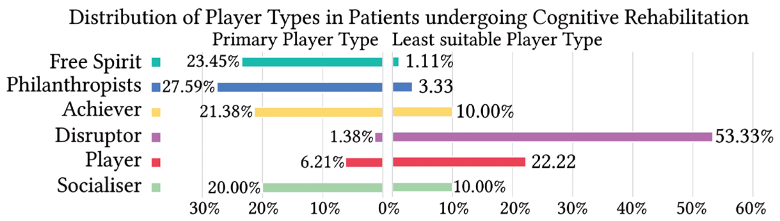


Figure 10. Distribution of Primary and Least Suitable User Type in Patients. Figure from Gabele et al. [136].

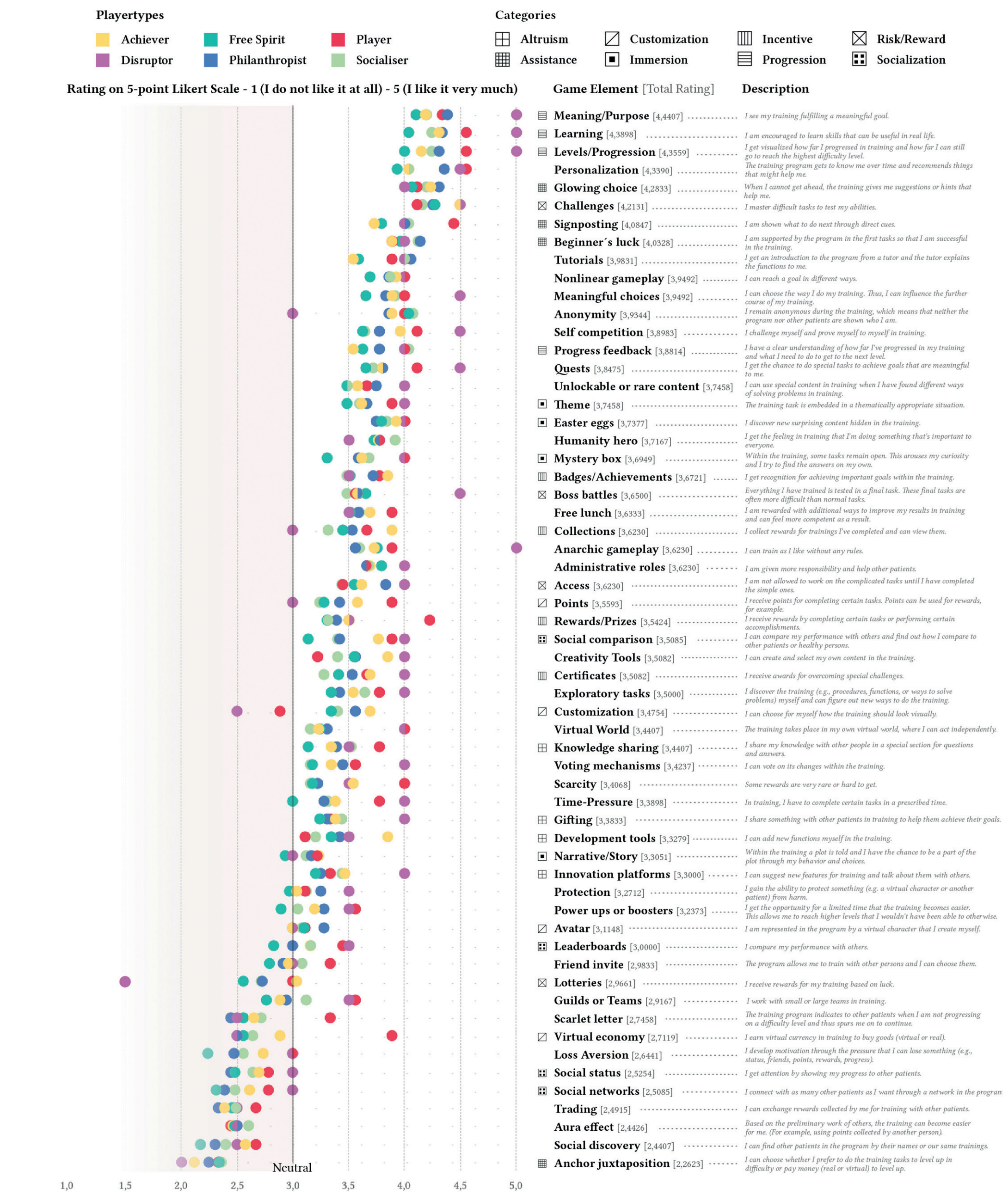


Figure 11. Ratings of Game Elements depending on User Type in Patients. Figure from Gabele et al. [136]. For better readability: graphic enlarged in the appendix.

Table 9. Requested game elements of patients by categories. Highest ratings are printed in bold, lowest in italic. Philanthropist (Ph), Free Spirit (FS), Achiever (A), Socialiser (S), Player (Pl), Disruptor (D). Values are stated in mean (standard deviation). Table from Gabele et al. [136].

Name	Overall (SD)	Ph (SD)	FS (SD)	A (SD)	S (SD)	Pl (SD)	D (SD)
Progression	**4,27 (0,22)**	**4,20 (0,25)**	**3,94 (0,19)**	**4,05 (0,30)**	**4,18 (0,08)**	**4,36 (0,23)**	**4,75 (0,43)**
Assistance	3,67 (0,82)	3,67 (0,83)	3,54 (0,70)	3,49 (0,81)	3,68 (0,76)	3,69 (0,81)	3,50 (0,87)
Immersion	3,62 (0,18)	3,54 (0,22)	3,38 (0,31)	3,60 (0,25)	3,56 (0,27)	3,78 (0,32)	3,75 (0,43)
Risk/Reward	3,61 (0,44)	3,60 (0,56)	3,51 (0,62)	3,68 (0,52)	3,45 (0,51)	3,53 (0,40)	3,63 (1,24)
Incentive	3,59 (0,06)	3,54 (0,12)	3,42 (0,07)	3,73 (0,15)	3,35 (0,08)	3,83 (0,23)	3,50 (0,35)
Altruism	3,36 (0,05)	3,34 (0,07)	3,23 (0,07)	3,51 (0,20)	3,40 (0,12)	3,39 (0,24)	3,75 (0,25)
Customization	3,22 (0,34)	3,19 (0,41)	3,07 (0,31)	3,29 (0,35)	3,09 (0,28)	3,44 (0,45)	*2,75 (0,25)*
Socialization	*2,89 (0,41)*	*2,81 (0,42)*	*2,69 (0,32)*	*3,06 (0,46)*	*2,92 (0,37)*	*3,22 (0,47)*	3,38 (0,41)

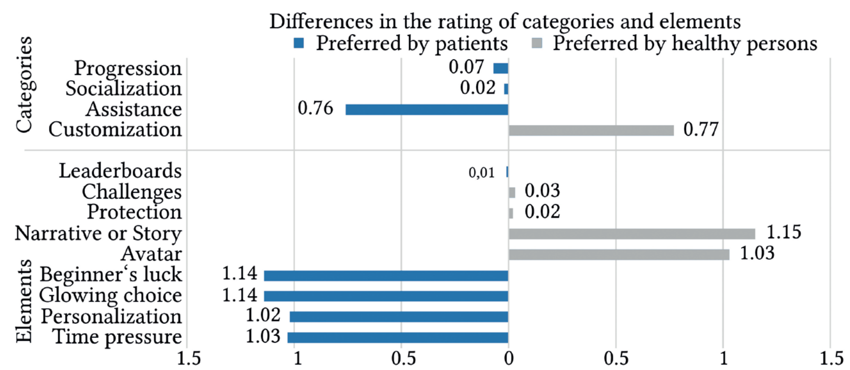


Figure 12. Main difference and similarities (mean value on a 5-point Likert Scale) of game elements and categories of healthy persons [372] and patients in cognitive rehabilitation. Figure from Gabele et al. [136].

The overall most requested element is 'Meaning/Purpose' (M=4.44, SD=0.64) and the least 'Anchor juxtaposition' (M=2.26, SD=0.96). For each element, the average ratings per user type are presented. 37 elements were rated higher than M=3.0 (neutral) by all types and are rather requested. 18 elements are neither clearly requested nor rejected. They received mixed ratings (positive, neutral, negative). 4 elements were rated lower than M=3.0 by all types and are rather rejected. The assignment of the elements to the categories (based on [372]) is illustrated by icons. The ratings per category are shown in Table 9. The most requested category is 'Progression' (M=4.27, SD=0.22) and the least is 'Socialization' (M=2.89, SD=0.41).

Analysis: Comparison of Patient and Healthy Persons Data

The results of RQ 1 (distribution of user types and requested game elements) were compared to existing data of healthy persons. The distribution of user types of patients was compared to existing data of healthy persons in a

Table 10. Rating and p-values of the Performance Curve as a Line Chart (Group A) and additional Mountain Ridge (Group B). Significant values (p<.05) are printed in bold. Items were rated on a 5-point Likert scale (1=Not at all true, 5=Completely true). Values (A and B) are stated in mean (standard deviation), p-value is based on the difference between group A and B. Table from Gabele et al. [136].

Item	Overall Group A	Overall Group B	Group difference p-value
Training progress: I have paid a lot of attention to the visualization of my current training progress in the performance curve.	4.00 (0.88)	3.72 (1.00)	0.42372
Comprehension: It was easy for me to comprehend the information shown in the performance curve.	4.00 (1.03)	3.88 (0.82)	0.4593
Assess: Information shown in the performance curve helped me to better assess my own performance.	3.94 (0.97)	3.72 (0.83)	0.37346
Details: I would like to receive detailed information about my current training to be able to better assess my current performance.	4.11 (0.81)	4.04 (0.77)	0.7414

Table 11. Rating of the elements of the gamified metaphor in group B. Items were rated on a 5-point Likert scale (1=Not at all true, 5=Completely true). Values are stated in mean (standard deviation). Table from Gabele et al. [136].

Item	Overall	Primary Socialiser	Primary Achiever
Metaphor: I like the idea of seeing my rehabilitation as a hike.	4.16 (0.78)	4.17 (0.80)	4.33 (0.75)
Goal: It felt good to formulate a goal and work towards it.	4.32 (0.68)	4.33 (0.75)	4.50 (0.65)
Visualization: I liked that the performance curve was shown as a mountain ridge.	4.08 (0.80)	4.08 (0.86)	4.33 (0.75)
Progress: The trail was a good way to see what I have already achieved.	3.88 (1.11)	4.25 (0.60)	4.42 (0.86)
Milestones: I was very happy about reaching milestones.	4.36 (0.69)	4.42 (0.76)	4.50 (0.65)
NPC: It was pleasant to have the person by my side.	3.56 (0.75)	3.67 (0.62)	3.75 (0.83)
NPC: It was great to support the person through the clothes / equipment we got in training.	3.00 (1.10)	3.67 (0.75)	3.34 (1.03)
NPC: It was great to get support from the person.	3.52 (0.90)	3.83 (0.80)	3.92 (0.76)

Table 12. Perceived emotions. Significant values (p<.05) are printed in bold. Values are stated in mean (standard deviation), p-value is based on the difference between group A and B for: overall, primary socialisers and primary achievers. Table from Gabele et al. [136].

	Overall			Primary Socialiser			Primary Achiever		
Item	Group A	Group B	p-value	Group A	Group B	p-value	Group A	Group B	p-value
Enjoyment	3.61 (0.95)	4.28 (0.72)	**0.03156**	3.63 (0.70)	4.50 (0.65)	**0.0251**	3.56 (1.17)	4.33 (0.85)	0.13622
Effort	3.56 (0.60)	3.36 (0.89)	0.71138	3.38 (0.48)	3.42 (0.64)	0.8181	3.67 (0.67)	3.58 (0.64)	0.9681
Competence	4.61 (1.16)	5.00 (0.87)	0.33204	5.00 (0.75)	5.04 (0.88)	0.8181	4.28 (0.89)	5.17 (0.85)	**0.0394**

similar age group (40-49 years) according to Marczewski [243]. Deviations in the percentage distribution of primary user types are very low, at maximum about 5%. Furthermore, the results of the requested game elements of patients with acquired cognitive impairment were compared to existing data from healthy persons, according to Tondello et al. [372]. The main differences and similarities in categories and elements are shown in Figure 12.

RQ 2: Emotions and Motivation

53 patients filled out the pre- and post-survey questionnaires and completed the training phase and 43 are included in the analysis. 25 patients were in group B (f=12, m=13; mean age=51 years; age range=18-78 years, 12 primary socialisers, 12 primary achievers). 18 patients were in group A (f=7; m=11; mean age=48 years, age range=23-63, 8 primary socialisers, 9 primary achievers). The rating of the performance curve's progress element (group A: line chart, group B: mountain ridge) is shown in Table 10. Both were rated positively concerning training progress, comprehension, assess and details. No significant differences were found between the conditions. However, the mountain ridge was rated slightly lower. The perception of the gamified metaphor and the integrated elements (presented in group B) were rated positively. Detailed ratings are shown in Table 11.

Significant differences were found within the items between primary and non-primary type. Within socialisers a difference arose in the perception of supporting the NPC through clothes/equipment (U=29, Z=-2.63805, p=0.0083). Primary socialisers perceived this as rather pleasant (M=3.67, SD=0.75), non-primary socialisers rather not (M=2.38, SD=1.00). In contrast, the difference of perception of getting support by the NPC was not significant (U=54.5, Z=-1.25104, p=0.2113).
Within achievers, a difference arose in the perception of progression, displayed by the hike (U=32.5, Z=-.2.44768, p=0.01428). Primary achievers perceive this as more pleasant (M=4.42, SD=0.86) than non-primary (M=3.38, SD=1.08).
Regarding emotions and motivation, the overall perceived enjoyment was significantly higher in the gamified version of the cognitive training. Perceived effort and competence were not significantly different. In detail, however, primary socialisers perceived significantly more enjoyment and primary achievers significantly more competence in gamified than in the non-gamified training. The p-values of the significance analysis overall and for individual user types are presented in Table 12.

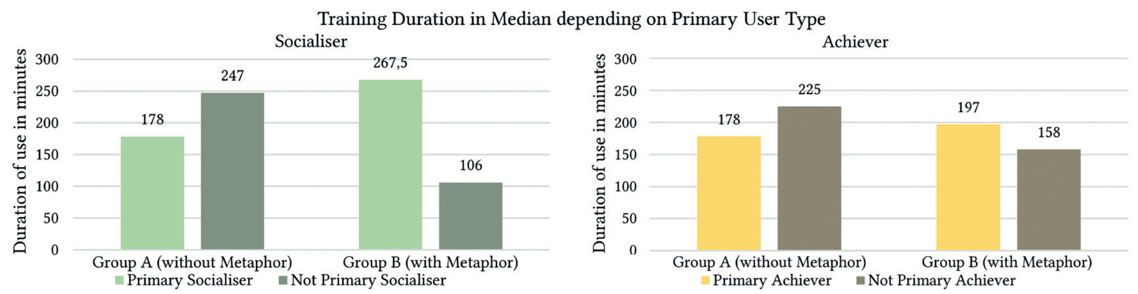


Figure 13. Training Duration depending on Primary User Type Socialiser and Achiever. Figure from Gabele et al. [136].

RQ 3: Performance in Training Duration

59 patients filled out the user type questionnaires, completed the training phase and were included in the analysis. 29 patients were in group B (f=10; m=19; mean age=49 years, age range=18 - 78 years, 12 primary socialisers, 14 are primary achievers). 30 patients were in group A (f=14, m=16; mean age=48 years, age range= 19-70 years, 13 primary socialisers, 13 primary achievers). Comparing the overall training duration revealed no significant differences between group A and B (group A: md=207 min; group B: md=194 min.; t=-0.42827, p=0.670069). For an examination of user type dependent behavior, socialisers and achievers were considered. The median training duration of both types in groups A and B is shown in Figure 13. Socialisers with the gamified metaphor and NPC trained the most (md=267.5 min, R=792). There was a significant difference in training duration in group B between primary and non-primary socialisers (t=-2.19206; p=0.037176). No significant differences were found between primary and non-primary achievers in group B (t=-1.26938, p=0.21514) or within the types.

3.3.5 Discussion and Conclusion

RQ 1: User Types and Game Elements

The results indicate that patients and healthy persons show similar distributions of user types, and cognitive impairment does not lead to substantial changes in motivational processes after brain damage. 'Progression' is rather more requested by both and 'Socialization' rather less, which is in line with other work [156, 372]. Social support is also often low requested in eHealth and eCoachig interventions. The use of social comparison between employees in practice can create negative feelings and fear of losing performance [10]. For older people, the social aspect 'Collaboration' and also interaction with virtual characters are a particularly positively perceived aspects, as Altmeyer et al. show [12]. Also, elderly people prefer collaborative rather than competitive approaches. This, as well as the reduced cognitive abilities, might be an explanation for the low demand for social game elements. However, 'Assistance' is requested more by patients than by healthy persons, which may be due to the acquired limitations.
The results also address the research gap that few results exist on tailored gamification for people over 30 years [215]. The healthy persons were younger on average (27 years) than the patients (47 years). Usually, the proportion of philantropists increases with increasing age [243]. However, if the difference found were only due to age, categories that correlate with philantropists (such as Immersion, Progression or Altruism [372]) should be more requested by patients. This is not the case. In contrast, the element 'Narrative or Story', which is assigned to immersion, is requested less by patients than by healthy persons. This reinforces the contextual relevance when using gamification [156, 160]. However, other factors such as the way of using digital media [194] may also influence the requests. The combination of different realizations and devices is considered in section 4.2.
The development of serious games [192] or new software requires time and financial resources. Therefore, gamification elements are usually additionally integrated into existing software [256], if possible in the early development phase [262, 284]. The 37 elements, requested by all user types, can generally be used as a basis. In a second step of development, these and additional 18 mixed-rated elements may be implemented for individual user types. According to Morschheuser et al., through step-by-step integration, it is possible to focus on an iterative implementation and optimization of elements [262]. However, for use in practice, it should be kept in mind that the use of several similar strategies probably won't reinforce behavioral change [201]. Also, elements may be rejected even though they correspond to the user type. According to Lessel at al., the option to turn them off can motivate instead [231]. This shows that the evaluation of individual gamification elements should not be considered entirely based on the overall average of mixed participants. Ratings of different types, individual evaluations or use-specific evaluations may deviate.

RQ 2: Emotions and Motivation

Both the visualization of the line chart and the transfer to a mountain ridge were rated rather positively. No significant differences were found, indicating that the integration of the metaphor may not affect the perception of feedback. However, descriptively, the mountain ridge was rated slightly lower. Here, a relation to the increased difficulty of gamified tasks found by Vermeir et al. [392] or a reduced usability, mentioned by Schmidt-Kraepelin et al. [334] could be an explanation. This should be considered further in detail and with a larger sample size. Thereby it also should be analyzed whether and if so which aspects (such as type of visualization or diagrams or complexity) might influence. However, the perceived effort was similar in the gamified and non-gamified versions, indicating that gamification elements neither reduce nor increase exertion in task execution. This is in line with the results of section 3.2.1, however, differs from the results of Vermeir et al. [392] or Mohammed et al. [256].
The gamified metaphor was rated positively overall and led to more enjoyment. This confirms the results of other work (e.g., [239, 329]) on higher perceived fun in gamified cognitive applications.
A closer look at the user types when using the gamified training revealed that perceived changes in emotions (i.e., enjoyment) and motivation (i.e., competence) were limited to the respective user type and did not influence the patients in general (i.e., despite improved competence, achievers did not feel more enjoyment). However, this does not confirm the relationship between competence and fun shown by Ryan et al. [323].
The findings replicate and support parts of observations in healthy persons for learning [327], games for change [280] and also cognitive training [392] or other rehabilitation domains [86], showing that perceived emotion and motivation can be influenced by gamification. The different effects within the user types highlight the relevance of tailoring game elements to the characteristics of the users [372]. The study's gamified metaphor was designed as a system with elements connected to each other to create a holistic valuable user experience [159]. Jagušt et al. suggest that the effect of gamification also depends on the combination of elements [183], what should be considered in the interpretation and further application and possible elements particularly suitable for combination according to Upshall [384]. The results show that the use of gamification elements may be planned specifically to address different emotions in different types [373].

RQ 3: Performance in Training Duration

Despite the increased emotions (RQ2), no significant effect was found regarding the performance in training duration in the gamified vs. non-gamified version. There were no differences, neither in the overall comparison, which confirms the initial results of the clinical study [401], nor in the individual consideration of the user types. Here the question arises whether the content-related stimulus of the training and the integrated game elements were not intense enough or the ultimate goal of the intervention - improvement of cognitive functions - may be so crucial that the patients executed the tasks motivated even without reinforcement through game elements [224]. Also, in gamified rehabilitation, no [86] or mixed [192, 239] effects on efficacy were found. However, partly evidence was found that game elements, which match the individual user type, are able to actually increase perseverance and training performance within gamified training. This is in line with other results [373] and similar to those found in other domains, such as sports in the gym [15].
However, this has not been the case for both user types. Social elements are rather low requested (RQ1). These primarily refer to interactions with real persons and the digital NPC implemented in this study seems to have left a different impression, resulting in a relevant impact on motivation [156, 417]. Tamayo-Serrano suspect in the low use of social interaction in rehabilitation that it was not hypothesized to increase the effectiveness of therapy [361]. The present results confirm the lack of increase and even show a decrease when not appropriate for the user.
Within training with the gamified metaphor, patients trained significantly longer, if they were primarily socialisers than if they are not. Although they are less in request overall, the suitability of socializing elements for the socialiser type is also shown in other works [156, 372].

As training duration represents one of the main reasons for efficacy [403], it was shown that the tailoring of game elements in cognitive rehabilitation is highly relevant. In terms of desired behavioral changes, the emergence of such effects should be considered more closely to achieve positive and avoid negative effects [199, 281, 320]. This should not only be considered between gamified and non-gamified, but also within gamified systems. However, achievers who usually request progression, but also socialization, did not differ significantly regarding their overall training duration. The following explanations for the missing impact on the behavioral measure might be suggested: First, the gamified metaphor included two elements requested differently by all patients before the training. While socialization was classified as least appealing, progression was the most wanted. That implies that user-centered tailoring may be particularly relevant for low-requested or polarizing elements. Second, for persuasive strategies, Orji et al. found for socialisers significant relationships between user type and among others goalsetting, cooperation and self-monitoring / feedback [284], but not for achievers. However, other works show effects on achievers through gamification, e.g., according to Lopez and Tucker through reward-customization strategies [234], which, according to Reyssier, vary depending on the element used and do not show any effect through progression [309]. Third, both categories are suitable for them, but not as high as socialization for socializers. Here, the level of the request might make a difference. Fourth, the group of non-primary types partly contains types with partial inclination to these elements. This might affect a possible difference. Here, instead of comparing the single types, a comparison might be made between the group of types that are appropriate or inappropriate for an object.
The results of this step support that within gamified applications, elements suitable for the type and intended effect should be used [373].

General Discussion

Gamification in health is intended to improve perceived emotions and motivation on the one hand and the targeted behavior on the other. The highest request for 'Progression' and 'Assistance' is in line with patients' situation to get support and improve their cognitive abilities. The possibility of impaired social cognitive functioning due to acquired brain damage [207] may have had a concomitant effect on the rejection of 'Socialization' elements. However, positive emotions and motivation have been shown in socialisers. Gamified training using elements of progress visualization and socialization showed relevant impact on emotions, motivation, and behavior for patients in software-based training during cognitive rehabilitation. Notably, the effects were mostly dependent on the individual user type, indicating that user-centered tailoring is particularly important in this user group. This has been shown in the different emotional effect in enjoyment and competence on socialisers and achievers and in detail by the example that primary socialisers tend to perceive it as rather pleasant to support the NPC, whereas non-primary socialisers find it rather unpleasant. The results address the research gap on neutral or negative requests and effects of tailored gamification in relation to user characteristics [215]. However, in rehabilitation, the focus is on receiving support. Thus, tailored elements may potentially address additional user needs that are not the focus of therapy, but are individually relevant for the patient's motivation. Goals of gamification, perceived emotions and motivation, and behavior are relevant for training efficacy [107]. This corroborates the approach to focus on the patients' needs in the conception of gamification frameworks [262]. Hallifax et al. point out that when planning gamification, the dominant user type may not be sufficient to categorize the users' preferences [158].
The user's initial motivation profile may also be used for dual adaptation, according to Hallifax et al., to optimize the tailoring of the elements [158]. Due to the observed differences in training duration depending on requested and declined game elements, it may be relevant to consider least represented types or elements that are low requested but fit to the type. Like in cognitive rehabilitation, additional factors such awareness of the disease, general compliance or goals could be considered. For user type-related effects other user type models that consider goal setting may be included [371].

For the acceptance of gamification in the context of rehabilitation, further aspects, such as visual style, onboarding, or depth of serious or gameful to playful elements, complexity should be considered.
The results support the relevance to define in the conception of gamification whether the requests of the users, emotions, motivation and/or the effectiveness shall be addressed.

Limitations and Future Work

In this study, patients from Germany in outpatient therapy with mild to moderate cognitive impairment were recruited. The results provide orientation, but generalization or transferability to other countries, rehabilitation systems, or application fields cannot be ensured. The questionnaires used were adapted to the patients' language and the rehabilitation context. This should be considered when interpreting the comparison with data of healthy persons. Due to the small number of the user type 'Disruptor' among the patients, corresponding results can only be considered to a limited extent. The questionnaires (RQ1) demonstrate only the request of game elements, not the actual effect on motivation during training. Also, by answering the questionnaire on gamification elements, there is the possibility of influencing the expectations regarding the training.

The sample of the study was rather small within the subdivision into the individual groups and in RQ 2 and 3 only two user types (socialiser and achiever) were considered. Furthermore, an exploratory approach based on parts of the data of the clinical study was applied. A different study design, consideration, or a different way of implementing a metaphor may affect the results. Further data from the clinical study should be related to the deepened analysis obtained here and analyzed. Further research is needed to investigate the differential impact of user types on performance in patients. Due to reporting averaged data, individual preferences may deviate from these results. Due to the combination of the elements' progression and NPC, separating their distinctive effects is not possible. The combination of elements can lead

to other varying motivational effects in comparison to single usage [325].
Likewise, some overlap between various user types is given because patients can tend to several types [371], even if they have partly different intensity levels. In line with Hallifax et al. [156], future work should consider reciprocal effects between elements and / or tendencies for different types of players. As this study was conducted in the context of a larger clinical study [401], some patients received additional advice for strategies during task completion and slight corrections were implemented. An additional effect of strategy teaching may exist but probably does not impact results due to distribution of them in group A and B. The study represents the requests and behavior of patients. When selecting game elements, the planned training content's therapeutic suitability should also be considered. Future applications could focus on emotional support and more specific tailoring of gamified elements with dual tailoring [158].
The overview shown in Figure 11 can be used as a static overview to support the selection of game elements for development in practice. To provide support for in-depth tailoring and interactive use, a tool can be designed for a software-based method for entering target group data and the corresponding output of suitable gamification elements. This is considered in the following section 3.4.

Conclusion

In this step, through the deepening of the clinical study [401], dependent on user type of patients was investigated 1) the request for game elements of patients in software-based training during home-based cognitive rehabilitation, 2) perceived emotional and motivational aspects in non-gamified and gamified training, and 3) the behavioral effect on performance (i.e., training duration). All user types of patients in cognitive rehabilitation request almost two-thirds of the elements, and others are considered differently or rejected.
Thus, implementing items identified as generally pleasant first can be recommended. Later, tailored gamification of additional game elements may be integrated individualized step by step. The gamified training led to more enjoyment overall. In detail, however, the user types reacted differently:
Primary achievers perceived a higher level of competence, primary socialisers perceived more enjoyment during training.

Despite perceived emotions and motivation, there was only a limited effect on behavioral performance of user types.
Although no differences were found in training duration between gamified and non-gamified training, in gamified training, primary socialisers trained significantly longer than non-primary socialisers. This indicates a possible dependence of user type, suitability of the elements used and training duration, emphasizing the importance of user-centered tailoring of gamification in cognitive rehabilitation.
Overall, the results indicate that gamification is suitable in cognitive rehabilitation and may lead to emotional and motivational improvements and differences in behavior. Here it is relevant to specify in the conception which aspect is to be addressed. It is also relevant to select appropriate elements depending on the individual user type to maximize the benefits and avoid adverse effects. The results of the present study contribute to improving the selection and use of game elements in a user-centered and tailored way. This may support the optimization of development of software-based training in cognitive rehabilitation.

Take-away & Key aspects

- *The use of gamification elements for progression and assistance is most requested by patients*
- *Differences in request are shown according to the user types: it can be classified into generally requested, mixed and rejected elements*
- *Tailoring is important for motivational / emotional adjustment of gamification for patients in cognitive training*
- *Motivational elements can be perceived differently in terms of emotion by different types of players*
- *A difference in training duration of gamified and non-gamified training was not found - but differences depending on user type*
- *Elements should be used that are suitable for the user type*
- *In the presented combination of socialization and progress, positive effects on motivation were found despite low requests for socialization elements*
- *The intended effect should be taken into account in the planning of the elements*

3.4 Outlook: Potentials of a Web-based Gamification Guide for Knowledge Transfer between Research and Industry - A Method to Support Design and Development

3.4.1 Focus and Purpose
3.4.2 Background and Related Work
3.4.3 Method
3.4.4 Concept Consideration and Prototypes
3.4.5 Results
3.4.6 Discussion and Conclusion

Research results show that gamification can influence emotions, motivation and behavior. However, in order to apply the results in the software development in industry, they need to be easily accessible.
In this step, as an expansion and deepening of the static visualization of user preferences on gamification in step 3.3 and to enable a knowledge transfer between research and industry, a concept and a prototype for an interactive web-based tool for guidance in the selection of gamification were designed. It summarizes and visualizes existing research results and practical examples in a simplified way regarding the use of gamification elements. Step by step, the user defines parameters such as context of use, age, gender, and user type for the target group. Based on this, effects in research results are presented, simplified and sorted in four categories in pie charts. This is intended to provide users in the industry with the competence to select appropriate gamification elements for their usage.
The approach was developed in a user-centered way, including interviews with seven participants from research and / or industry in a) a pre-study and b) evaluation with a clickable prototype.
Potentials for industry and research and their possible interconnection were examined. The approach was perceived as supportive in selecting appropriate gamification elements for use in industry. It may lead to faster finding of research results, promote networking, and may generate a kind of meta review. The elaboration of such tools may support the interconnection between research and industry, as well as the transfer and applicability of knowledge in gamification.

3.4.1 Focus and Purpose

Gamification can support motivation in various application areas [219]. However, Gartner already pointed out that by 2014, 80% of gamified applications could miss their target due to poor design [293]. The use of gamification is still challenging in health [292] and for traditional software developers, since the selection of appropriate elements requires knowledge in different areas, such as effects on perception and user behavior, as well as concept design [262]. In the application of gamification, extrinsic elements which often address short-term effects and are easy to implement (e.g., points, badges or leaderboards) dominate in general [219, 271, 354] and are frequently used in cognitive training [392] (rewards/ feedback, but also story/theme). Koivisto et al. suggest that the popularity of these game elements is due to the use of pattern-based design for gamification, whereby it was mistakenly assumed that a particular implementation or simple selection of game elements for all users would have a positive effect on their motivation [219]. For the conception of gamification, it is important to include aspects such as characteristics, needs and goals of the users [3, 234, 262]. The tailoring to the user can help develop gamification systems that support personal connection as well as the development of motivation, and are thus perceived as meaningful by the user [271]. However, according to Tuah et al., guidance is needed in the development of gamification in rehabilitation [379]. Getting an overview of individual existing research results often requires a lot of time, which is usually not available in development of gamified application in practice [262]. This, the presentation [255] and the different communication channels used [370] can lead to the problem that results and recommendations for use, as shown in this or other works, do not or only poorly find their way into practice. This leads to the following research questions (RQ):

- RQ 1: Does a visual, simplified presentation in access to scientific knowledge have the potential to assist industry in the development of tailored gamified software?
- RQ 2: Does the knowledge transfer approach show potential for the application of gamification and interconnection of research and industry?

To address this, qualitative interviews were conducted in a preliminary study with seven potential users from research and industry. A concept and a click prototype for easily accessible tailored research results on gamification were developed.
The focus of this step is on the accessibility and simplification of research results for developers for easy use, tailored to the individual target group. The purpose of this step is to provide developers with the competence to select appropriate motivational supporting elements for the individual situation in perception and / or effect. Furthermore, a closer networking of science and practice could support the application of knowledge and the research with needed results for practical problems.
In a qualitative evaluation, the prototype was presented and open interviews were held. The main contribution and goal of this step is the consideration of possible potentials that a web-based tool can have for applicability of gamification, knowledge transfer and strengthening the interconnection between research and industry.
Thus, the step contributes to the development and design of software-based methods to support motivation and enables both the individual focus on patients in cognitive rehabilitation and the further integration of different fields of expertise.

3.4.2 Background and Related Work

In a statement for Elsevier, Moore points out the relevance of different stakeholders being able to understand the research being presented [255]. He emphasizes that good research communication is important, especially for multidisciplinary teams, as not everyone can be an expert in everything. Tom Nutt and Cherie Millar recomment devices such as lay summaries and visual abstracts [255]. Tondello points to different platforms used in disseminating results in academic (e.g., journal, workshop, conferences) and non-academic publications (e.g., blogs, magazines, videos, social media) [370]. For non-academic audiences, research results should be prepared

with focus on the results and how they can be used to solve problems [370].
Knowledge transfer between academia and industry supports the development of innovations and application of research results, for which collaboration is an important basis [101]. The use of gamification is of interest for research and industry [180, 379]. Knowledge transfer is relevant in various areas. Mazorodze and Buckley show in their review of knowledge transfer tools in knowledge-intensive organizations, that a community of practice is most appropriately evaluated through team communication, followed by mentoring, storytelling, succession plans, coaching, and knowledge repositories [248]. Brumana et al. point out the suitability and crucial role of technology-based sharing tools when considering perception gaps in the knowledge transfer of multinational companies [57].
Existing guides for gamification often refer to the design process [260, 262]. The relevance of specified use and tailoring, in addition to the previous steps of this work, is also evident in frameworks with integrated customization options of game characteristics and rehabilitation objectives by, for example, the therapist of, among others, Afyouni et al. in motor hand rehabilitation [4] or Shapi'i et al. in cognitive rehabilitation [339].

In the use of gamification, both negative and positive results can be found [54, 160]. For a motivating effect, various factors are relevant, such as the context of the application and the personality of the user [156, 160, 189], age [243] or gender [215]. An appropriate adaptation to users is relevant for the intended effect [373]. However, due to the different areas of application and effects, it is difficult to compare results in the use of gamification [239].
In research, correlations between players and elements can be examined in different ways: First, using correlations between user types and elements are determined by surveys [372]. Second, using empirical studies based on the application of gamification elements in specific contexts and implementations measure effects of gamification usage [234, 373]. This can result in various publications with different orientations, characteristics, variables, or application areas. As a result, more and more detailed recommendations can be developed, making it increasingly complex to include the various factors and analyze appropriate elements. However, on the one hand, these have to be reviewed for a quality overview for the individual field for the application, and the knowledge must be kept up to date, which takes time. On the other hand, a compromise has to be found in the development between development time and effects on the motivation [234].

Morschheuser et al. suggest that one of the main reasons for failure of gamification is that underlying concepts were not sufficiently well understood [262]. In science communication, various search engines for scientific literature are available, such as Google Scholar [150] or ACM Digital Library [2]. 'ACM Computing Classification System' offers a categorization of work based on a decision tree and associated papers [2]. Concepts based on this and the simplification of results support the demand for knowledge transfer between researchers and persons without scientific background (e.g., [sci]mmary [222]). Blogs also deal with gamification and partly refer to scientific articles or promote exchange (e.g., Gamification.co [139], For the Win: Serious Gamification [126], or Gamification Research Network [140]). For teaching, professional platforms offer guides on how to gamify for different learning types specifically (e.g., Desire2Learn [96]). Here, the detailed relation to scientific results is difficult to assess. Tuah et al. propose a static classification of elements and application in rehab domains for gamification in rehabilitation [379].
Despite such opportunities, creating literature reviews or finding specific results is often time-consuming.
Possibilities for tailoring can be given via recommender system. Tondello et al. propose a recommender system for gamification based on an input from, e.g. user profile, items, the currently performed activity, and the context [374]. In addition, they propose recommendation algorithms. Recommendations and ratings should be generated as output. Thereby they propose a possibility for personalization. Based on and extending this system, in 2022, Vasconcelos et al. propose ‚ReGammend', a recommendation system and an exemplary implementation [389]. User's input on the personal type is incorporated into the recommended design for gamification. An admin is responsible for the application of parameters. However, it lacks the inclusion of the context. Rodrigues et al., propose a system for personalization that integrates information about the user (e.g., in relation to the game or the character) on the one hand and the context in which the gamification is to be used (e.g., location) on the other [314].

To support the realization, visualizations that are well prepared can provide considerable support for knowledge transfer [279]. To the authors knowledge, there is only limited support for knowledge transfer in gamification for development for tailored use in healthcare for cognitive rehabilitation.

3.4.3 Method

The problem of a lack of knowledge transfer for practical application of gamification has been observed in the cooperation between industry and research. To address this gap, a concept for a web-based prototype was designed, which summarizes and visualizes research results according to a previously defined target group. Based on this the potential of knowledge transfer and interconnection of research and industry was explored.

The concept is based on human-centered design and design thinking and the user group was assessed using methods such as brainstorming, empathy and scenario maps. This identified two core user groups: UG 1) industry employees (developing digital software) and UG 2) researchers (providing research in gamification). It was hypothesized that users could be categorized in the types 'Newcomer', 'Experienced', and 'Curious'. Due to the lack of support in the healthcare sector in cognitive rehabilitation and for the possible further integration of results of this and other work, this is used as a domain for the approach.
To evaluate the basic idea and concept and to identify user requirements and requests, a preliminary study was conducted by qualitative interviews with one or two participants in video calls (duration approx. 60 min each, recorded). The participants were potential users from the two UGs: (medical) industry for software development and / or research in games (female: 4, male: 3, average age: 31.57, age range: 26-37) (Table 13).
After informed consent, demographic questions, questions about knowledge, application and research on gamification, requirements and requests, and the basic concept were asked. Each interview was followed by an open discussion. Based on this, the participants were classified or classified themselves in the respective type (added to Table 1). According to the basic idea and results, the concept was detailed, a visual representation, a click prototype, and an initial technical backend prototype were created.

Table 13. Demographic data of the participants and analyzed application type. Table from Gabele and Fischer et al. [130].

Participant ID	Area of work	Age	Gender	Analyzed type
I1	Industry	26	f	Newcomer
I2	Industry	37	f	Newcomer
M1	Industry and Scientific research	36	f	Curious
S1	Scientific research	29	m	Experienced
S2	Scientific research	32	m	Experienced
S3	Scientific research	29	m	Experienced
S4	Scientific research	32	f	Curious

Figure 14. Interaction path of the prototype (Left: input and defined filters, Right: outcome). Figure from Gabele and Fischer et al. [130].

Qualitative individual interviews were conducted via video calls (30-60 minutes each, recorded). For this, the participants (N=7) with whom the requirements were defined, were interviewed again. The click prototype was presented by screen sharing. The participants controlled the cursor by verbal instructions, which a member of the study team executed. Participants commented based on the Thinking-Aloud method. Supplementary questions were asked by the study leader. Then, an open discussion was held. The topics included, among others, overall impression, possible helpful aspects and potentials for use, further ideas/feedback, and partly usage in other areas and (in the open discussion or subsequently written) connection potential between industry and research. Questions and topics varied partly due to the nature of open discussions. In the results is listed with which participants the topics were discussed. With regard to the RQs, the following parts of the final interviews / discussions were included in the results:

- Basis: comprehensibility and interaction with the prototype (positive, negative, requests),
- RQ 1: a) Interpretation of the presentation of the results, b) Conclusion of the industry (the focus of the presented results of the evaluation here is on participants with industry background),
- RQ 2: a) Potentials / helpful use b) Connecting research and industry.

Associated statements for these categories were sorted, and the key statements were compiled and summarized.

3.4.4 Concept Consideration and Prototypes

Results of the Preliminary Study, Concept Consideration and Prototype

The results of the preliminary study confirmed the defined user groups and application types, the problem of a missing knowledge transfer tool in gamification and the demand for it, and first potentials of the basic idea. In the current research procedure of the participants, websites are an important source of information. Various necessary requirements were identified, in excerpt: Filtering per user group, including the context, recommendations for game elements, transparent validity of the publication results, examples and hints, storage and export functions of information, and saving time.
With this background, the basic idea was refined in a concept for a web-based guidance tool ('Gamification Guide'). The main function in the application is for developers to first define an area of application and a target group, and then to obtain a summary of research results for individual game elements. Thus, it assists the industry in selecting appropriate gamification elements. Researchers integrate their research results and thereby promote their applicability. The concept was exemplified in a click-through path prototype. For flexible use, it should be possible to integrate different disciplines in the long term.

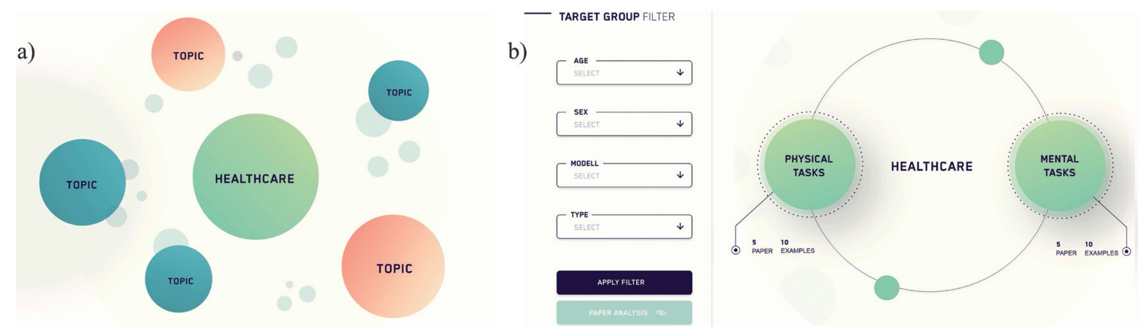


Figure 15. Details a) Defining the application context of gamification, b) refining it and defining target group. Figure from Gabele and Fischer et al. [130].

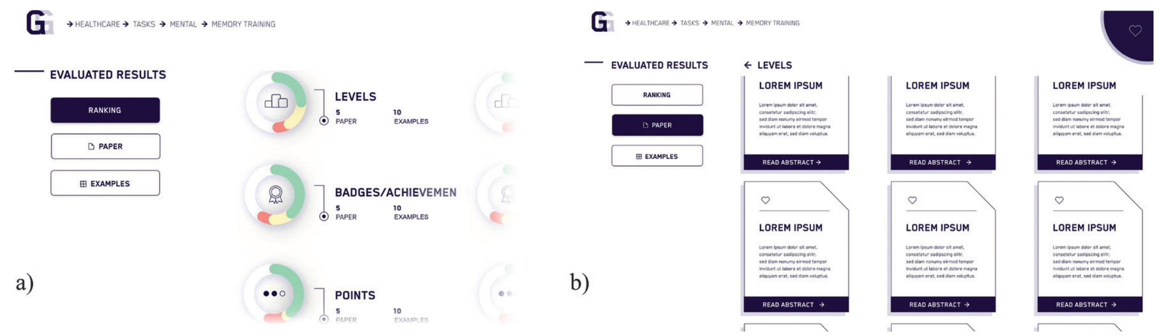


Figure 16. Details a) Exemplary visualization as pie-chart of summarized research results based in specific context and target group (Figure 15), and b) related publications / examples. Figure from Gabele and Fischer et al. [130].

According to Nielsen's mental models [273], and in line with the 'ACM Computing Classification System' [2], a decision tree [2, 317] was used, because this reflects the steps and decision process. Users are guided step-by-step (Figure 14).

In the beginning, users select the context (Figure 15 a, b), which is visualized in line with bubbles in networks [222]. It can be refined and optional filters can be selected in an overlay menu, allowing for the tailoring of gamification to the target group (Figure 15 b). After applying these selections, scientific results within the defined target group are presented (Figure 16 a). The summarized results / player-type - game-element correlations are shown in pie charts: positive (green), negative (red), neutral / no or mixed effects (yellow), or paper without calculation of results or correlations (white). To enable good legibility and knowledge transfer, they are presented in a simplified way [279].

The current visualization is an exemplary representation of potential results and is not based on research results. Finally, users can browse publications and examples (Figure 16 b), create favorites and export data. Based on these results, users from the industry are given the competence to select gamification elements appropriate for their individual development.

The video prototype can be found on ACM Digital Library: https://dl.acm.org/doi/10.1145/3450337.3483458 [130].

First Steps of Handling of Data from Research Results, Database and Server Communication

The realization as a website is intended to support global networking for the exchange of knowledge [252].
To enable interactive use and tailoring, the relevant target group and application factors are presented in clusters in the individual steps, and the research results are classified into the corresponding categories.
However, research results are predominantly embedded in papers. In the future, these will have to be extracted for application, which is planned in the current concept version as input via crowdsourcing, submitted by the corresponding authors.
Another future possibility is the automatic analysis of papers by artificial intelligence, following Krasizkaja and Fox [222].
The data entered has to be stored in a database from which they can be extracted by the web-based 'Gamification Guide'.

The concept of the database is demonstrated by a segment of an entity-relationship (ER) model in the example of tailored gamification in healthcare used in this section (Figure 17) [124]. This model can be extended for further integrations. For a first partly prototypical implementation of the backend prototype, the open source program package XAMPP was used [25].

Database queries can be made for relevant information such as the number of relevant publications. Initial integrated user-type - game-element correlations are to be extended in the future with empirical data and examples based on a comprehensive literature review. An implementation of the concept presented in section 3.4.4 in the click prototype and visualization as a frontend, as well as a connection between frontend and backend have to be developed in the future.

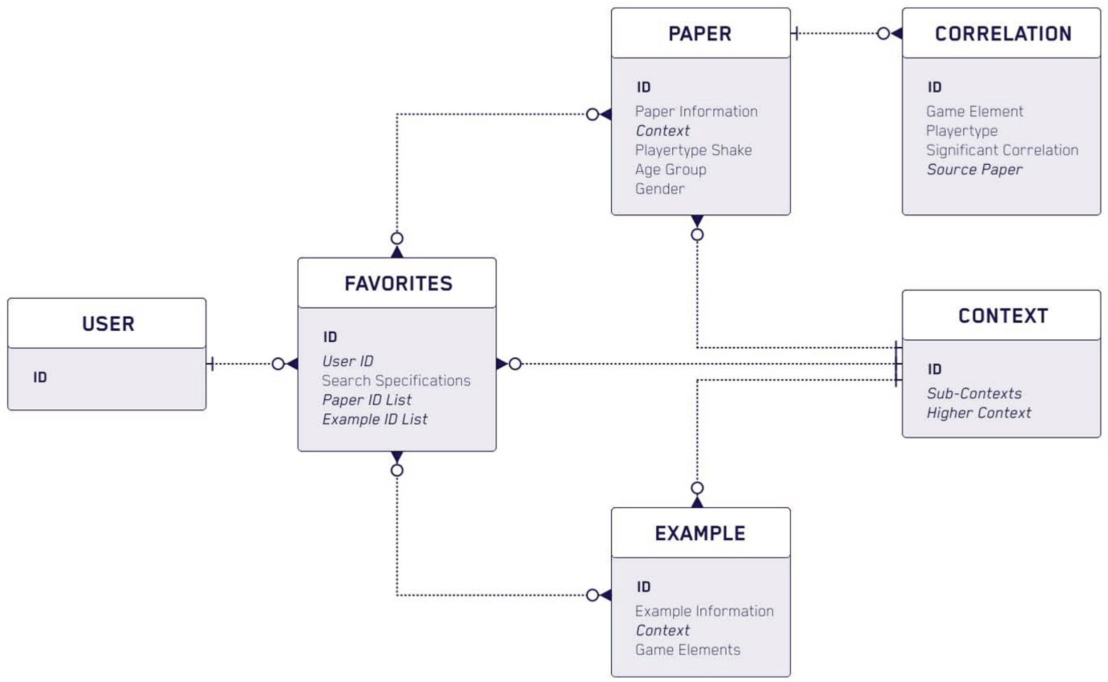


Figure 17. 'Gamification Guide' database ER model. Information is summarized in a simplified form (publications include title, authors, year of publication among others, examples include respective information). Figure from Fischer et al. [124].

Table 14. Positive and negative key aspects and requests for 'Gamification Guide' click prototype. Table from Gabele and Fischer et al. [130].

Step	Positive	Negative	Request
Decision tree / Context and refinement	Specific/focused context filtering; Animations supportive; 'Hand holding way'	Redundant clicks; Clickable elements unclear	Reduce clicks; Refine animations
Filtering of the target group	Provides orientation; Filter can remain empty; Filters sufficient	Filter area not found directly; Type model unknown	Explanations (e.g., for type models); More type models; Alternative search (e.g., keywords); Immediate update
Results in diagrams	Most important; Colour coding recognized; Exactly what expected to see	Source or context of data unclear /Interpretation problem (all); Order first recognized as rating; Forgot filter	Iterate legend / Integrate label: percentages / numbers
Publications / Examples	Good overview; Selection option/own favourites; Neutral layout	Less space for title and abstract / read full abstract; Presentation unclear (examples)	Integrate diagram classification; Sum up key findings; Link: original source; Use keywords; For examples, extract prototypes from papers
Favourites	Basically, the clustering is perceived as structured; Search history	Naming own search as 'User' unclear; Interactions and reference to previous content unclear	Filtered users more prominent; Show time of search; Own sorting / naming; Filtering in lists/projects, Integrate own search factors; Clarify connection: paper / elements
Export	Very good function	Misleading name: download rather than export	Individual / group download; separate paper / examples; Preferred-formats: PDF, BibTex, video

3.4.5 Results

The results first describe the interaction with the click prototype and then the impression of the overall concept.

Interaction with the Prototype

All participants completed the screenshared click prototype and provided feedback. According to the basis results, Table 14 shows an excerpt of the positive and negative key aspects, as well as relevant requests.

According to the potential for assistance in RQ 1, a) interpretation of results in diagrams (pie-charts), the following comments from users with an industry background (I1, I2, M1) provide examples of how diagrams would be interpreted for use. The researchers (S1-4) also identified the diagrams as ratings, but they should be explained further.

- 'Green [means] that it is positive. [...] Collect, for example, has more green content than Level, that it may resonate better with users. [...] Points is the best element in the ranking.' (I1).
- 'When I search in general [...] I would first look at what has the most green percentage and in the second instance at the things where there are outliers.' (I2). 'It always depends on the objective, if I want to have a criterion that has a very wide acceptance, then of course one would

choose the one with the largest green percentage. [...] If I want to develop a module where I don't have a specific player type, then I would like to choose things where many have said that they like it.' (I2). 'Then I would pick the element where are either the most papers [...] or also the most examples.' (I2).

- 'Then Points would definitely have the most positive results, closely followed by Badges and then by Levels. [...] then I would interpret Points as a recommendation here.' (M1).

Overall Approach

All participants provided a final conclusion. According to the potential for assistance in RQ 1, b) industry conclusion, key statements in conclusion of the participants with industry background (I1, I2, M1) are considered. Overall, the approach appears to be helpful at supporting the selection of gamification elements for industry.
The following is an excerpt of positive aspects and optimization options. Positive rating in the conclusion:

- In general, I like [...] [the decision tree] very much, because it targets the different personas or user groups.' (I1) 'The most important part of the website is the result page and the paper overview.' (I1).
- With regard to the procedure I2 stated: 'I would cross-google [...] If I have a better database that I can use, sure that would be more helpful'. (I2). 'I would probably first make a very rough screening [...] giving as good as no filter criteria. Then one needs a good overview, where one can see everything summarized. That was already quite good. [...] And then I would search in more detail'. (I2).
- 'I compare it to Research Gate or Google Scholar, which is classically often used to search, and I see a lot of benefits there. I have everything here at once [...].' '[...] it's fun and one wants to use it too.', 'With the industry, I think it depends a lot on who is actually using it in the end. [...] I know enough people who work in the field of serious games, who work in the industry and who are interested in whether there are any evaluations of anything [...] For a slightly more niche industrial company, this is already very exciting and for the researchers definitely yes, absolutely!' (M1).

Optimization options in the conclusion:

- 'Filters or sorting options. Or that one has different ways to add the favorites [...]. Also, that there is more assistance in some parts. (I1) 'The way is still a little too long at the beginning [...]' (I1).
- What would still be incredibly beneficial would be [...] a summary [...] of the essential information of the results [...]' (I2). 'The question is [...] whether one needs one or two more filters [...]' (I2).
- With regard to the diagrams: 'Maybe it would have helped me to know what the traffic light stands for during the preselection process.' 'Maybe a percentage would still help, something numerical. [...]' (M1).

According to the application in RQ 2, a) Potentials / helpful use, all participants provided feedback.
The 'Gamification Guide' shows different potentials in the basis: scientific resources are helpful in the discussion with stakeholders (I1, S1), the compact collection leads to faster results (I2, M1, S2, S3), it could promote representation of research (M1, S1, S2, S3) and generation of a kind of meta review (S2). For this, more overview data (year span, conferences, etc.) could be added (S4). Participants indicated that the tool has the potential to make scientific knowledge easier to access. Context filtering is relevant because it has a relatively high influence, yet is considered relatively little (S1).
Not only from industry (RQ1), but also in research, the tool was considered helpful. In industry, the guidance is relevant, in research the focus is on the development of new papers (S1). Furthermore, the tool could be used for teaching and to identify research gaps (S4), for higher-level like content designer for teaching software (S3) or acquisition of third-party funds and networking (M1). To get the researchers to submit their data, further incentives might be offered (M1, S1). By networking with Google Scholar, new papers could be detected and matched with the database (S1). Six of the participants would use the tool themselves (I1, I2, M1, S2-4). S1 would need a function to discover new literature due to the own expert status.

According to the connection of industry and research in RQ 2b, the statements indicate that the tool could promote the exchange between research and industry (I1, I2, M1, S1, S3). Moreover, core comments on the interconnection of industry and research of the participants with whom the topic was discussed deeper (I1, I2, M1, S1) are listed exemplarily:

- 'I think that the 'Gamification Guide' also has the potential to bridge the gap between industry and research [...] I think it is also attractive for new employees that there may also be potential for further training. [...] There are also certainly hurdles and obstacles [...] because you may not always have the money to put into research or because certain solutions are not ready for the market or useful for industry.' (I1)
- 'Well, I think the first step is to prove the need for gamification in the products. [...] This is followed by effective and focused work with the gamification elements. Here, I definitely see an advantage in applications such as the 'Gamification Guide'. Since these elements can only be integrated into daily work through a healthy relationship between effort and benefit.' (I2).
- 'Yes absolutely, I think that's a great point because it's so networky. [...] Accordingly, I feel that this is a very good point, and perhaps it could also be considered whether there is also an [...] exchange option or connect option there, where people can also, if they wish, leave their contact data, that would be exciting.' (M1).
- 'A knowledge pool, can manage it, as they are a concrete recommendation for action.', 'If it can be brought to a common level, where researchers can turn a little bit of a blind eye [on details] and the industry gains something, they can make use of, then this can work', 'For this, it must be simplified, and that's what the 'Gamification Guide' does'. (S1).

3.4.6 Discussion and Conclusion

Discussion

Based on the results, various potentials have emerged. Regarding RQ 1, the potential to support industry, discussions with industry and researchers indicated that there is less specific knowledge in industry about the use of gamification, but this knowledge is profound in research. The results indicate that a simplified presentation in access to scientific knowledge has the potential to support the development of gamified training software. However, based on the interpretations for the element points (largest green, but also red percentage), it seems relevant for knowledge transfer in gamification (in tools, but also previously in research [215]) not only to focus on positive effects, but also to raise awareness for negative ones. Therefore, although a ranking in the order of the elements was expected, the approach should rather avoid this and instead strengthen the competence for individual decisions for use.
Optimizations of the visualizations are relevant to avoid negatively affecting understanding [279]. This may result in the potential to focus in industry not only on classic extrinsic, but also on individually suitable elements. The results support filtering the user group via the context of use of the application [156, 160]. The decision tree is perceived as a 'hand holding way' (S3), which is especially relevant for Newcomers who have tended to show up in industry. Also, the search behavior of I2 could be taken up to tailor the website itself: a more general search for beginners and an expert search for deeper understanding (S1). Despite some ambiguity, which can be solved by minor optimizations, the participants were able to follow the interaction path. A backward search, starting from an element (S3), might promote more flexible use. A problem is that results are often mixed, which means that they cannot be clearly assigned (S2), and this is reflected in the fact that often only parts of tests are positive [160]. Measured variables should be included (S2) to avoid that and to

enable comparability. By integrating tags (e.g., for fun), individual results of papers can be classified as positive, negative or in between. In the future, this might allow sorting by categories such as requests, emotion, or behavior, which, as section 3.3 has shown, can lead to different results and should be included as a starting point for the selection of elements [202]. The results may also further support the application of existing gamification frameworks (such as developed by Khaleghi et al. [211]). They contribute to the understanding of the user on the one hand, and on the other hand also to the consideration of application examples.
The results from the preliminary and main studies of this step reveal relevant aspects, whose principles can serve as a basis to the development of further knowledge transfer tools in gamification.

Regarding RQ 2, the application and connection of industry and research, a particularly important trade-off was pointed out: Simplifying results through the 'Gamification Guide' at a level that is applicable to industry and acceptable to researchers (S1). If the tool is web-based, it may also support internationalization [252]. Existing knowledge gaps or needed answers can further be identified and communicated in various ways: By 1) lack of results in the presented diagrams, 2) analyses of the results by researchers, or 3) information on needed results by industry. By identifying and filling these gaps in joint projects, both parties can benefit. Exchange functions (M1) such as contact, comment or discussion options should be integrated to promote the potential for overcoming differences, developing trust and engagement, and interdisciplinary exchange [101]. Using the database, automatic basic meta-reviews might be generated, which in turn might save time in research and conception and development in the industry.

Overall, the results reinforce the notion that the user groups emphasized different goals as particularly relevant [101]. In research, the relevant factors were discovering new literature and being able to identify research gaps. However, a risk exists in the lack of integration of knowledge. More incentives should be created to motivate researchers more effectively. Also, AI assisted summary and integration [222] could further encourage this. For industry, in contrast, time during use was relevant. However, besides the transfer of knowledge from research to industry, experiences and requests from industry can be given to research, and knowledge can be shared within the groups. The purpose of using gamification in industry is to achieve motivational effects. Detailed data is needed to 'prove the need for gamification' (I2). A problem in the basis of the research, and thus for application of the results, is a good comparability (S2). Different systems exist, but more consistency is needed in, e.g., naming, user models and interpretation of game elements. Koivisto and Hamari, in gamification research for motivation systems, point to the need for better comparability of results through better coherence of measurement [219]. Sardi et al. also point out the lack of a unified framework for evaluating principles / outcomes in gamification [329]. Furthermore, the possibility should be considered whether the unification of such structures in research and practice and in the tool can be mutually beneficial.

Nuijten proposes the ‚SciModeler' system, using behavior change as an example, through which research can be analyzed and structured [277]. This allows to analyze different information from texts and to examine underlying theoretical constructs and scientific theories. This enables comparisons and inferences to be made with other information such as platform or context. Such an approach can also expand the filter possibilities of the 'Gamification Guide' in the future.

The click prototype and the backend prototype initially indicate the conceptual, graphical, and technical feasibility of the approach. For software development, additional guidance might be relevant (e.g., therapists in the healthcare example for cognitive rehabilitation). Furthermore, according to Perry et al., it is relevant to consider the therapist's requirements for technologies for therapy support during implementation [294]. Therapists could be a third user group to optimize implementations and should be integrated next, which is in line with, e.g. van Dooren [388]. The tool shows potential to support both user groups, which should be taken up further. If both can benefit from the use of the tool, an interconnected use may be promoted. The results support the potential in use, but also the chance to interconnect research and industry stronger and to make knowledge more easily applicable.

Limitations and Future Work

The evaluations are based on a qualitative approach. The number of potential users included was low and not sufficient for quantitative evaluation. In the example context of healthcare, corresponding experts from industry were integrated. A generalization of the results therefore cannot be guaranteed. Also, a different way of designing and implementing the concept may influence the results. Participants' quotes are partially translated into English and therefore do not represent the original wording in the native language. For evaluation, a click prototype was used. Additionally, an effect should be analyzed in the long-term and independent use of an implemented version by users from different disciplines, companies and research institutions in different countries to prevent a bias by institution-specific procedures.
The filter results are exemplary and intended to reflect corresponding results from scientific research. For use, an expert (e.g., therapist in healthcare) should confirm the suitability of planned gamification for the intended target group. Implementations such as further developing and connecting frontend and backend, fixing usability problems and integrating additional functions are needed.
For the integration of further disciplines, respective experts should be integrated and practitioners should be considered as a third user group.
Due to the relevance of communication and a community of practice as shown by Mazorodze and Buckley [248], the emerging suitability for interconnection of research and industry is particularly important and should be further promoted in the future.

Conclusion

In this step, the potential for design, development and usage of a web-based gamification guidance tool for knowledge transfer and interconnecting industry and research is considered. The goal was to simplify the access, overview and applicability of research results in gamification. The results of this step illustrate the need, relevance and feasibility of such assistance tools.
The prototype presented, might, among other things, assist in faster identification of research results and use of gamification elements in practice. Furthermore, the potential to foster interdisciplinary connection between industry and research was indicated. Expanding such links of communication and making them available may be relevant for the effective further development for both user groups.
This step contributes to make emerging and complex diverse research results more easily tailorable and applicable. The results thus contribute to the support of the application of gamification and the selection of suitable elements to be implemented (TRQ1) in practice. Thus, in the future, the competence in the design and development of software-based methods in practice to support the motivation of patients in cognitive rehabilitation may be strengthened. In the long term, this might support patients in the conduct of the required training. An extension into other fields is possible.

Take-away & Key aspects

- *The 'Gamification Guide' might support the industry in the selection of tailored gamification elements*
- *Both positive and negative outcomes should be highlighted*
- *Instead of classifying complete papers, individual results should be tagged and categorized between positive, neutral and negative*
- *A kind of meta review can be generated and research gaps can be identified*
- *Results may be simplified in a compromise that is acceptable to researchers and easy for industry to use*
- *Networking and exchange between research and industry can be promoted*
- *Industry and research have different goals to address in terms of use*
- *In addition to industry and research, the involvement of specialist stakeholders, such as therapists in the field of cognitive therapy, may be necessary*

3.5 Discussion

3.5.1 Thesis Research Question 1
3.5.2 Thesis Research Question 2
3.5.3 Overall: Thesis Research Question 1 and 2

3.5.1 Thesis Research Question 1

Gamification has been shown in past research in cognitive rehabilitation to support motivation in perception, emotions, and behavior [44, 192, 239, 329, 361, 392], which the results of this chapter confirm. It is increasingly being used in software-based training in cognitive therapy, but requires further study and knowledge of how to integrate it for design and development [392].
In this chapter, the focus was on methods to deepen the knowledge on the use of gamification to support motivation in software-based cognitive training for patients with acquired brain damage and the resulting effects, to consider specific tailoring in the context of cognitive rehabilitation and to find ways and methods to support the implementation in practice accordingly. To address this, various individual elements or combinations in the general and in-depth implementation were examined, the request for different game elements for overarching comparison was analyzed, the effects of element (combinations) and dependencies on the user type were considered, and a tool was proposed on how to make research results accessible for appropriate implementation in practice. This results in orientation and implications for design and development, which are summarized at the end of this work in chapter 5.

Regarding TRQ 1 (Implementation of elements), for supporting the implementation of gamification for use in software-based cognitive rehabilitation for patients with acquired brain damage, several interesting aspects have emerged.
Interestingly, there was a high request from patients for assistance elements, which should be given special focus in design and implementation as a complement to progression elements. This supports the relevance of considering individual target group and context, which has been pointed out by other work [156, 160, 219].
It is interesting to note that, according to Vermeir et al., stories/themes are frequently used in computer-based cognitive rehabilitation [392], but are rather moderately requested by patients. However, depending on the implementation, stories/themes in a real-world setting can also promote meaningfulness [271]. The integration of interactive storytelling and quest in section 3.2.1 and also the metaphor in section 3.3 has been shown to be interesting for further use by patients. After basics of progression and assistance have been integrated in section 3.3, these and also possibilities of tailoring should be more deeply investigated.
The element of 'Meaning/Purpose' (the fulfillment of a meaningful goal of the training) is on average the most important element for patients and can therefore be recommended to deepen and further strengthen the im-

plementation. This further supports, e.g., the concepts of meaningful gamification for long-term motivation by Nicholson [271] and the use of meaningfulness in cognitive rehabilitation [60]. Koivisto and Hamari point out that, besides tailoring to the user's role, also tailoring to the goal is important [219]. In addition to meaningfulness, the 'Meaning/Purpose' item also includes the integration of a goal ('I see my training fulfilling a meaningful goal'), which is shown in the literature to have a positive effect on behavior and performance [227, 233], and in the clinic on motivation [417]. In this chapter, goals were represented, for example, in storytelling by solving the story of a detective case (section 3.2.1) or, in a metaphor, by reaching the top of a mountain via a hiking trail and setting personal goals in training or real life (section 3.3). A general orientation to real life is, among other things, a relevant aspect for patients [178]. Such implementation approaches are shown, for example, in 'RehabCity' [396], which is based on reality, or the daily goals to be entered in the 'PRIME' therapy app [333].
This illustrates, on the one hand, the wide range of goals in the game, goals in training and goals in real life and their integration possibilities, and, on the other hand, the relevance of an implementation focused on the needs of the patients.
The way, combination, tailoring and depth of gamified goals (primary or secondary/additional) in cognitive rehabilitation should be further deepened. Furthermore, this aspect of tailored meaningful goals will be taken up in section 4.3.6 of this work.
Also, possible emerging differences between request and emotion should be explored to support targeted development.
Through the implementation, different effects can be created [156, 329]. This is shown, e.g., in the different possible role models [114, 316, 398] of an NPC in other and prior works. For patients, instead, an NPC may be used to address the requested 'Assistance' through aspects such as motivating or guiding, and such as giving tips or helping, but also to illustrate progression, as in the example of the hiking trail.
Robson et al. point out that players might want to try to cheat [313]. Schmidt-Kraepelin et al. point out that the use of gamification in health behavior change can lead to cheating oneself [334]. Interestingly, however, despite the existing limitations of the patients, no simplifications of the training, such as anchor juxtaposition ('I can choose whether I prefer to do the training task to level up in difficulty or pay money (real or virtual) to level up.') or aura effect ('Based on the preliminary work of others, the training can become easier for me. (For example, using points collected by another person.)') are requested. Possible explanations may be a) the higher relevance of the personal health effects than the progression in the training tool or rising of levels, or b) the need for training adjusted to individual abilities rather than in more difficult tasks. This could indicate a future deepening of an individual meaningful representation of individual health progress rather than the implementation of standardized levels.
The results confirm the need for external personal factors for motivation in the clinic, such as, e.g., patients' goals, which were shown by Yoshida et al. [417]. Although the demand does not confirm the need for social relationship factors or socialization elements, it does confirm their individual effect and thus their individual motivational aspect [156].
For the implementation of elements in cognitive rehabilitation, it might be recommended to focus on meaningfulness [60], progression [230] and assistance [228], which supports and expands other results and frameworks. Furthermore, a tailored integration of socialization for rehabilitation and patients is recommended, as well as for the mixed elements and resulting effects.
For the integration of requested gamification, the infographic (Figure 11) can be used as a basis for design and development. Results on gamification may be used interactively in the proposed tool 'Gamification Guide' after its further development. In addition, possible differences for use in clinic and home training should be deepened in the future. Rehabilitation-specific guidelines for recommendations for use should be integrated into tools such as the 'Gamification Guide'.
The results of this chapter show methods, orientations and support in the implementation of (tailored) gamification in cognitive rehabilitation in practice to address patient motivation.

3.5.2 Thesis Research Question 2

Regarding TRQ 2 (Effects in perception and training duration) of this work, for the effect of the implementation of (tailored) gamification on motivation in perception and usage behavior, the following interesting aspects have been shown:

Perception

In perception, the results of the chapter indicate interest of patients in the use of gamification elements for software-based cognitive training in rehabilitation. The comparatively higher perceived fun/enjoyment in line with other work [239, 219, 329, 361], and likewise the effect of gamification on competence is confirmed [264]. Instead of a general effect, however, differences in a role model and requirements specific to rehabilitation using the example of the NPC as well as in the perception of the user types are shown. This supports tailoring in terms of user types [284] and context [156].

It is interesting that the problem named in other works, that implementing complementary content like gamification leads to a higher demand / difficulty, was not shown initially in the storytelling and quest in the exhaustion aspect during the course. Likewise, in the study in section 3.3.4, no significant difference was found in the perception of effort between gamified and non-gamified training.
Both could have been expected due to a possible higher required cognitive performance by the gamification complements in patients with cognitive impairments. However, considering the hiking trail (section 3.3.4), descriptively slightly lower scores in the areas of 'comprehension' and 'access' indicate possible difficulties due to the changed visualization in the metaphor.
Different results can have different reasons, such as a) different methodology in the data collection, b) different game elements and their implementation [156], or c) a different goal of the implemented elements. In the future, this can be considered further.
Further, the increase in complexity and dynamic difficulty adaptation mentioned by van de Weijer [387] could also be made possible in the implementation of gamification elements in addition to the increase in training. This might result in a scale from simplified to complex representation, depending on the suitability for the user's limitation, which should be further studied in-depth.

Behavior

Lopez and Tucker show in the general use of gamification, the positive effects on the performance of adapted and weakening of counter adapted gamification [234]. In the use of the combination of progression and socialization, a significant difference was found in the comparison of primary socializers, for whom there is a particularly high suitability of socialization elements [372], compared to non-primary socializers. This indicates differences in the effects on the different types. It supports the relevance of tailoring game elements to user types to address performance, in line with Lopez and Tucker [234]. The differences between requested and non-requested elements, effects and the height individually for each type should be further deepened.

3.5.3 Overall: Thesis Research Question 1 and 2

By integrating elements or overarching methods, different motivational aspects can be addressed, as shown by the system of Sailer et al. [325]. E.g., Progress can be focused on aspects of trait, cognition incl. achieving personal goals or interest, and meaningful stories can be focused on interest and emotion. This supports the different effects on requests, emotions and behavior found in this chapter in the application of gamification. Comprehensively, Tuah et al. point to the future need to tailor gamification to the individual needs of patients, as rehabilitation is a long process and motivation must be maintained [379]. The chapter therefore contributes, on the one hand, to the deepening of the implementation of individual elements (NPC and storytelling/quest), and on the other hand, to overarching tailoring possibilities for the tailoring of elements to the user type in the context of cognitive rehabilitation. The results show the individual motivational effect between the types. This supports the relevance of the concrete planning of intended effects [180, 202, 373] and proposes possibilities for design and development for the application of gamification in cognitive rehabilitation.

Limitations

Some limitations of the chapter should be noted. The included participants and patients are predominantly from Germany and the German rehabilitation system is considered in specific phases. A transfer to other countries or cultural groups, phases of rehabilitation or application areas can therefore not be ensured. In the qualitative approach, or partial consideration of subgroups in quantitative approaches, only a small number of probands are included. This shows tendencies, but generalizability should be considered with caution. Some of the questionnaires used were translated into German for the target group, reduced in items to reduce cognitive demands, or only considered in extracts. Likewise, a different type of study design and / or implementation of gamification may influence the results.

3.6. Summary

In this chapter, the supporting implementation (TRQ 1) and the effects (TRQ 2) on patient motivation were considered based on perception and usage behavior in the use of gamification elements as a complement to software-based training in cognitive rehabilitation.
In line with other work [392], the chapter confirms the feasibility and suitability of using gamification for software-based cognitive training.

In the general use of gamification for patients based on the elements of storytelling and quest, the implementation supports the wrapping of the training task [47, 256], which enables an independent development of both areas.
In the detailed implementation of an NPC, the results show a focus on the integration of a younger man or a middle-aged woman. For the characteristics, the focus should be set on emotional, friendly, but also competence-oriented characteristics, and that the NPC can take on the leading role. This combines several classic role models from games.
In the overarching analysis of the request for different game elements, the results show that elements of progression and assistance, but not by paying money for level up, are particularly relevant. Considering the individual user types, there are elements that are requested by all, only partially requested, and rejected by all. Socialization and mixed rated elements should be used individually based on the user type. A high relevance for meaningfulness in its implementation is shown.

For the implementation, a visualization for the orientation for the selection of requested elements is presented. For further knowledge transfer and deepening tailoring, the prototypical tool of a 'Gamification Guide' is presented. In this guide, users can define a target group, including user types and receive summarized research results for individual elements in a simplified visualization. Thus, the competence for the development should be transferred on the basis of research results, their target group, and needs to independently select elements.

Considering the effects, effects on motivation are shown.
Based on storytelling and quest, the interest in the use of gamification and interaction is evident. It shows the integration and perception of another goal besides that of completing the training task.
The results of the chapter do not show a significant increase in effort through the integration of gamification. An individual perception of user types is shown, using the example of increased fun and social support for socialisers and increased competence for achievers.

In terms of training duration, there is no difference between the gamified version in a metaphor with, among other things, NPC and progress on a hiking trail and the non-gamified version, however a significant difference arises in the gamified version between socialisers and non-socialisers.

The results show, on the one hand, the general interest in some elements, but also the relevance of tailoring when using less requested elements. This points to the relevance of planning gamification based on the intended effects [180, 202, 373]. The results suggest that, in the future, it might be considered to use generally requested gamification for all users as a basis for development, and to tailor further in-depth effects specifically to the user types, resulting in a partially tailored approach [43]. This might result in a compromise between the effort of development and the level of the desired effect in the future, as suggested by Lopez and Tucker [234].

The results of the chapter contribute to a targeted selection of elements and their tailoring to the target group. The results thus contribute to the consideration of the application of gamification and support in practical implementation, to the way of implementation and to tailoring and deepening the knowledge of application (TRQ 1) and show in-depth effects on motivation in consideration of perception and usage behavior (TRQ2) in the specific context of software-based cognitive training for patients with acquired brain damage.

Complement of Browser-Based Training: Grouped Gamification, Mobile App Game and Smart Home Device - Tailoring and Combination

4

4.1 Focus and Purpose
4.2 Effects of a Tailoring Method and Combined Browser-Based and Mobile Cognitive Software Training
4.3 Outlook: Smart Home Feedback Object - Further Development, Implementation for Independent Use and Tailoring of Gamification
4.4 Discussion
4.5 Summary

The increasing connectivity by means of wireless technology, smart devices, and smart homes offers various possibilities to extend and complement the training, and for independent use outside the clinic. This results in different scenarios for implementation and combination. Thus, the integration of gamification elements can be implemented, on the one hand, in existing conventional software training on the computer. On the other hand, training can be complemented by gamification or games, via various devices, or by physical objects. Therefore, in this chapter, selected possibilities for combination with computer-based training in use are considered.

This section contains texts from the author's own publications (see 'List of own publications' in the appendix) and partially extends prior work. The chapter is based primarily on the following publications:

Section 4.2 (Browser & Mobile):

- Preliminary concepts, designs and studies were created and conducted within parts of the given lecture 'Visual Communication - Digital Media' with the students to deepen the topic (Hochschule Magdeburg-Stendal). The results contributed to the decisions, but are only in excerpts integrated deeper in this work (P. 9)
- P. 9 A. Endler et al. (EEE EMBS ISC 2019): Overall Project Idea, Lecture, Supervision and Evaluation: M. Gabele. Detailed Concept and Design: A. Endler and T. Heidel.
- P. 1 M. Gabele et al. (MMM 2022)

Section 4.3: (Tailored) Smart Home Feedbackobject

- Prior project: Master Thesis M. Gabele [129], developed further in this work
- P. 11 M. Gabele et al. (IHCI 2019): based on [129], honored with the Encouragement Award
- The further development, technical implementation and evaluation, as well as conceptual tailoring have not yet been published or submitted at the time of the submission of this work. The author of this work (concept and realization) was primarily supported in various areas by: Danny Schott (design and product), Benjamin Hatscher, (implementation), Simon Schröer (implementation), Fabian Joeres (evaluation concept), Marie Steinbrügge (design), Juliane Weicker (feedback: concept and evaluation), Andrea Thoms and Hasomed GmbH (connection to the online training).

4.1 Focus and Purpose

Since the focus in the first phases of rehabilitation is on inpatient and / or outpatient therapy with close supervision by therapists, the computer training (desktop / browser-based) used frequently for this purpose is taken as the basic step. In ongoing steps in the rehabilitation process, it can be complemented, e.g., in home training [171] (see section 2.1.3) for individual use and ubiquitous integration in daily life.
Colzato and Hommel discuss the future and change of cognitive training and mention the increasing number of apps and gamification being used [79]. This makes the training easier to integrate into real-world settings and more accessible. To support the development and prevent a high drop-out rate in the everyday life situation, they suggest the integration of visible feedback, which maintains the training motivation even in slow progress, where gamification can support. Extensions of motivation through aspects of games and feedback visualization also build a basis in this section.
In practice, training on the computer and mobile devices is offered (see Table 2). White et al. state that different devices have different advantages and weaknesses and are used one after the other or simultaneously, depending on their function and the requirement [408]. Here, screen and non-screen based devices can be combined.

To explore different potentials in the combination, this chapter considers:

1. The effect of the method of grouped tailoring in a browser-based (gamified) cognitive training as well as the possible combination with a following mobile serious game training app and
2. The further development and the feasibility of the implementation of a physical feedback reminder object for independent home training of the user to a browser-based cognitive training and a concept for further design and development for tailoring to the different user types.

This section contributes to promote the applicability of tailoring motivational methods in cognitive training and analyzing its effect. Furthermore, it contributes to the method and application of complementing computer-based cognitive training with mobile and smart home devices. Methods will be practically implemented, evaluated and further developed. The goal is to support the development in practical application and thus the motivation and conduct of the users.
The consideration of smartphones as a complement to browser-based training is due to their widespread use [192] and the implementation of a smart home device to create a bridge to software training in everyday life.

Thus, in this chapter, the overall questions TRQ 1 (Implementation of elements), TRQ 2 (Effects in perception and training duration) and TRQ 3 (Training supplementation) of this thesis are addressed.
Challenges include the design of combinations that are suitable for therapy and are developed for independent usage. The main contribution of this section is the consideration of the (tailoring) combination approaches for development, as well as motivation and possibility of independent application in home training used in practice.

4.2 Effects of a Tailoring Method and Combined Browser-Based and Mobile Cognitive Software Training

4.2.1 Focus and Purpose
4.2.2 Background and Related Work
4.2.3 Feasibility of a Serious Game Approach
4.2.4 Effects and Combination of Tailored Browser-Based and Mobile Cognitive Software Training: Concept and Implementation of the Prototypes

In this section, for the implementation of elements and development of software products in practice, the grouped characteristics of the user and needs in terms of game integration and the combination in the use of browser-based and training (games) via smartphone are considered.
For initial feasibility, the method and effect in practice are investigated in an explorative between-subject design and hypothesis generating study (N=68). First, the effect of a browser-based training without gamification or with assignment of gamification appropriate to the grouped mean user characteristic on behavior in training duration is investigated. Second, the effect of this training and a subsequent serious game app video prototype on perception and possible combinations of different media is investigated. The results of behavior lead to the hypothesis that with grouped characteristics for tailored gamification in browsers, users may train longer in the middle range of training duration. The results of perception show a significant difference and higher perceived value/usefulness and overall rating, as well as the assumption of a higher effect in computer and mobile training in the group with tailored gamification. This could provide an important basis for this combination. A combination of both usage scenarios, browser-based and mobile, is perceived by users as most reasonable for a positive training effect. Nevertheless, there is a high variance for self-assessed personal usage.
Thus, the results support developing multiple combinable scenarios, tailored to the user, in-game elements, media devices and game integration to address intended effects, development and user needs to support the effect of cognitive software training in practice.

4.2.1 Focus and Purpose

Motivation can be supported by gamification and games in rehabilitation [239, 294, 329]. Software-based training, gamification complements and games are offered for various devices besides the computer [42, 115, 181, 329, 379] (see Table 2). For the integration of gamification, there are several methods for implementation: Firstly, offer elements suitable to all users. Secondly, offer the most suitable element for each type. Thirdly, offer elements suitable for a combination / group of types.

A challenge when assigning users to gamification elements is that they are often a mix of different characteristics [371]. Additionally, in practice, there is usually a short time frame and limited financial options for the development of gamified systems [262]. In the previous chapter, the evaluation in section 3.4 indicated the need for a 'healthy relationship between effort and benefit' [130]. For this, costs and benefits must be balanced [292]. To achieve a positive effect of gamification using few resources for development and including different characteristics, the third option was targeted and a possible method by summarizing groups of character traits in the mean was applied. This leads to:

- RQ1: What is the effect of grouping characteristics in the mean and assigning them to a rather appropriate gamification scenario in browser-based cognitive training on behavior in training duration?

In addition to behavior, tailoring can be reflected also in the perception of users. Furthermore, not only tailoring in a single application, but also in combinations of different multimedia devices, such as computers and mobiles, is relevant [142].
For a possible complement of computer-based training, the first approach was used in a serious game app video prototype, using an element that is rather suitable for all users. In everyday life, often multiple devices are used, whereby their tasks and the combination of the personal systems vary [194]. Depending on the way of combining both training applications and multimedia devices, there could be different effects. This leads to:

- RQ 2: How are the application and combinations of a previous browser-based training perceived A) without and B) with gamification, with a subsequent serious mobile game app?

For this the perception and comparison of both applications and combinations by participants are considered. To address the research questions three application scenarios (one without and two with grouped tailored gamification) were implemented. Perception and training behavior in the self-selected training duration were considered as an indicator of motivation.

The main contributions of the step are the consideration of 1) the effect in training behavior by user grouping and assignment to (gamified) cognitive training and 2) the perception and potential in ways of combining different applications and media devices. To address this, two possible ways of combining different training scenarios in practice were considered:

- The browser-based training without (one version) or with (two versions for tailored use) gamification and
- A subsequently mobile serious game video prototype addressed to all users were designed and evaluated as possible combinations.

The goal of this step is to explore basics for developing and connecting (tailored) cognitive training in different multimedia in practice. The results contribute to the implementation of elements, effects and range and expansion of use options to support design and development and thus the user motivation.

4.2.2 Background and Related Work

Tailoring gamification is often based on the characteristics of the users [215, 372]. However, the consideration of the primary type only excludes other characteristics. Hallifax et al. therefore point out that the combination should be considered [156]. Also, Santos et al. point out that the assignment should include not only the primary type, but the different scales of the types in their levels, among other things, because the user type can change over time [328]. Further, according to Koivisto and Hamari, there is a lack of consideration of the link between gamification and psychological outcomes, such as frequently considered enjoyment or perceived usefulness/effectiveness, although outcomes are frequently considered in empirical research papers [219].

According to the World Health Organization (WHO) and the European Respiratory Society, mHealth (Mobile Health) describes an aspect of eHealth where mobile devices are used [412]. With increasing [412] and high usage [194] and increasing availability of mobile devices, mHealth technologies and apps offer potential for use in the health sector [223] and rehabilitation [102]. Thus, resources can be economized, and the patient can be monitored and supported [412]. However, as in eHealth, it is not intended to replace conventional medical therapy or therapists, but to supplement it [102, 185]. In practical use, training for various devices, like computers (download or browser-based), or apps for mobiles such as smartphones or tablets, are offered for patients [181]. According to a review by Johnson et al., existing papers often consider websites or mobile devices as platforms [192]. Mobile devices are widely used and possibly make gamified applications more accessible than specialized devices [192]. In studies on gamified cognitive training, tablets are more likely to be considered for the use of mobile devices, while smartphones tend to be less frequently used [392]. Smartwatches have been used for a reminder prototype in prior work [129], with potential suitability as a reminder for people with acquired brain damage, which was also noted by Jamieson et al. [185].
How et al. consider in a co-design approach possibilities for future approaches to use, among other things, mobile technologies in cognitive telerahabilitation [178]. They show a variety of concepts, such as a reminder on strategies in everyday life, which can be given by a smartwatch depending on location and situation. However, when considering motivation, they also point out the relevance of meaningfulness and the setting of goals that are relevant for the patient.

Chandrashekar indicates the potential of mobile applications to fill treatment gaps where access is lacking, and to enable technology-based changes in the offering of therapies, but for this, a linkage of science, policy foundations and design is necessary [68]. Real-time engagement, usage reminders, and gamified interactions are suggested as supporting factors for the required high level of personal motivation. For a low cognitive load, a simple user interface should be implemented in the apps.
When care is needed, it is technically relevant, according to Dicianno et al., as in the 'iM-Here' system, that a tool used by a caregiver is linked to the patient's mobile devices [102].

In mHealth, Vella et al. show in the use of the app MindMax the potential for users to supplement mental and well-being content in an app with casual games [390].
Nuijten shows the potential of gamification elements (reward mechanisms, social comparison and adaptive goal setting) to address engagement in mHealth applications [277]. However, they did not find this effect for personality tailoring.
Dennis and O'Toole show that the use of a gamified mobile application can help reduce subjective anxiety in highly anxious people [95]. Thereby, various advantages of mobile devices are pointed out, such as the easy accessibility and distribution of offered services. In mental health, Mak et al. show positive effects and reduction of psychological distress by using the modules of the app 'Living With Heart' [240]. They also address the high prevalence, pointing out that mobile apps could thus address public mental health. Schlosser et al. show with the mobile app intervention 'PRIME' for patients with schizophrenia in an iterative development process the increase of motivation, whereby an experience that included several aspects of the Self-Determination Theory was preferred [333]. They point out, among others, the design of a friendly, non-stigmatizing approach [333]. In a review, Rathbone et al. show that the use of mobile health apps is endorsed with regard to Cognitive Behavioral Therapy [305]. In this field, Tang and Kreindler propose the use of mobile devices to promote the carrying out of homework tasks related to therapy [362]. They point out the relevance of various aspects, such as therapy congruence and emphasis on completion for integration into the app.
Dobosz et al. have developed 'RehaMob', an android tablet-based training program for old patients in neurological care for the training of various cognitive impairments after a stroke [105]. This shows that the mobile training is suitable for use in cognitive rehabilitation in terms of usability for patients. Furthermore,

the mobile training was shown to be more attractive for most patients than a conventional paper-based training [105]. They point out that the use of mobile devices in long-term rehabilitation can support further training. In addition, they suggest the use of game elements for mobile cognitive training in rehabilitation to make the application more attractive.
A comparison of computer based and mobile training for alcohol avoidance by Boendermaker et al. showed minor differences, such as slightly higher involvement with respect to mobile training, but no substantial differences [44]. Although initial indications suggest that there is a higher motivation for mobile training in terms of how often training is carried out, this was offset by the basic motivation to train before training [44].

When considering multi-device use, Jokela et al. point out that different devices are used for different tasks, situations, and environments, and the selection may depend on one's habits and preferences [194]. Smartphones are used for various everyday tasks, while tablets are mostly used for consuming content and entertainment. Laptop computers are used for more complex tasks and more complicated content, often for more important and serious tasks such as work. Users want to use content on different devices and that the devices work seamlessly.
In the 'Ubi4Health' application for healthcare environments, a multi-device system is used, and Garrido et al. point out that this provides an important infrastructure for improving context-awareness [142]. It enables users, staff and patients to use and interact with appropriate devices according to their needs.

Despite a possibly increased difficulty in mobile training games by changing the surrounding, they may support the practical training needed and the learning effect [116] (see Pre-Study, section 4.2.3). Playing on the computer, however, is not substituted by apps for users due to the various needs [117]. The computer is more often used for playing games at home than the smartphone, and has a high visual recognizability due to the large screen [117]. A typical reason for playing games on mobile devices is to bridge time in waiting situations [117].

To support motivation, there is a wide variance and depth of integration: From basic training tasks to serious training games [47]. In eHealth studies, both gamification and serious games are often considered in the field of rehabilitation / chronic disease management [329]. As in the preliminary study, serious game app concepts can be partly based on basic cognitive training approaches [116].

Beyond mobile training in therapy, brain jogging apps such as 'NeuroNation' [270], 'Lumosity' [238], or 'Elevate' [113] are developed for cognitive exercises [270]. They are often characterized by gamified or game-based implementations. Fun and entertaining implementation are relevant aspects. Like therapy tools, many brain jogging apps offer training in various ability categories. However, they tend to focus on prevention or improving current skills. They do not tend to be integrated into therapy processes and, in contrast to the use of rehabilitation tools, do not tend to take place under the supervision of psychologists/therapists [181]. Due to their differing intended use, Irazoki et al. point out, that they should not be used for treatment [181].

4.2.3 Feasibility of a Serious Game Approach

The feasibility of combining an existing medically approved cognitive training and a casual mobile game was considered. Several requirements were defined for this. In addition to enjoyment and personal responsibility, autonomy as part of the Self-Determination Theory contributes to support motivation [323]. This is to be addressed by mobile training that can be used flexibly in terms of space and time. For usage in rehabilitation, it should be based on an existing training, but not merely offer a porting of the training to another platform, but offer a separate approach which is appropriate for the device. Motivational elements are to be integrated to support usage. The approach should be used on mobile devices and offers the possibility to connect it to computer-based training.

Figure 18. Mobile Training Concept for Smartphone and Smartwatch. Figure from Endler et al. [116]. Note: The following rendering was used as the basis for the visualization: [51]

To explore possibilities, various approaches have been designed within a lecture given by the author at the University of Applied Sciences Magdeburg-Stendal. Based on the requirements and consideration of motivational support by games, one resulting approach is considered further, which uses a game concept as a basis and combines it with an existing cognitive training for logical reasoning [165].

Logical reasoning training is about analyzing and identifying the underlying concepts of a problem to find a solution, which forms a basis for solving problems in everyday life. In the existing training, image series based on shapes are shown, which are to be supplemented by a further series element [165].

A concept and a video prototype for a proposed mobile casual training game for smartphone and smartwatch were designed. The concept is intended to complement the cognitive training given by the therapist. In the video prototype, the scenario, function, screens and interactions were illustrated.

Within the game, shapes are displayed in a row and have to be logically completed (Figure 18). If the answer is correct, the row disappears. If the answer is wrong, it remains. The goal is, similar to the game 'Tetris' [286], to get as few as many remaining rows as possible, or to achieve a number of correct rows. By a planned server-based connection of the app to the training profile of the patient in the system of the therapist, an adjustment of the difficulty to the abilities of the patient can be implemented.
In a semi-structured qualitative expert interview with a psychologist and a product manager of the rehabilitation software used as a basis, the various approaches developed, including the game approach described above, were evaluated. It was shown, among others: The time-reduced task at the personal ability level is suitable to promote the practice that is necessary for rehabilitation. A changing environment makes training more challenging, but may promote the learning effect.

The gameful approach may expand the current training in a motivating way and thus it shows a high potential for use in clinics and home training. The combination with an existing training system distinguishes it from existing brain jogging apps and provides a reliable therapeutic background.

This step indicates the feasibility and suggests that the game approach might be suitable for use. The concept shows the combination of existing cognitive training and its transfer into a serious game. It expands the potential of cognitive training for flexible use of the patient's individual situation. Based on this step, such an approach will be further developed in the next step and the effect and connection with browser-based training will be evaluated.

4.2.4 Effects and Combination of Tailored Browser-Based and Mobile Cognitive Software Training: Concept and Implementation of the Prototypes

In the next step, for the connection of browser-based and mobile training, a mental calculation training was chosen as an application example close to everyday life. Due to the widespread use of the devices, a smartphone was used for a prototypical example.

Based on a pilot study (N=13, 10 calculation tasks) a suitable difficulty level was identified. This is set to avoid boredom, overload, and to prevent drop-outs in training due to these factors, which are not related to gamification. In mean (standard deviation), individual calculation skills (5-point Likert scale: 1: poor, 5:good) were rated at 3.15 (0.95), 4.08 minutes (2.09) were needed, and 1.38 (1.39) errors were made. Using the NASA TLX (21-point Likert scale, 0: low, 20: high) most results were in the medium to rather low range: Mental Demand (8.62 (4.76)), Effort (8.54 (4.41)), Performance (7.77 (6.12)), Temporal Demand (7.15 (3.86)), and Frustration (5.62 (4.29)). Physical Demand was rated lower (1.62 (1.86)). Based on these findings, the prototype was designed.

Regarding browser-based training, one basic version, inspired by an existing medical training for calculations [163], and two extensions for gamified versions were designed. The Unity based prototypical implementations were integrated in an existing browser-based online training environment for cognitive rehabilitation [162]. This allows users to conduct it independently at home in their personal environment and according to the intended everyday life usage scenario.
After tasks for familiarization, the basic training (Figure 19 A) contains blocks of 10 tasks each, according to the pre-study: exercises range between 1 and 1000, up to three decimal places. Then a hint appears to start the next block. According to the results of the preliminary study, an average of 1-2 errors per set were incorporated. This was aimed primarily to provide a sense of success, but also a sense of relevance to the training.

The two additional gamified versions and elements were chosen based on the results of Tondello et al. [372] in a way that each type can be assigned to an element that is rather appropriate:
For the category 'Immersion' (suitable for: Philanthropist, Free Spirit, Achiever, Disruptor) a story based on the popular leisure activities gardening, going shopping or out for a meal [353] was added (Figure 19 B). It is wrapped around the basic training task blocks. For 9 or 10 correct answers, users receive a compliment and a story related picture, for less, a supportive remark.
For 'Socialization' (suitable for: Socialiser, Player), a cooperative setting was integrated (Figure 19 C), which has shown a higher effect than competition in physical activity [70]. It is aimed to avoid potential shaming for low skills, stress and negative emotions and shows also a positive effect for these user types in contrast

Figure 19. Browser-based cognitive training software: A) Basic training and extensio by B) a Story and C) Cooperation; Serious game app: D) Selection of numbers, E) Successfully achieved result. Figure from Gabele et al. [134].

Table 15. Procedure of the explorative study. Table from Gabele et al. [134].

Step 1		Step 2 (Browser-Based)		Step 3 (Mobile App)	
Pre-survey and assignment (Between groups and in group B gamification)	**Group A**	Calculation without gamification	Post survey A	Serious Game App Video Prototype	Post survey
	Group B	Calculation with gamification (Immersion or Cooperation)	Post survey B		

to competition [284]. The player is assigned to a computer generated teammate, who simulates a real player, but behaves the same way for each participant. Both calculate simultaneously individually received tasks. For 9 or 10 correct answers, both receive a green star, for less, a supportive remark. The programming of the teammate is based on a repetitive sequence in winning (W) and losing (L) (W, L, L, W, L, W, W, W, L, L).

In all versions, gamified and non-gamified, this created short breaks between tasks. Thus, the procedure was approximated, as in other studies [45].

Regarding the combination, a serious game app video prototype was designed (Figure 19 D, E). Based on the suitability for all users, its concept is based on 'Progress', as this is highly requested in the cognitive training of patients [136] (see section 3.3). Due to potential distractions in the environment [76], the difficulty in game potentially should be lower than that of computer training. The game is intended to compete with other games on the smartphone in terms of entertainment value [117]. Short exercises allow users to start and stop the app flexibly.
The goal is to calculate a target number (17 in this example) by collecting and adding numbers. To collect, a ball moves through a

tunnel, which can be rotated by arrows. The numbers are created in a way that the target number can be reached.

Evaluation

Method

An explorative between-subject design study with two groups was conducted: without (Group A) and with tailored gamification elements (Group B) in browser-based training, followed by a serious game app video prototype. The study was conducted in three steps (Table 15) and blinded for participants. They were given the opportunity to receive personal partial results and / or to take part in a draw for a gift. Participants over 18 years who showed interest in improving their mental calculation skills were recruited. Sufficient language skills, basic skills in addition, access to computer, internet, and email were required. Data input until 07/07/2020 was included.
In step 1, after informed consent, a pre-survey was conducted to collect demographic data, self-assessment, and user type based on Player and User Types Hexad Questionnaire [374]. To avoid bias, group A and B were balanced according to enjoyment and self-assessed abilities in calculation (7-point Likert Scale (1: Absolutely no / very bad, 7: Absolutely yes / very good), age, and gender. For a possible way of assigning gamification (B), the mean values between the results for the types that are suitable for the two gamification versions as described above were used.

In step 2, participants received information and login data via email. The training had to be conducted in a single session with a free choice of time, place and duration. To avoid overload, maximum duration was set to 90 min (including gamification), similar to a lecture. For the analysis of training duration (excluding gamification), the time considered was reduced: 1. Since different amounts of time for familiarization was needed, the longest required time (10.42 min) was considered as the starting point for all. Lower total times were set to 0. 2. Since gamification also requires additional time, in Group B of those who reached the total time (90 min), the minimum calculation time (without gamification) was considered (68.5 min). If the training was started more than once, only the first start up to stop via 'esc' was included. An unpaired t-test was used for determining significance in training duration between group A and B (two-tailed, threshold for significance: 0.05). In the post-survey, questions about the perception were asked: Personal Gratification based on questions of GUESS, Value/Usefulness, Enjoyment, Competence on parts of questions of IMI, workload on NASA TLX, possible (A) and used (B) gamification, presentation, effect, requests and reasons for stopping.

In step 3, the participants received the link to the serious game video prototype and post-survey via email. Questions were asked about the perception, effect, possible use, relevance of different aspects, and comparison between web based training, app and combination. A Mann-Whitney U-test was used for determining significance in difference of perception between Group A and B and browser and app based prototype (two-tailed, threshold for significance: 0.05).

Exclusions in the analysis were based on technical, procedural or organizational problems, misunderstanding tasks or missing steps. For quantitative analysis of training times (RQ1), participants were included who completed the browser based training. For perception (RQ2), to draw conclusions between the prototypes, participants who answered all questionnaires and did not independently conduct types of training that were not part of the study were included. For the evaluation, the parts of the results that were relevant for RQ 1 and 2 were considered in excerpts.

Results

In the following, the summarized results considered regarding RQ 1 and 2 in the explorative study are presented. The number of missing data is indicated by the number of asterisks in the corresponding parts. Significant p-values are printed in bold. 68 participants started, 49 were included in different parts of the analysis, without significant difference regarding assignment factors between Group A and B in both RQs. 17 dropped out before,

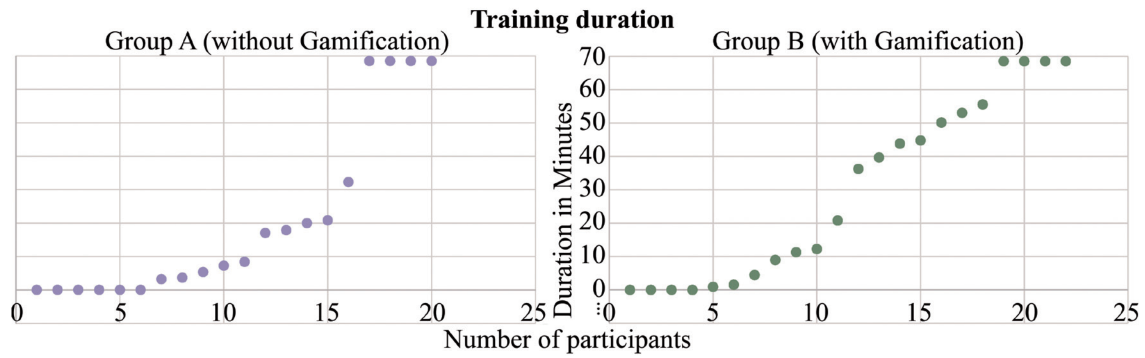


Figure 20. Training duration of participants without and with gamified training (pure time of calculation, reduced and sorted by duration). Figure from Gabele et al. [134].

2 during browser based training, and 10 at different points later. Reasons included technical, organizational and language problems, and dropping out without feedback.

Regarding the behavior (RQ 1), 42 participants were included in the analysis regarding training duration. 20 participants in group A (mean age: 44.05 years, age range: 20-83 years, female: 10, male: 10, enjoyment (4.40) and individual abilities (4.05) in calculation) and 22 participants in group B (mean age: 44.64 years, age range: 22-73 years, female: 10, male: 12, enjoyment (5.09) and individual skills (4.68) in calculation).
Deducting the reduced times the training duration results in a median of 7.49 min in group A and 28.30 min in group B (no significant difference (t=-1.1443, p=0.2593)). The individual values are shown in Figure 20.
Regarding the perception and comparison (RQ 2) of browser-based training and the serious game app, 34 participants are included. 15 participants were in group A (mean age: 39.33 years, age range: 20-70 years, female: 7, male: 8, enjoyment (4.53) and individual abilities (4.33) in calculation) and 19 in group B (mean age: 44.95, age range: 24-73 years, female: 9, male: 10, enjoyment (5.26) and individual abilities (4.74) in calculation). Results are presented in mean (SD).
In the post-survey of step 2, a significant difference has emerged for (Group A, Group B, p-value): Value/Usefulness (5.13, 5.88, **0.02642**) and overall rating on a 7-point Likert scale (1: very poor - 7: very good) (4.73, 5.42, **0.0466**). No significant difference has emerged for: Personal Gratification (5.57, 5.87, 0.34212), Enjoyment (4.60, 5.28, 0.05), Competence (5.20, 5.37, 0.28014) and the scales of NASA TLX. In detail, in the ratings of the individual aspects of training and gamification and the request for integration, a wide variety was observed. Reasons why the training was stopped were, among others, in group A: lost interest, repetitive, same types of tasks, no progress / goal indicated; concentration waned, trained enough / end of training reached; and in Group B: no progress / goal indicated, concentration waned; same types of tasks, trained enough / end of training reached.
In the post-survey of step 3, the serious game app (4.73, 5.33*, 0.15272) was rated overall also rather well. The relevance of different aspects in training were assessed on a 7-point Likert Scale (1: absolutely not important, 7: absolutely important) (Item (Group A, Group B)): train at a time I want (5.93, 6.42), train at a place where I want (5.6, 5.95), have fun with training (5.8, 6.26), effectiveness of the training (5.86*, 6.05). Assessment of possible effect and usage within browser-based training and serious game app are shown in Table 16. A comparative assessment of the effect for different multimedia applications in Group A and B is shown in Table 17. Figure 21 shows how the browser-based and app-based training was perceived in comparison. Figure 22 shows which way of combination is perceived as most effective and most likely to be used.

Table 16. Presumed effect and individual training behavior in browser-based training and serious game app (7-point Likert Scale (1:Absolutely not true, 7:Absolutely true)). Table from Gabele et al. [134].

	Browser-Based Training			Serious Game App		
Effect and Usage	**A**	**B**	**p-value**	**A**	**B**	**p-value**
With regular use, the training has a positive effect on my calculation skills.	5.14* (0.83)	6.21 (0.77)	**0.00318**	4.79* (1.21)	5.47 (1.19)	0.08726
I should do training like this, adapted to my abilities, more often.	5.07 (1.18)	5.47 (1.39)	0.34212	4.36* (1.34)	4.89 (1.48)	0.29834
I would like to do training like this, adapted to my abilities, more often.	4.40 (1.14)	4.58 (1.57)	0.75656	4.21* (1.86)	4.44* (1.67)	0.78716
I will do training like this, adapted to my abilities, more often.	3.40 (1.25)	4.28* (1.66)	0.15854	3.31** (1.54)	4.05 (1.70)	0.25848

Table 17. Presumed effect for training in different ways and multimedia (7-point Likert Scale (1:Absolutely do not agree, 7:Absolutely agree)). The number of asterisks indicates the number of missing data. Table from Gabele et al. [134].

Presumed effect	Group A	Group B	p-value
Training on the computer results in a high training effect.	5.00 (1.10)	5.89* (0.81)	**0.0226**
Training on the mobile phone results in a high training effect.	4.71* (1.03)	5.72* (0.93)	**0.03**
A game on the computer results in a high training effect.	5.33 (0.70)	5.47** (1.19)	0.40654
A game on the mobile phone results in a high training effect.	4.92** (1.07)	5.47** (1.14)	0.22628
I would like to use the training from the computer as it is as an app for mobile phone / tablet (instead of the app as in the video).	4.47 (1.86)	4.65** (1.57)	0.89656

Discussion and Conclusion

RQ 1: Behavior in Tailored Browser-Based Training

Although there are significant differences in cognitive training and duration [45, 275] and in behavior in other domains, in line with previous steps in this [136] (see section 3.3) and other work [239], there was no significant difference between training duration with and without gamification in browser-based cognitive training in this study. However, the median with use of gamification is noticeably higher. Without, in line with Knop, the large proportion of participants showed rather low usage, also some high performers and few users in the middle range of training duration [217]. In the middle range, participants with gamification achieve partly higher training durations. However, the hypothesis that tailored gamification in cognitive training may support increasing the training duration in the middle range should be evaluated in further studies. This should include the classification of baseline

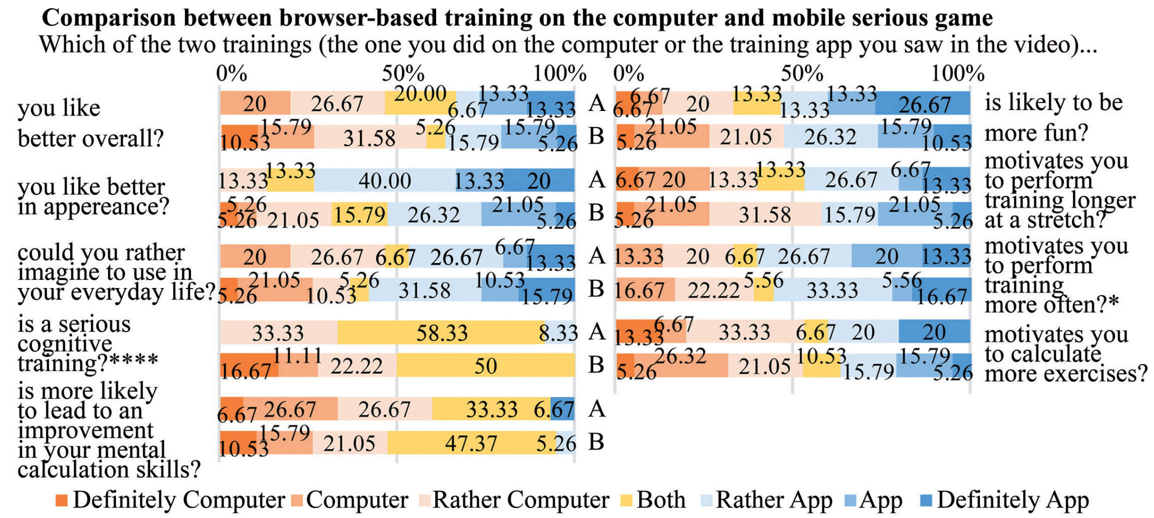


Figure 21. Comparison between browser-based (gamified) training and serious game app. The number of asterisks indicates the number of missing data. Figure from Gabele et al. [134].

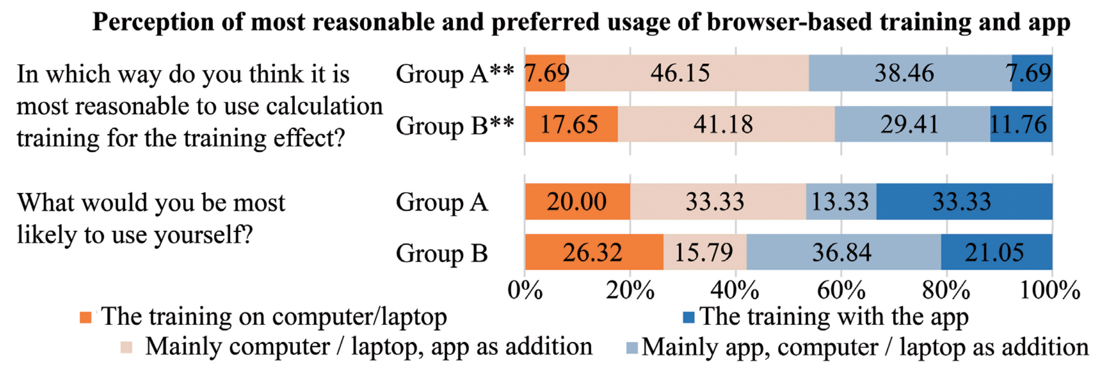


Figure 22. User report on most reasonable and preferred method. The number of asterisks indicates the number of missing data. Figure from Gabele et al. [134].

motivation, as exemplified by Boendermaker et al. [44]. Also, it should be considered why this occurs only in some participants.

Reyssier et al. show a positive effect on those with the highest amotivation and a significant influence of initial motivation and user type in students learning mathematics [309]. This supports the differences found in this step, as well as to include both aspects in further considerations. However, they also show the decrease of motivation with high initial extrinsic and intrinsic motivation through progress and ranking [309]. This aspect should be included in future consideration and assignment.

For development of tailored gamified applications in practice, a compromise is integrated between a few elements to be used, considering the mix of user characteristics and assignment of users to the solution that may be most appropriate for them. Thus, according to the approach proposed by Hallifax et al., several character types are included [156]. Also, this might reduce gamification assignment and development effort, which might potentially address the compromise between development time and motivational support mentioned by Lopez and Tucker [234] and similarly mentioned in section 3.4 [130].

Barata et al. also show in the area of student learning different performance groups in a gamified system by Achievers, Regular, Late Awakeners, Halfhearted, Disheartened and Underachievers [29, 30]. Achievers and Underachievers are consistently identifiable, whereas the others appear at specific points in the course. They propose to use an analysis algorithm to detect Underachievers early and to dynamically integrate gamification elements to motivate them [29].

Tamayo-Serrano et al. point out the relevance for stroke rehabilitation of analyzing motivational elements based on automatic recognition of engagement and emotion in the future [361]. A motivation-centered automated approach may be useful for patients in cognitive training, especially in independent home training to prevent dropouts or too low training [388]. Utomo and Santoso suggest for students with low performance based on agents used to implement instructions and suggestions and to increase the activity level [385]. Signposting is also an element of assistance requested for cognitive training (see section 3.3) and could be considered for use in the future when low performance is analyzed.

RQ 2: Perception and Combination

The higher perception of value/usefulness of gamified browser-based training in group B shows an effect on emotions. The results also support the relevance of autonomy [323], as training at a time and place that participants want was rated as rather relevant. The stated relevance for fun in training supports the integration of motivational elements like gamification, considered by Vermeir et al, and their conclusions that gamified training is more motivating / engaging [392]. This has also partially shown to be evident evident in section 3.3.
The assessed relevance of effectiveness can indicate the relevance of its integration and confirmation, as well as communication to the user. However, the users missed a presentation of a goal or progress, which is highly requested in cognitive training, as analyzed in section 3.3 [136]. However, despite the rewarding story related picture / green stars for successfully completed tasks, dropout reasons such as no progress / no goal were indicated in both groups. This suggests that a more explicit representation of goal and progress may be needed than the number of successfully completed tasks. Positive feedback was mentioned by van de Weijer as an important basis for gamification [387]. Feedback on progress is relevant for users in training [178] and to repeat the behavior [313]. Its deeper or more meaningful integration may further support emotions, for example in enjoyment, where the results are on the verge of significance in this step ($p = 0.05$). Especially with increasing age, the focus shifts from competence to enjoyment [41].
Also, a more meaningful approach might support relation to the rewards [154]. Individualization of rewards, goals and possible meaningful implementation is considered as a complement in section 4.3.6.

Perceived usefulness is a relevant aspect to continue [219]. Talaei-Khoei and Daniel show, based on the example of a brain training game, that younger older adults believe that it can improve their cognitive skills, including daily living skills, and help them to live independently [360]. The results support the positive effect of gamification on perceived usefulness in cognitive training.
According to Sardi et al. a risk exists that gamification or games lead to less serious perception of training [329]. Similar indications can be found for the different implementations in this study. Although predominantly the implementations for both devices are rated as serious training, the following tendency for the (non-)gamified training on the computer can be observed.
However, a significantly higher effect is assumed in gamified training and after its use also in training on computers and mobiles in group B, which is particularly relevant for the development and implementation of gamification elements. The belief in the effectiveness of cognitive training is a relevant predictive factor for the willingness of users to carry out training [161]. This indicates that the integration of gamification might be a supporting factor in training behavior in different media devices. Although this difference is not shown for games or the serious game app and browser-based training is perceived as more skill-supportive, differences in the way of use are indicated. Slightly higher motivation for frequent repetition of training with the app and, and in contrast, more tasks in browser-based training may support the different ways of using the devices [194]. The wide range of individual ratings and interest in the use of both versions can have different explanations beside this: First, in line with Lessel et al. [231], there may be different levels of interest in integrating game support. Second, in line with Jokela et al., device usage and needs in everyday life differs [194]. In the study, smartphones were used as an example for the mobile version. According to Lu et al., tablets could be more suitable for older people, among other things because of the larger screen and the corresponding recognizability [235]. An implementation for both devices could therefore support availability and accessibility.
Altogether, based on the results, differences can be seen between preferred individual use of the application and different devices [194], and moreover in the assumed effects.
The autonomous selection of devices could, in line with the autonomy aspect [88, 321], support usage. This effect has been shown by Kaptein et al. in self-selection of game elements and increased compliance [201].

General Discussion, Future Work and Limitations

In the combination of applications and media devices, the suitability for the users, the training goals as well as the feasibility in development should be considered. The results indicate that tailoring gamification and grouping in mean characteristics could increase motivation and may partly influence training behavior, while integrating different user characteristics. Compared to individual implementation of elements for each user type, the complexity of the development may be decreased in the future. This supports the suitability of this approach for practical development.
In line with Vermeir et al., the gamified approach is partly more promising in terms of motivation compared to the non-gamified approach [392]. The results, the level of potential effects on behavior and motivation and influence in training effect should be evaluated in further studies and directly compared with other ways of assigning gamification. To address the different needs shown in comparisons, based on adaptive game elements [395] and combining media devices, different usage possibilities can be developed. Furthermore, training can be individualized and adjusted to required training factors corresponding to the abilities, level of possible or desired distraction stimuli in everyday life, the required integration of routine or commitment to training in everyday life, or intended intensity and duration, etc. The focus of the combination might be also change over the training period, depending on the goal and user. This also might create new feedback loops [392]. In this way, the relevance to consider users' needs [262] and learning therapy aspects can be included. However, it is relevant that all systems simply work with each other [194].
In line with Eysenbach, on behavior in eHealth [120], the study shows a high drop-out rate. It is relevant to analyze reasons and points of dropout to develop strategies for reduction. Also, the remaining group of low performers in gamified training should be considered. The stage of change in the user's awareness can be relevant here, as it is also related to experience and motivation [12, 286], as well as the level of belief in one's own abilities [66]. In addition, following the review by Killikelly et al. and the indication that younger/male users might have a higher dropout rate [212], relevant factors such as combinability for different age groups should be further considered.
Boendermaker et al. found no difference between pc and mobile training after including baseline motivation in the quantity of conduct [44]. Based on the results of this study, the different preferences found should be included in further studies as a basis for a comparison of motivation in perception and quantity of training, in order to consider subgroups in detail instead of the entire population and address tailoring.
Altogether, the results indicate for practice, that it seems useful to tailor the way of design applications and the combination of different multimedia products.

Some limitations should be considered. The browser-based prototype was used once and the serious game app watched as a video prototype. The presumed use is based on participants' assumptions. Using both (longer), a different implementation or gamification, or another study design can influence the results. The sample size of participants is rather small. A transfer of the results to other countries or cultural groups cannot be guaranteed. Although the non-gamified browser-based training is inspired by an existing clinical training [162] and integrated in the corresponding browser-based training environment, there is no direct comparison of the prototypes to different state-of-the-art training. This should be considered further for comparison of behavior. The gamification approach (step 2) supplements the browser-based training. Although the task of calculating remains in its basic form, it is changed in its way of realization due to the character of the casual serious game (step 3). Whether a training effect is maintained by the presented design cannot be guaranteed and should be further evaluated. Also, only two combinations of devices and realizations were considered. In practice, possibilities go beyond and should be analyzed further.

Conclusion

In this step, two main aspects were considered: 1) for implementation, the effect of the method of grouped mean characteristics and assignment to an appropriate gamification scenario in comparison between a stationary browser-based training with or without tailored gamification on behavior and 2) its effect on perception and the combination of different media devices by a subsequent serious game app for cognitive training. In the behavior in browser-based training (RQ 1), indicators were found for the hypothesis that users with grouped gamification show a higher training duration in the middle range than without. Regarding perception (RQ 2), a higher perceived overall rating and value/usefulness with the use of gamification and a higher presumed effect in browser-based training, computer and mobile training is shown. This may support the conduction of training in the future. Although the combined use of browser-based training and serious game app is assumed in both groups to have the highest effect, there is a wide variation in the demand for individual use.

Based on the results, for implementing gamification elements, grouping characteristics in mean could be suitable for use in development in practice. For the development of combinations, integrating a gamified training version, but also offering multiple combinable options in gamification or game integration and multimedia device combinations, adapted to the everyday life, intended usage behavior and users' needs can be reasonable. Thus, positive effects in combinations might be addressed, also for users for whom only one system is suitable.

The overall results support the implementation of tailored game elements for appropriately grouped user characteristics and tailored usage of devices to support behavior, perception, and motivation in cognitive software training in practice.

Take-away & Key aspects

- *The behavior shows the hypothesis that in browser-based training the integration of gamification leads to higher training duration in the middle range of the training duration*
- *A browser-based gamified training increases perception in value/usefulness, overall evaluation and presumed effect on pc and mobile*
- *A combined use of computer/laptop and app is perceived to be the most reasonable, but the presumed personal use differs from this*
- *Autonomy in the time and place for training and both its fun and effectiveness are rather important aspects for users*
- *For development, the characteristics of a user's individual user types can be grouped into means to allow tailoring of gamified approaches to assign and simplify implementation*
- *Overall, the different methods have different effects on motivation. Tailoring should therefore include both the degree of game (element) integration and the device usage, respectively their combination for design and development*

4.3 Outlook: Smart Home Feedback Object - Further Development, Implementation for Independent Use and Tailoring of Gamification

4.3.1 Focus and Purpose
4.3.2 Background and Related Work
4.3.3 Pre-existing Approach
4.3.4 Further Development
4.3.5 Evaluation: Feasibility Study
4.3.6 Discussion, Further Concept and Conclusion

Prior to this work, a concept and a prototype for a light-based visualization of training feedback were designed [129, 135]. Based on this, in this section, a next iteration was designed, a software connection to a browser-based cognitive training was implemented and evaluated, and a concept for tailored use was designed. Thus, 1) technical feasibility and 2) interaction and perception and 3) tailoring were considered in the context of complemented browser-based cognitive training.
In a qualitative study, two participants conducted an independent cognitive training at home over three weeks and used the feedback object as an addition. The results confirm the technical feasibility of the combination during independent use in a home environment. Primarily relevant seems to be the presentation of feedback. The expansion by an additional incentive through responsibility seems to be secondary to less relevant. This shows a basic suitability as a supporting tool for independent execution of cognitive training through feedback, but also the different perception of the different goals set for the object and the need for further iterations to optimization and enable tailoring to users. Therefore, further possibilities for tailored versions for different user types are proposed as a concept. Through the complementation and tailoring, this step contributes to the development of methods to support the use of appropriate motivational support in requested assistance and independent cognitive training in everyday life.

4.3.1 Focus and Purpose

As shown in this work in section 3.2.1, through additional elements, additional goals can be integrated. Also, the request for aspects of 'Progression' and 'Assistance' and elements of 'Meaning / Purpose' and rather requested 'Progress feedback' is shown (see section 3.3). In addition, in section 4.2, indication has emerged that individual steps and progress elements should be clarified to prevent dropout and might potentially be associated with more meaningfulness, in cognitive training in line with Burke et al. [60].
Based on these results for methods and elements to be used and requirements for independent use of cognitive training, the realization of a prior feedback object [129, 135] will be further developed.

Feedback is an important aspect of self-regulation and behavior change [82]. During the use of a screen-based system (e.g., pc installation, browser-based or mobile), integrated calendar items can be accessed and training reminders such as push-notifications can be sent. A lack of push factor, e.g., by reminders, is suggested by Eysenbach as a possible drop-out factor, among others [120].
However, if training or devices are not actively used, there is only limited access to corresponding reminders. Therefore, to remind predefined days according to a training plan, ubiquitous computing or smart home devices with reminder functions can be connected to the training account. This possibility leads to the research question:

- RQ 1: How can a light feedback concept for everyday life be implemented in a way that it can be used independently by users in combination with an existing browser-based cognitive home training according to their training plan?

- RQ 2: How is a combination of a feedback object used independently and browser based cognitive training perceived in technical combination and interaction?

For this, and to support regular and long-term training, an existing concept for a light feedback object [129, 135] was used in this step, further developed and connected to the server of an existing online training platform [162]. This implementation was evaluated qualitatively.

Considering this step for the implementation of the feedback object and the results of this work for the tailoring to the user in cognitive training, the following research question for next steps arises:

- RQ 3: How can an additional (secondary) goal be used in a feedback object as a complement to browser-based cognitive training, tailored to the characteristics of the user?

For this, at the end of this section, a concept for addressing the different types of players according to Marczewski [244] was created and a proposal for a future evaluation was elaborated.

The goal of this step is to present an up-to-date assessment to the user of the cognitive training to be performed in relation to the training days and the development over time in between, and to develop supportive, feedback-enhancing goals tailored to the user. This method is intended to support the motivation of the user in the conduction of training, according to the planned training days, and in the long term to achieve the number of required training for a positive training effect even within an independent home training. The focus of this step is on the implementation of such a system and a first consideration of the feasibility including further motivational aspects. Furthermore, the question arises how tailoring possibilities for different character types (see section 3.3) might be integrated with focus on motivation. This is considered as a subsequent concept.

4.3.2 Background and Related Work

The idea of ubiquitous computing (or pervasive computing) was coined by Mark Weiser and refers to the ubiquitous support of computers and connected everyday objects, which, however, fade into the background [404]. This is enabled by, for example, the connection of objects to the internet, the internet of things and smart home devices.

For the field of 'Pervasive Healthcare', Bardram sees the potential for a decentralized personal addition to the healthcare service system [31]. This includes pervasive assistive technologies that support the user's independence, such as telemonitoring and reminder systems. The use of appropriate new technologies is a relevant factor here.
When considering users with acquired brain injury in rehabilitation, Jamieson et al. pro-

pose four different technological approaches to support: social assistance, motivation support, guidance and personalized interfaces, and planning support [185].
Bennett et al. include in their definition of 'Smart Healthcare in the Home' for connected devices and sensors the adaptability of remote or on-site to support healthcare services in addition to health and wellbeing [40]. They point out that, in addition to improving the quality of life for users, on technical perspective, processing collected data internally or externally can help identify problems early and provide support quickly. Here, intelligent systems consisting of a combination of hardware and software can provide autonomous behavior to support the user. The processing of the data for the telemonitoring system can be implemented within the system on a main computer or cloud-based. Bennett et al. also show possibilities of monitoring users in different main areas, such as Activities of Daily Living. This allows to detect possible deviations from the behavior. Thereby, they classify different application areas. Monitoring and its processing can be used, for example, for medical interventions, such as online medical tools or for the implementation of reminders and information. For further application of the existing technical implementations, Bennett et al. point out, among other things, the need for further dissemination and user-friendly, simple application.

With a multi-device usage in smart home application for user assistance, White et al. demonstrate the combination of tablet and smart speaker, connected via a cloud AI service [408].

Lentferink et al. show that in eHealth interventions for persuasive eCoaching, personalization, suggestion, goal-setting, simulation, and reminders are frequently used components, and smartphones are most frequently used [230]. They point out that, among other things, the division into short-term goals and the personalization of goals, encouragement messages and reminders to input self-tracking data can positively influence health outcome and usability. Social support, however, was rated negatively, but is more accepted when close friends or family are involved. They show that reminders are perceived as useful by most, but also that the way of reminding in time and frequency is relevant to avoid negative emotions like guilt or annoyance. Furthermore, they suggest for future research the deepening of reminders and social support [230].

Technologies from the IoT have been combined with gamification in various approaches and domains, among others, to a large extent in the health sector [8]. In a review of IoT-enabled gamification, Xioa et al. point out the combination of addressing user interest and low technical barriers to entry [413]. Overall, the results in user experience, motivational and behavioral engagement were predominantly positive. A frequent area of application is the domain health care/wellbeing.
Tan et al. propose for IoT-enabled health promotion, a loop of IoT enabled tracking and feedback, reward, and the development of routines [362].

Gamification can not only be implemented screen-based, but also physically, as e.g., Degraen et al. showed and pointed out that for physical implementations, beginning and end has to be be represented, as well as intermediate steps and progress [92]. Altmeyer et al. show in their example that physical elements lead to a higher persuasiveness and meaningfulness than virtual elements [13]. The transfer of gamification approaches into physical objects [13, 92] offers the possibility of spatial translation and permanent presence [129]. Meaningfulness is a relevant psychological aspect for the development of intrinsic motivation [322]. Based on the example of home-based rehabilitation, Gabrielli et al. point, among other things, to the relevance of developing meaningful game-based experiences that can be personalized and provide feedback on the performance of tasks [137].

Zuckerman et al. show that tangible user interfaces (TUI) are inferior to graphical user interfaces (GUI) in terms of usability, but were preferred due to their high stimulating and enjoyable effect, which results from physical contact, feedback, and realism [420]. Meder et al. show that receiving tangible, physical rewards in form of vouchers increases user

activity more than intangible virtual rewards (points, badges, levels, and feedback message) [251].

Visualized and positive feedback are shown, among others, in a study with different games by de Vries et al. to be relevant factors for motivation and to address the drive to perform [100]. Feedback loops can contribute to modifying personal behavior and are frequently used in gamified training for computer-based cognitive training, while social interactions are rarely used [392]. Using a brain training game, Burgers et al. show, among others, that positive feedback supports intrinsic and long-term motivation, while negative feedback reduces the feeling of competence but supports the correction of poor short-term performance [59].
Pham et al. demonstrate the technical feasibility of a cloud-based smart home environment system that tracks user data to monitor, among others, behavioral change and rehabilitation processes [296]. These are processed in a smart home gateway, sent to a private cloud-based server and can be monitored by caregivers. By analyzing such data, as in the 'VictoryaHome' project, caregivers and relatives can follow the status of caretakers, receive information such as forgotten medication, and remind the caretaker [338].
Lentferink et al. point out that mobile reminders have more possibilities than computer reminders and are less likely to be ignored [230].
Jamieson et al. propose 'ApplTree', a smartphone reminder app for users with cognitive impairments, which provides a way to set reminders in their personal daily lives [184].
In a previous work, a prototype for the connection of a visual reminder on a smartwatch and the execution of a training on the computer was shown [129].
Calzolari and Nardotto demonstrated for the use of reminders to train in a gym that a weekly reminder led to an increase in attendance and additionally found indications of habit building [64].
Uhlig et al. designed different reminder objects for independent use at home, based on everyday objects enhanced with digital information, which fit into the user's situation at home [381]. Here, the original use of the objects is to be preserved. In their work, they present best practices for different user groups, scenarios and connected smart objects as reminders. This includes a reminder system for people with dementia that reminds them of relevant objects based on their behavior, such as a certain key when a door is opened. Also, a door mat that uses a water sound based on the weather report to remind to take an umbrella if users steps on it and it is raining outside, and a jacket for the elderly that navigates the user by producing vibration. Thus, they demonstrate the possibility of simplifying and integrating complex digital data into objects of everyday life. Also for the simplified visualization of complex digital data in physical form, Schröder et al. present a shape-changing interface that dynamically visualizes company data, such as employee presence, in a flexibly changing object by means of shape, color, and organic movement in the office environment [336].
Wardono and Soelami indicate the varying effect of using different lighting [397]. Based on the design of luminous furniture, they have shown that constantly illuminated furnishings are best suited to influence mood. The reasons for the lack of a positive feedback to dynamic lighting are assumed in the problems it causes in the situation of eating and identifying. The control of light in the home environment is offered in various smart home systems, such as 'Philips Hue' [297]. In the project 'MoodLight' by Snyder et al. it is used as a feedback display by connecting it to a biofeedback sensor, which reacts to the arousal state of the user by changing the light color [344]. Snyder et al. note an advantage of the light in presenting feedback in the current moment as part of mindfulness and reflection techniques and flexible use in the everyday environment. However, they also point to the relevance of individualization, such as choosing colors that are meaningful to the user, and maintaining users' control of the system and their ability to understand what is presented.
In a comparison of different research methods, Voit et al. use ambient lights integrated into objects to present information, such as a plant pot, in which the level of water is indicated by the color of the light [394].
Cheok et al. use DNA transformed E.coli bacteria as a display. According to the connected input data, they light up as living feedback

and address the user's empathy [71]. Hong et al. have developed a flower avatar that mimics the user's sitting position through motion, light and sound, providing ambient feedback and promoting healthy sitting [176]. Degraen et al. have developed a robotic plant that can provide ambient feedback by moving its endoskeleton [91]. They use it for example connected to a TV to support the movement animation in a fun racer game [93]. The 'Pico' project uses a grow light to support plants and a watering system [11]. To connect digital components and nature, Steiner et al. in the project 'Florence' enable a way of interacting through text input and connected light with a plant, whose response incorporates their measured reaction [357].
In the following, as a combination, a technical implementation is considered based on a smart home object to provide direct feedback, and responsibility for a plant and support for conducting a browser-based cognitive training [129, 135].

4.3.3 Pre-existing Approach

Within this section, the pre-existing concept and its first prototype for a light feedback with integration of a plant for the extension of a training relevant for health is described below, which was designed and initially evaluated in an experimental pilot study prior to this work [129, 135].
The problem was addressed that only limited feedback on the training plan and the user's own behavior can be given between the planned training sessions in everyday life. Based on a white light (LED (light-emitting diode)), it was shown to the user whether the training plan is being adhered to (light on) or whether training is necessary (light off) which was intended to create a nudge effect. The LED was connected to an ESP Wifi module and web interface, through which the status of the light (on / off) could be controlled. ESP Wifi module and LED were powered by a rechargeable battery. The LED was positioned inside a closed glass body above a plant inside. By looking at the plant, the approach of Ulrich et al. should be taken up to reduce negative emotions like stress and to create a calm promoting effect through vegetation [382].

The conducted explorative qualitative evaluation consisted of two steps. First, one participant used the feedback object for four weeks as an addition to light physical training, which was to be carried out several times a week due to a physical disease on three self-selected training days. A study assistant switched the LED off on these days and on after the training was completed. It was found that the switching on of the light was perceived as a training success and a light that was switched off was perceived as a spur. The experience of the interaction was rated rather positively. The participant oriented the training to the light, even if a training day was rescheduled. Second, the approach was presented to an expert and an interview was conducted. Among others, the system was rated as good, coherent and functioning with feedback presented in an easy-to-understand way, which transfers responsibility to the patient, involves patients in therapy and may be used for patients.
The results have indicated that this approach may be a possible method for providing feedback on training, and thereby provides a basis for further development. Based on the results, for adaptation to individual user preferences it was proposed to combine different elements with the light. This approach is taken up in conjunction with tailoring by character type in section 4.3.6 of this chapter.

In the prototype used in this pre-existing approach, however, the light was switched on and off manually by a study assistant via a web interface, which was planned to be not necessary in future steps. There was no automatic software-based link between training and light. Furthermore, physical training was performed. The use of cognitive training and the connection to it were further suggested, as well as strengthening the emotional connection to the system or picking up the feeling of social connection or responsibility. In the following steps, these basic concepts were taken up, further developed and evaluated in the next iteration.

Figure 23. Feedback object with different light statuses

4.3.4 Further Development

The pre-existing concept (section 4.3.3) was further developed in this work in different aspects, which addresses RQ 1.

Concept and Design Considerations

In several brainstorming sessions and development iteration, different forms and approaches for realization were created (e.g., with and without connection to the online training, spherical or column-shaped, reduction to the light feedback, replacement of the light feedback by muscle wire or shutter glass). However, to preserve the potentials of the pre-existing approach, the light feedback and the natural component are used as a basis. To address the proposed strengthening of the social connection, a second component is integrated regarding motivation. Similar to Rieß et al.'s approach for senses [310], this is intended to address different perceptual aspects.

1. Pre-existing: presentation of an additional plant and feedback on the behavior in the training plan and possibility of addressing the sense of competence by lighting or turning off the light
2. Further developed: Addressing the strengthening of emotional and social connection through responsibility for the plant. For this, the LEDs simulate in their wavelength Grow-LEDs, which support the growth of plants, instead of, as before, only showing a white light status. This is intended to reinforce the meaningfulness of the personal action in adhering to the training plan and to create a further goal besides improving personal abilities. The integration is based on the gamification element 'Meaning / Purpose', which was revealed in section 3.3 to be the most requested by patients and was therefore proposed for further deepening. In addition to competence, this might address a further aspect of the Self-Determination Theory [88], the social relatedness, through personal importance for others, which in this case is the plant.

The body of the feedback object is changed from a closed glass body to an open cylinder, in which a plant including a pot is placed to allow watering and growth of the plant.
The body is formed by two plastic pipes of different length, inserted into each other, and 3D printed covering of the ends. The inner ring forms the container for the plant and is protected with silicone against water penetration.

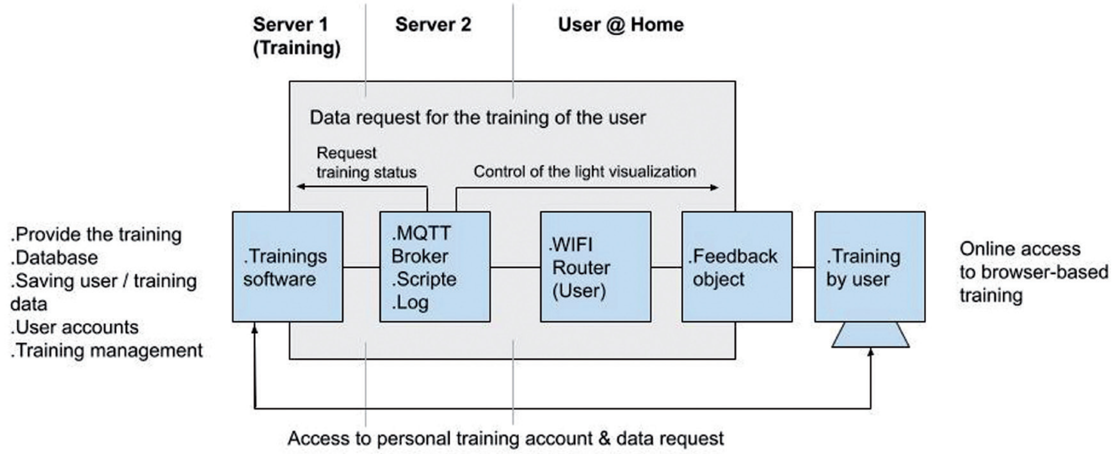


Figure 24. Schematic representation: communication between training server, feedback object control server and feedback object.

This results in a combination like in project 'Pico', which uses a Grow-LED to support growth, but allows self-watering from an underneath container [11].

The feedback object (FBO) is still equipped with an ESP module and connected to the user's Wifi, but now it is connected to the server of an existing browser-based version of cognitive training [162] (for implementation see 'Technical and Software Realization'). Within this existing training software used for the prototype, each user receives an account that is managed by a therapist/administrator who creates a training plan by defining training and training days. The training can be carried out independently by patients at home by logging in to the web interface.
Instead of a single LED and a binary feedback as in the pre-existing concept (section 4.3.3), an LED ring with several LEDs was integrated in the top. Their light is linked to the defined training days and shows feedback on the training status as in a countdown (see Figure 23): If a training was conducted, the entire LED ring lights up. During the following days, the LEDs in the ring turn off successively until the next defined training day. Some LEDs, however, remain permanently lit to arouse the user's attention on the one hand and to symbolize that training is still needed on the other. The frequency with which the LEDs turn off depends on the distance to the next defined training day.
The appearance is following current familiar smart home devices (e.g., [17, 150]), so that it integrates into the patient's environment and does not cause irritation. All technical components, as well as the plant, are made available to the user, who provides access to a Wifi.

Technical and Software Realization

The technical hardware components of the FBO (ESP Board, cables, LED Ring, power adapter (5V): see Figure 25) are integrated into the case.

The software-based implementation is shown schematically in Figure 24. An existing server is used as the starting point [162] (Server 1). This server provides the login via frontend, the browser-based cognitive training for users and its administration (e.g., creation of accounts, setting of training sessions and training days, etc.), and also a database with user data and their training behavior, etc.. For training at home, users access server 1 by logging into their personal training account via their browser.

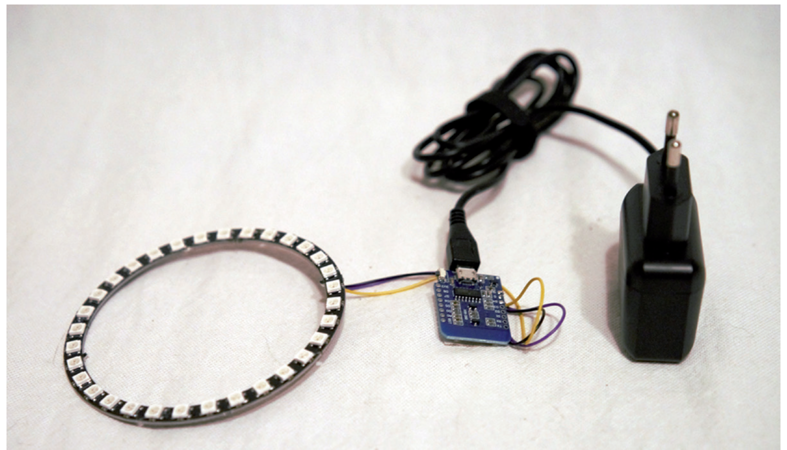


Figure 25. Technical components (ESP Board, cables, LED Ring, power adapter (5V)) integrated within the feedback object

For the control of the feedback system, server 2 was set up. Server 2 requests the user's training plan via HTTP from server 1. A second communication path exists to the FBO, which is connected to the Wifi provided by the user at home. For connection and communication, the FBO contains an ESP module and the firmware Tasmota [364], which enables the communication with server 2 via MQTT protocol. To control the behavior of the LEDs, messages are sent from Server 2 to the FBO, turning the LEDs on or incrementally off.
The messages depend on the defined training days, the behavior of the user and the data stored on server 1. When the user performs a browser-based training, this is also stored in the database of server 1. Server 2 listens to server 1 via long-polling. A new training received by server 1 triggers an event on server 2 updating the corresponding FBO. The user ID is linked to the device ID. A message is sent from server 2 to the corresponding FBO of the user, whereby all LEDs of the FBO are switched on. The training plans and the last completed training are cached on server 2. From these, the amount of LEDs that have to be turned on is computed and sent to the corresponding FBO.

In the communication with the feedback devices, only minimal read and write permissions are set for the device accounts. Commands for, e.g., the LEDs brightness and color are sent to control the devices. The devices respond with the confirmation of the execution, as well as status information (e.g., software configuration of the client, software version, alternative MQTT topics to reach the module, device identifier, local IP address). In this way, the FBO's light is constantly updated according to the patient's independently performed browser-based cognitive training.

A local rehab hub, web-based services, and user input is also used for gamification and personalization by, e.g., Jung. et al. [196].

4.3.5 Evaluation: Feasibility Study

Following successful functional tests, which ensured the set-up process, interaction and technical functionality, an exploratory qualitative feasibility study was conducted on the independent use of the implemented FBO by users. This addresses RQ 1 and RQ 2.

Method

In the exploratory qualitative feasibility study, participants conducted a three-week computer-based online cognitive training at home using the existing platform [162] used for this purpose and complemented by the FBO. Training should be conducted twice a week for at least 30 minutes each. Additional training is possible. The goal of the study is to get a first insight into the technical implementation during independent use and a basic impact of the FBO. Based on this, positive aspects and hurdles are to be identified and iterative further developments will be enabled.
For independent use, users receive information on the functionality and setup of the system. Included are users with sufficient language skills, interest in participating, a computer / laptop, email address and Wifi access. For appropriate training and basic interest and to avoid a possible bias, participants choose two out of three possible trainings (Attention: Reaction behavior [166], Memory: Working memory [167], Executive functions: Logical reasoning [165]). In the training plan, three sequential training sessions are set for each selected training on the days chosen by the participants. After informed consent and completion of a contact questionnaire, the procedure was:

1. Participants receive: Study procedure sheet, FBO, and information/instructions for using the FBO. Pre-survey: demographic data, interest in plants, choice of trainings to be conducted (2 out of 3) and fixed training days (2), assessment of expected adherence to training days (5-point Likert Scale (1: difficult, 5: easy), prior experience, technology affinity based on TA-EG [203] (analyzed in the average), user type (based on Player and User Types Hexad Questionnaire [374], translated into German). Setting up the training (selected training and days) by study leader.
2. Reading the information and step-by-step instructions for independent setup (incl. personal ID, login and passwords for FBO and online training account, safety instructions (e.g., electronic device: do not put it under water outside the soil, do not cover (heat development), do not disassemble the device) and set it up in a visible place.
3. Interim survey: Setup of the FBO (evaluation of the individual steps (5-point Likert Scale (1: difficult, 5: easy), assessment of the expected adherence to the training days (5-point Likert Scale (1: difficult, 5: easy), perception of the setup as a problem to start (5-point Likert Scale (1: yes, 5: no), help needed, requests
4. Training phase: Collection of training data / behavior
5. Post-Survey: setting up and perception of the FBO, compliance with the training days (5-point Likert Scale (1: difficult, 5: easy)), questions on suitability, comprehensibility, presence, and originality (based on challenge for reminder objects according to Uhlig et al. [381]), sorting the relevance of possible abilities of the FBO (proposed properties by user type), technical difficulties, aspects of the user experience (based on subscales of UEQ+]380]). Return of the FBO.
6. Semi-structured interview (in person or by phone): including among others questions about personal motivation (based on various questions of the IMI plus explanation), effect of the object, function, use and connection of technology and plant, adherence to the training and, due to the nature of the interview, more in-depth or other questions beyond

For the analysis and results, only partial aspects are considered to address the research question and are presented below in excerpts, partly summarized. Core aspects from the interview are analyzed and factors for further development are described.

Results

To answer the research question, summarized partial results of the qualitative feasibility study are presented below, following the steps of the method. Two participants took part.

Table 18. Participants, technology affinity (TA-EG: 5-point Likert scale (1: Totally not true, 5: Totally true), and analyzed user type

Participant ID	Age	Gender	Technology affinity (TA-EG)	User type
P1	33	male	3.16	Soc, Phil
P2	63	female	3.68	Soc, Play, Phil, FS

Table 19. Challenges for reminder objects (designed according to Uhlig et al.) and further use (5-point Likert Scale: 1: no 5:yes)

Category	Item	P1	P2
Suitability	Does the object support the regular conduct of online training?	4	4
Suitability	Does the object support remembering the training?	5	5
Comprehensibility	Was the information about the status of the training (indication of the upcoming training by light) understandable?	5	5
Presence	Did the object independently provide you with the information when you needed it?	4	5
Presence	Was it possible to forget about the object when you didn't need it?	4	5
Originality	Did you water the plant as your other plants?	3	5
Further use	If you wanted to continue training in the future to improve your cognitive performance, would you continue to use the object as a support?	4	5
Further use	Would you recommend the object to support online training?	5	5

Pre-Survey

Data of participants, technology affinity and user type are shown in Table 18. P1 and P2 like plants, use digital media several times daily / daily, have little / no experience with cognitive training, and rate it moderately difficult (3) to adhere to training days.

Interim Survey (Technical Setting Up)

The steps for technical set up were rated between medium and easy. Both participants needed or received help with the setup. For P1, the technical setup was rather no hurdle to start the training, for P2 rather yes. Both would not have wished the setup to be any different.

Training Phase

For both participants, 6 training days were planned, but it was conducted differently. P1: conducted: 4 (of these: planned training started on the planned day: 2, delayed: 1). P2: conducted: 8 (of these: planned training started on the planned day: 4, delayed: 1). The duration of the training varied. In some cases, more or different training sessions than planned were conducted.

Post-Survey

Both participants placed the FBO near their computer and visible. P1 stated that this allows to train directly after the reminder, P2 that it was far away from the window.

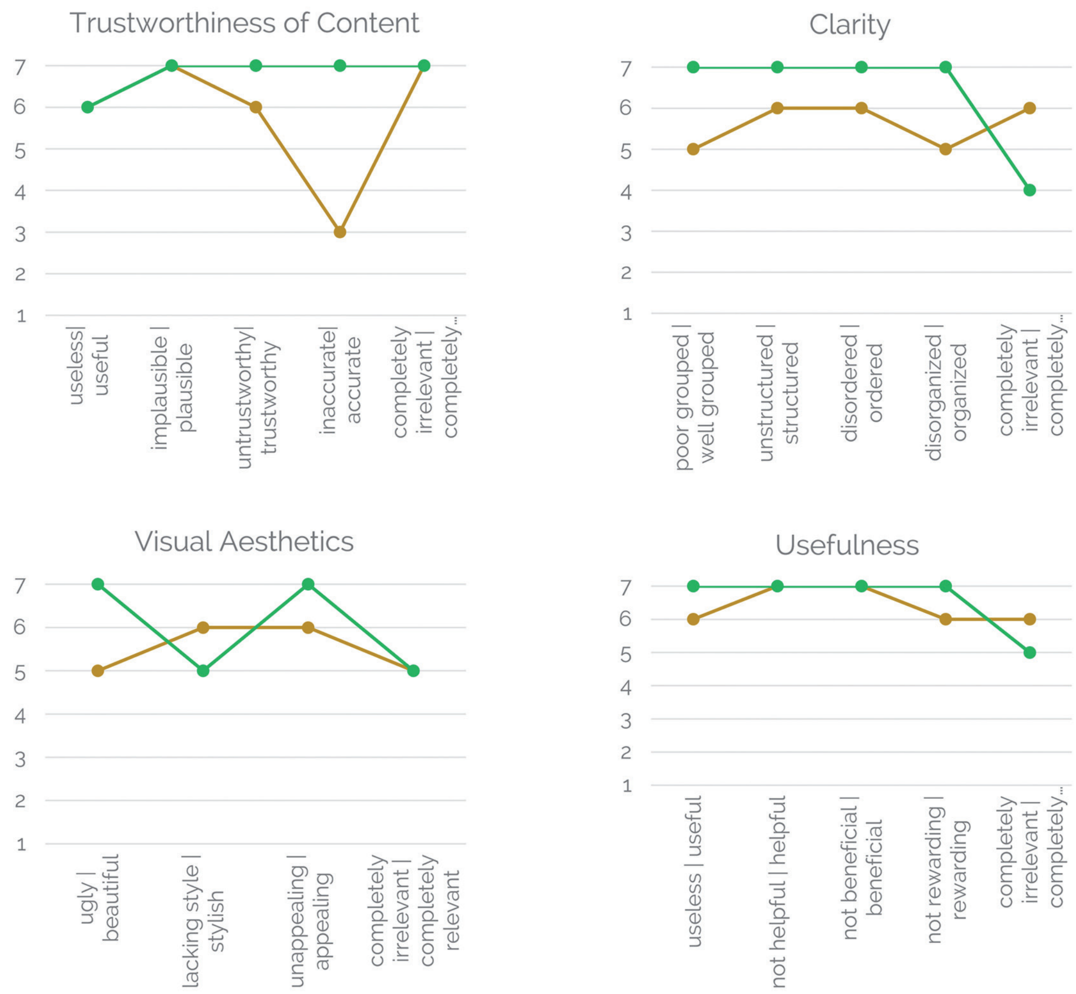


Figure 26. Subscales of UEQ+: trustworthiness, clarity, visual aesthetics, usefulness (7-point scale 1: negative, 4: neutral, 7: positive), Yellow: P1, Green: P2

For P1, adhering to the training days was medium difficult (3), for P2 rather easy (4). Table 19 shows the items considered for challenges for reminder objects and further use.

In the ranking of the object's abilities, both participants consider it most important to feel good when the object indicates personal progress / achievements. A reward is rated by both on the fourth rank (out of six).
The items beyond this vary in rating. Figure 26 shows subscales of UEQ+. During use, P1 noted no technical difficulties, P2 a one-time problem in establishing a connection to the online training server.

Interview

The interview resulted, among others, in the following:
Both (rather) enjoyed the interaction with the FBO, but are only moderately satisfied with their own performance (P1 delayed by lack of time, P2 due to health problems). Both made an effort to carry out the training. For P1, a connection to the FBO is more caused by the light, P2 states to have a little bit of a feeling of doing something good for the plant. P1 felt pressured and had a bad conscience when the light was low, whereas P2 did not, but rather felt motivated. P2 had the feeling of being able to decide independently whether to train, P1 only moderately, because during the study there was a binding to the self-selected training days.
Both perceived the technology and the plant rather separately from each other. P2 had the feeling of making the plant dependent and felt sorry for it. P2 does use daylight lamps for other plants, but would also have used a simple light progress bar instead of the FBO and placed the plant by the window. P1 would have rather used irrigation instead of light in the apartment. Both stated that they did not water the plant inside the pot due to the connection with the technology, among other things. Both did rather not feel a responsibility for the plant due to the light.

Regarding the impact, both considered it more important to get the light feedback than to support the plant. P1 noted that the plant is more about the optics, but that an emotional connection is more likely to be established with organic than with technical objects. The light, however, is more important because it gives feedback, which the plant cannot.
When a training was not adhered to, both recognized that it had been a training day. Reasons for not conducting the training included health (P2) and time (P1). P1 would have been aided by a mobile training and an installation instead of the detour via the browser. For the FBO, P1 proposed, among other things, to additionally link the light status to planned training duration or to show the plant in the software to strengthen the relationship and provide faster feedback, for example, through growth. P1 believed that further support should be provided by sharing results in the software and allowing the FBO to be viewed with friends, but not with strangers.

4.3.6 Discussion, Further Concept and Conclusion

Discussion

Regarding RQ1, the technical feasibility of the combination of FBO and browser-based cognitive home training for independent use and presented feedback according to the training plan has been confirmed. This supports the successful further technical development compared to the previous iteration. Independent setting up by the user can also be supported, even if some help was received. However, the level of assistance required by users with a lower affinity for technology or cognitively impaired users should be considered further.
In contrast to the prior existing approach (section 4.3.3) [129, 135], the further development in the presented iteration (section 4.3.4) can establish a connection between two trainings. However, an overview of the process as shown by the path in section 3.3 is missing. Furthermore, a way to integrate this may be considered.
As considered by Synder et al., light feedback has the advantage that it can be given in the present moment [344]. In the future, the technical connection will allow the consideration of further possibilities for the presentation of feedback through light, also in direct reaction as through the plant in the project 'AmbiPlant' by Degraen et al. [91, 93].

Regarding RQ 2, the results confirm the results of the pre-existing approach and continue to indicate a possible fundamental suitability of the object as a reminder of a training session in this iteration. In use, both participants recognize their training days, even if they did not consistently adhere to them. Challenges such as suitability (support for remembering / regular performance), comprehensibility and presence were addressed. However, the original use as a plant pot in combination with the technology extension turned out to be problematic, as both participants did not water the plant inside the pot due to this. Thus, the design needs further reworking. The way of reminding should also be reconsidered in order to prevent negative emotions, following Lentferink et al. [230], as shown by feelings of guilt in P1. Also the use of accountability and partly perceived dependence of the plant on the user's behavior should be further critically questioned based on the results. A different type of realization or deepening of the social connection may be required to achieve more impact.

Also, potential optimizations could be made in the adjustment of the accuracy. After that, another iteration of the study could be conducted. However, the different negative emotions that arised, such as dependency or feelings of guilt, should be further considered in relation to the user types. Nevertheless, the interaction and perception of the object showed a rather positive perception in the surveyed aspects of user experience, is in line with the prior version [129, 135], and should be preserved.

Considering the two motivational aspects (1. existing light feedback and 2. enhancement through responsibility), a higher relevance of the feedback is shown. The perception of the FBO as supporting adherence to the training days supports previous [129, 135] and Cugelman's findings [82] that providing feedback on performance prompts self-regulation to monitor personal behavior and addresses behavioral change.
That sharing visualized light is preferred with friends rather than strangers confirms the findings of Snyder et al., who suggest, after the use of the 'MoodLight' project, that permanently active light feedback interrupts self-regulated decision-making about when to disclose personal information to someone else [344]. This is also in line with Lentferink et al. who showed, using the example of eHealth and eCoaching interventions, that social support is less in demand from strangers and more from friends or family [230], and also with Ha et al. who showed that fitness tracking, due to the personal matter, is not shared [154]. However, this could be counteracted by the independent choice for the positioning of the FBO in the personal environment.

A possibility of realizing the reminder as a mobile implementation, as requested by P1, has already been presented in a concept and prototype, for example, prior to this work [129]. There, a smartwatch was used as a reminder to perform software-based motor training on the computer. This can also be built upon in the future.

Gamification provides an important basis as a method for developing such complements to cognitive software-based training in terms of their focus on motivation. The FBO is currently based on a one-size-fits-all approach. However, for gamification it is pointed out that a tailored approach is more effective [79, 234]. The relevance of tailoring for motivational methods in cognitive training was also shown in this work. Already the qualitative evaluation of the iteration points to different possibilities to tailor the FBO to individual needs. For this, as suggested in the pre-existing step (section 4.3.3) [129, 135], different elements can be combined with the light. In this way, a progress- and assistance-based approach with complemented elements may be in line with the results of section 3.3. Thus, in line with other work [13, 92], digital gamification concepts can be transferred to the physical object. In this way, a tailored approach may be used to consider whether the user-type-based tailored adaptation in software-based and physical combinations may support motivation.

Some limitations should be considered. The approach was further developed based on a pre-existing prototype. The further technical development in the presented iteration is based on a prototype for basic research and does not claim to be a medical product. The evaluation was carried out qualitatively with a small number of participants and cannot be generalized. Presented is the development and evaluation of an intermediate step in the development process. The participants have no cognitive impairments. Thus, the results provide a basis for further development, but cannot be generalized for patients with cognitive impairments.

Overall, the results of the current iteration support the technical feasibility and suitability as a reminder object through the light. The secondary functionality, the transfer of responsibility, as well as the shape may be reworked. Instead of general realization, elements suitable for the user type may be considered. The development is in an iteration, further steps are necessary until actual use.

Further Concept and Evaluation

Through the further concept and the draft of a possible evaluation, RQ 3 of this step is addressed.
Achievable goals and competency-based feedback can address the experience of competency, based on Self-Determination Theory [318]. Meaningfulness is one of the most important aspects of the use of games in rehabilitation, according to Tamayo-Serrano [361]. To support gamification approaches according to Nicholson, which involves individual meaningful perception and suitable goals and is not externally prescribed [272], in the following, a further development of the concept for tailored use to address intrinsic motivation [87] and a possible evaluation approach are presented. By these concepts among others the suggestion of Ha et al. to strengthen the meaningfulness of rewards is taken up [154]. They also point out their lack of alignment with personal health goals.

Van Dooren points out that rewards should be used according to the user, context, and intended effect, and the type of reward needed may change over time [388]. For customization, they propose, e.g., the Player and User Types Hexad.

Through the concept, the problem mentioned by Sardi et al. that rewards are sometimes perceived as irrelevant is to be addressed [329]. Furthermore, Lentferink et al. point out that personalized goals and reminders for input behavioral data are associated with high ly effective study outcomes [230]. Thus, the goals could be tailored to the patients in more depth [417].

Table 20. Concepts for a tailored extension of light feedback

Baseline (Light feedback)	**Philanthropist** (meaning and purpose / altruism, Elements: Altruism)	**Free Spirit** (autonomy and self-expression, Elements: Immersion)	**Achiever** (mastery / competence, Elements: Immersion / Risk/ Reward)	**Socialiser** (relatedness, Elements: Socialization)	**Player** (rewards, Elements: Incentives)	**Disruptor** (change, Elements Risk / Reward / Immersion)
If the training is adhered to over a certain period of time:						
Physical feedback through light (different realization depending on object types).	Object: Keyboard Choice in a forum: a) sharing knowledge or tips about the training or the situation, b) answer a question asked there.	Object: Book. Through the object, different content is provided (e.g., unexpected facts, background information, short thematically appropriate stories or unique new options (flexibly adapting the training).	Object: Whiteboard A task for everyday life is given, which is to be solved within a week. By solving it, access to new, special or difficult training tasks is unlocked.	Object: Ticket Obtain access to an event (digital or present) with, if desired, training and communication with other users, comparisons, or solving joint event tasks.	Object: Slot machine. Direct obtaining of reward or its use in the game: betting on the number of achieved training for the next week. If the number is reached, the reward increases. If not, it is lost.	Object: Scale (one side positive / negative). Receiving a training aspect that can be evaluated with the scale (e.g., variety of tasks) and a short usage scenario. The results are sent to the development team.

For a tailored extension of the preceding concept, the technical solution developed in this iteration (section 4.3.4 'Technical and Software Realization') can be used for connection with a software-based independent training. The light, previously considered relevant for feedback, is used as a basis and tailored elements are added. This takes up the approach proposed in the pre-existing work of combining light with different elements for individual use [129], as well as the further development in this work (section 4.3.4). Thus, the progression and assistance requested by patients (section 3.3) is intended to be addressed (see Table 9). Incentive or reward-based strategies are mainly suitable for players [372] and achievers [234]. The presented concept combines rewards, goals and reminders as a basis and tailors them to the characteristics of the Player and User Types Hexad [244] in the concept of addressing meaningfulness. Concepts are based on the proposed appropriate categories and game elements according to Tondello et al. [372]. The individual elements of the concept are shown in Table 20.
The physical approach is maintained for the reminder in everyday life connected to the software-based system. The tailoring is intended to further pursue the goal of strengthening the meaningfulness and behavior depending on the user type in addition to the personal goal.
However, in this step, the suggestions for tailoring to user types are based on a theoretical concept and require a prototypical development, integration of the presented software connection above and evaluation for a statement on suitability or efficacy. With regard to a possible further evaluation, different approaches can be considered.

Possible research questions for the next step are:

- RQ 1: Does a light feedback object affect a) compliance and b) subjective perceptions of training of patients in home training in cognitive rehabilitation?
- RQ 2: Does the use of a tailored feedback object affect a) compliance and b) subjective perceptions of training of patients in home training in cognitive rehabilitation?

To address this question, a between-design study should be conducted with three groups (Table 21). All participants use the browser-based cognitive training with training durations and modules suitable for them, group B receives light feedback and group C tailored light feedback based on the analyzed user type. The dependent variable is the total training duration within the training phase (determined by the behavior of patients in online training) / perception (surveyed in post-survey), the independent variable is the presence of the feedback object(s).
Patients with confirmed acquired cognitive impairment, for whom home training is suitable, should be included. The study should have an adequately large sample size for a quantitative analysis and be conducted over a long-term period to reflect behavior in everyday life.
Regarding the RQs, for RQ 1 a comparison between group A (control group) and group B in behavior and perception can be drawn, for RQ 2 between group A, B and C. The hypothesis is that a) adherence to training days will increase from group A to group B to group C, and b) perception of training will improve. Both factors are considered as indicators of motivation. The aim of this evaluation approach is to determine whether and with which level of effect the training motivation can be influenced by an external complementing feedback object. The results can contribute to the assessment of possible benefits for supporting patients in training in practical development.

Table 21. Study design for the further evaluation of the (tailored) feedback concept

	Group A	Group B	Group C
Browser-based cognitive training	yes	yes	yes
Basic light feedback	-	yes	yes
Tailored extension	-	-	yes

Conclusion

In this step, a pre-existing approach of a light feedback object was further developed in motivational aspects, technically connected to an existing browser-based training for independent use, qualitatively evaluated in this iteration and a concept for tailored use was created. The technical implementation shows the feasibility of the connection to an existing browser-based cognitive training and independent visualization of training status triggered by the user's behavior in software. The suitability of the developed system for independent use as a reminder object can be supported. In the perception, feedback was confirmed as a relevant aspect, the integration of social connection with a plant less.

Indications of the possible integration of the additional goal as a complementary method for motivational support have shown, but also the need to adapt the concept.

Based on this, a concept to combine light as a progress indicator with tailored elements based on different user types and a further evaluation were proposed. Thus, the effect of the approach and possible tailoring should be considered further.

This step thus contributes to the iterative development of possibilities to support users in independent cognitive training by reminder objects. It contributes to the combination of possible ways of implementing gamification elements (TRQ 1), initial effects (TRQ 2) and in the complement of browser-based training (TRQ 3).

Take-away & Key aspects

- *A software based connection as smart home object of a FBO and cognitive training via servers, as well as the resulting automatic control of the FBO based on the interaction of the user with the training is possible*
- *The feedback can be presented individually depending on the duration between two defined training days with reference to the remaining time to the next training session*
- *Feedback from the light is perceived as primarily relevant, social connection and responsibility for the plant less, possible dependence as potentially unpleasant*
- *There are indications of the possibility of complementing the training objective and the primary relevant feedback related to it*
- *Indications of individual needs for the conduct and complement of the training become apparent*
- *A concept to obtain the light feedback and advanced complement to tailor it to the user is presented*

4.4 Discussion

4.4.1 Thesis Research Questions
4.4.2 Limitations and Future Work

In this chapter, possibilities for complementing browser-based training by (tailored grouped) gamification and possible combinations with a mobile serious game and external objects for independent home training were considered. In this way, conventional existing training tasks from cognitive therapy can be complemented and expanded, and applications in practice for mobile or local use are deepened in the understanding of a possible usage. This supports the approach proposed in a previous work to connect multiple steps and devices to a whole system [129].

4.4.1 Thesis Research Questions

Regarding TRQ 1 (Implementation of elements), the feasibility of grouping character traits into means is shown. An application of this method in practice for the assignment and development of gamification and comparison and use of possible further methods should be considered further.

Regarding TRQ 2 (Effects in perception and training duration), with regard to behavior, it is interesting to consider the indication of possible higher training durations in the middle range when using grouped tailored gamification.
The hypothesis of a shift in the distribution despite non-significant differences in the overall comparison of the groups should be considered further. A possible explanation for this may be a different motivational background of low, medium and high performers and its possible changes. However, there are other reasons, such as the engagement type considered by Lavoué et al. [229], which should also be taken into account.
Another interesting aspect is the perception of a higher presumed effect when using the training regularly and the expected higher effect of training on the computer and mobile devices after using grouped tailored browser-based gamified training. This might also influence behavior in the long term, which should be considered further in the next steps.
Both studies support the results from section 3.3 in the analyzed request for the presentation of progression, which further supports the suggestion for its use as a basic element.

In consideration of TRQ 3, the complementing of different usage scenarios and devices to address motivation, several interesting aspects emerged.
It is interesting that an uncomfortable feeling resulted from the dependence of the plant on personal action. An uncomfortable feeling due to the high level of responsibility transferred was also indicated in section 3.2.1. This supports that the level of responsibility might be chosen with caution. This should be further studied in-depth.
Furthermore, it is interesting to consider the variation of preferences in the use of different combinations of gamification complements and devices that has been shown in home training. Here, both studies show differences in requests for the use of different levels of gamification, use of devices, implementations, and use in everyday life, which is in line with and supports Jokela et al.'s findings [194]. There may be various reasons for this, such as the availability or lack of technical equipment/devices [178], preferences and habits [194], level of tendency to play [231], user type or (varying) structure of daily routines (section 4.3). In this context, for further development of combinations for practice, it should be kept in mind that the results indicate that the assessment of the most effective way of training and the training of presumed independent use partly differ from each other. The different needs also support the tailoring and future development of the feedback object.

The chapter also shows in section 4.3 the feasibility of linking the reminder feedback object with cognitive training for independent use in home training via the training server. This method shows potentials for further iterative development and subsequent long-term evaluation, also in the proposed tailored version, in practice by patients. Thus, both the translation into tailored physical gamification for consideration in research and the support of patients may be addressed.

In the details of the qualitative study, different reasons for not conducting the training were found. Further on, such reasons could be requested in the software and (automated) suggestions could be made to adjust the individualization and optimization of the combination or complement or way of conducting the training. Such automation is in line with the analysis of user types during interaction proposed by Altmeyer et al. [16] and Hallifax's proposed dynamic gamification adaptation [156].
The results confirm, extend and deepen the approaches of the previous work regarding the software-based implementation in use for different devices in combination [129].

The results of this section show different methods to support the design and development of software-based methods in cognitive training, as well as their appropriate assignment to the character and situation of the users.

4.4.2 Limitations and Future Work

Limitations

Different aspects and limitations should be considered. The studies in this chapter were conducted in independent use at home to create a scenario that corresponds to the future intended use. Although it is possible to give users a guideline for carrying out the task, this is difficult to monitor.
The participants were mainly healthy people. On the one hand, this has the advantage of evaluating the systems in a first step for general effectiveness, usage and required optimization without possible disadvantages for patients, but on the other hand, it has the disadvantage of distances to the target group. Partly, the training was carried out once or was seen as a video prototype, partly it was carried out for a longer time but was initially considered.

Future Work

Furthermore, for future work, among other things, various aspects may be considered. By integrating additional devices, further advantages and features of the devices can be implemented. As suggested by White et al., digital assistants such as smart speakers can also be used in multi-device settings [408]. Bräuer and Mazarakis show that gamification can also support motivation without a screen using intelligent smart speakers [55]. Kim et al. also show their successful use in the implementation of cognitive training [213]. This can be used to address physical limitations and thus prevent a reduction in conducting the training, as in the case of a participant in section 4.3, but also for reminders or direct interaction during or outside of the training.
The results of the feedback object also indicate the possibility of deepening meaningfulness [271] in physical gamification, as well as the possibility of taking up and further evaluating tailored approaches in smart home devices for feedback.

In future developments and comparative studies, the effectiveness of complements for motivation, measured by training behavior and perception of the training, should be compared and further deepened. Results can be presented in tools like the 'Gamification Guide'.
This can provide support for tailoring to the user and also for the selection and development of complements.

4.5 Summary

The goals of this chapter were to consider the implementation of motivational gamification elements tailored to the user (TRQ 1), methods to complement browser-based training (TRQ 3), and resulting effects (TRQ 2) as well as the resulting support and orientation for development in practice.

Considering the implementation of gamification (TRQ 1), a method for grouping user types in mean was used for a browser-based training and the feasibility of assigning them to existing solutions was demonstrated. In the future it also may be used as a basis for new developments of gamification.

The complementation (TRQ 3) of a (gamified) browser-based training with a mobile serious game app on the smartphone was considered. Also, the further development and feasibility of implementing an existing reminder feedback object with an additional goal in a smart home system with automatic adjusments depending on the independent use in training is shown. Furthermore, a concept for a method for prototypes is presented, by which the additional goal of the reminder can be tailored to the user types.

Considering the effect (TRQ 2), the hypothesis emerges that grouped gamification leads to a higher training duration in the mean training times. This has to be further evaluated.
In combination with a mobile serious game app, significantly higher assumption of the effect value / usefulness was found after using the gamified training. This indicates that previous gamified training can also have a positive effect on the perception of a subsequent mobile usage.

Although a combination of conducting the training on computer / laptop and app is rated as the most reasonable, higher individual needs are shown in the potential own use. This indicates a need for tailoring if training is to be used independently in practice.

The independent usage of the FBO was confirmed. Feedback showed to be the primary relevant aspect. The planned secondary or additional goal can be further developed by the proposed concepts to the primary relevant perceived feedback to address meaningfulness and relevance. For this, the proposed study should be carried out further.

In conclusion, both studies support tailoring to the user [215] and the individual life situation, e.g., home training [361] and mobile use [194], in the use of motivation-supporting methods for cognitive training in the use of gamification and complementary devices. In addition to the use of different devices for different tasks, habits and preferences, in line with Jokela et al. [194], intended training behavior and training factors such as duration, degree of difficulty and distraction may also be taken into account. In addition to motivational factors, motives and factors of compliance, such use-related therapy-relevant factors can be further considered in-depth.
The results contribute to addressing the training duration and conduct of planned training by providing support for the development and design of training to support the patients' motivation.

5 Summary, Discussion and Implications of Contributions

5.1 Challenges and Summary of Contributions
5.2 Discussion
5.3 Limitations

This chapter summarizes and discusses the results of this work. Limitations of the work are listed and implications of the meanings of the results and for the application in practice are pointed out, as well as conclusions are drawn.

This section contains texts from the author's own publications (see 'List of own publications' in the appendix).

5.1 Challenges and Summary of Contributions

In the development of software-based training, motivation support is a relevant aspect to support emotions and therapy adherence. The design and development is challenging due to the characteristics, specific context and the required intertwining of multiple disciplines. This work addresses the lack of context-specific deepening in cognitive rehabilitation, tailoring and inclusion of an elderly target group. To create motivational support and a training situation close to the intended usage, it was relevant in this work to offer software and complementary elements that can be used independently at home instead of in the laboratory [361].

This work contributes to the state of research and application by providing guidance for design, development and selection to the implementation of software-based methods to motivate users in cognitive training.

In line with other work on cognitive training [106, 239, 392], or from other fields [86, 160, 280], this work confirms and supports that motivational factors can be influenced by gamification, also specifically in the context of cognitive rehabilitation [44, 192, 239, 361, 392]. By supporting motivation, behavior can be addressed on one hand, and emotional perception on the other. Gamification, however, offers the use of various elements [372, 392] and combinations [384]. Therefore, in the context of software-based cognitive training, questions regarding TRQ 1) supportive implementation of gamification elements, TRQ 2) resulting effects of their (tailored) application on motivation in perception and training duration, and TRQ 3) possibilities to complement browser-based training were addressed in this work. This includes, among other things, supporting methods for addressing the user's motivation on the one hand and supporting methods for software development on the other hand.

Regarding the implementation of gamification (TRQ1), the work offers methods, results and orientation for the application of elements in cognitive rehabilitation. It supports, in design and development, the feasibility of wrapping gamification around a training task with the option to use it over several sessions. For the in-depth integration, implementation guidelines for the integration of accompanying NPCs are presented. The transfer from a conventional progress graph representation to a gamified method in a metaphor based on progress and social elements is shown as an example.
For overall support in design and development, this work provides an analysis of requests for different game elements in relation to the user types of patients and a corresponding graphical presentation for practical application in cognitive rehabilitation. To further deepen the support for the selection of game elements tailored to the target group based on a knowledge transfer between research and practice, a browser-based supporting method is presented in the form of a prototype version of the tool 'Gamification Guide'. To simplify development, a method is used by using the grouping of user characteristics in mean to assign existing gamification approaches or to develop new ones. This aims for a compromise between the effect of gamification and the simplification of development.

Regarding consideration of the effects by the implementation (TRQ2), effects on the motivation are shown. In regard to perception, effects on e.g., fun, competence and belief in the effect of the training become apparent individually for type and implementation.
No significant increases in the effort has emerged. However, there are indications for further consideration in the future regarding the level of transfer of responsibility, as well as the possibility of integrating additional (tailored) goals to address motivation.
In terms of behavior, there is no overall increase in training duration due to gamification. However, there is a partial individual difference between the user types and a change in the medium performance range. The results contribute to the targeted development of gamification in the future to adress the desired effect and adherence.

The work shows and deepens methods to complement the software-based training browser-based on the computer (TRQ3). This contributes to the understanding of the effects of combined application of (non-) gamified browser-based training followed by mobile serious games. For an additional reminder system, a software-based connection and further development of an existing smart home reminder concept to a training conducted independently at home is presented. This is expanded with a concept for tailored meaningful realization based on the user types. Thus, this work contributes to the tailoring and complementary use by combined devices in software-based training.

Overall, the results in line with other work [239, 392] and practice support the complementation of cognitive training with gamification and devices as well as its application and suitability to support motivation. The results provide guidance for design and development for implementation of software-based methods for computer-based training and combination with complementary devices in practical application.
In the following discussion section, implications of the results for application in practice are presented.

5.2 Discussion

5.2.1 Thesis Research Question 1 - Implementation of Elements to Support Motivation
5.2.2 Thesis Research Question 2 - Effects in Perception and Training Duration
5.2.3 Thesis Research Question 3 - Training Complement
5.2.4 General Discussion

5.2.1 Thesis Research Question 1 - Implementation of Elements to Support Motivation

Gamification Elements

In the individual steps of this work, the integration of gamification elements that are usable over several sessions, in line with the requirements of Lumsden et al. [239], has been developed and analyzed for the application.

The request confirms the need for the progression elements frequently used in rehabilitation according to Tuah et al. [379], as well as from the general observation and other fields [156, 157, 372], especially in combination with feedback [247]. The relevance of the progress shown in the results on gamification and motivation used in rehabilitation can be explained by theories and results of other work on specific goal setting and compliance [190, 227, 233, 272, 276, 417]. The use of progression is also supported by the lowering of amotivation, as shown by Reyssier et al. [309].
By integrating goals, such as the detective case in interactive storytelling, the mountain ridge in the progress presentation, or in the further development of the feedback object, alternative or additional goals to the goal of rehabilitation could be set in line with Ha et al. and the use of virtual rewards [154].
Boendermaker et al. indicated, using the example of alcohol drinking, that additional game elements can also distract from the goal of the training [46]. Advantages and disadvantages for cognitive training, as well as effects, should be considered further in more detail.

Through the presented progression, an extrinsic incentive and reward could be set for future use, and thus, in the next step, the implementation could be expanded through meaningfulness, the inclusion of new personal goals, and the enjoyment of achieving them, and thus, intrinsic aspects of motivation [87, 154, 272, 320]. Interestingly, the relevance of progression is shown both in request (section 3.3) and in use (section 4.3), but is also given as a criterion for dropping out if it is missing or not clear enough (section 4.2). This indicates the importance of the progression elements to use in training.
In addition, assistance elements for patients is shown to be relevant. One explanation can be the intended goal of rehabilitation and the assistance potentially needed due to the personal limitation. It is therefore recommended to especially focus on these categories as a basis when integrating gamification in cognitive training.

The social elements in section 3.3, in line with Hallifax et al. [157], are rather less requested and point to the need for tailored use of social elements, as well as in section 4.3 which points to the different involvement of friends and strangers, in line with Lentferink et al. [230]. So far, they have been rarely used in cognitive training [392] and are therefore examined in more depth in this work. Reyssier et al. also point out that game elements for social comparisons could have a negative effect on learning motivation [309]. Here, a further deepening for the use of motivation-supporting software-based methods in rehabilitation should be conducted in the future. This is indicated in particular by the differences in perception and behavior with regard to socialization and the different effects on the user types.

Some element categories and elements are generally requested by all user types, even if individual needs may differ in individual cases. Nevertheless, this work, in line with other work [158, 215], supports the implementation of tailored gamification, also for patients in cognitive rehabilitation, but with the focus on certain parts of the elements. Besides the generally requested elements, others are rated mixed or rather rejected and show different suitability for different user types [284, 309, 372]. Further consideration should be given to whether a differentiation can be made between generally usable elements as a basis in the implementation and those with tailoring relevance for mixed rated as a further addition. Through partial tailoring, possible negative effects might be avoided [199, 281, 320]. This addresses the approach of Boendermaker et al. to first obtain positives [44]. In addition to generally suitable basic gamification, tailored solutions could be used to address effects in a more targeted way. At the same time, such partially-tailored solutions might reduce the effort for implementation compared to fully-tailored solutions. This approach should be deepened and evaluated in practice of cognitive training in the future.

According to Santos et al., however, the characteristics of the user type change over time, so they suggest regularly measuring and dynamically adapting the content to the user [328]. With regard to the integration of gamification elements into cognitive therapy, this can be particularly relevant, as patients should frequently use the systems over a longer period of time or several sessions to achieve a therapeutic effect [368, 403]. However, the use of motivational methods should not result in a large reduction in therapy time or in the cognitive capacity of the patient. To further strengthen the perception, e.g., the experienced enjoyment during use, approaches such as those of Altmeyer et al. can be used in the future, which propose a selection system based on the Hexad User Types Questionnaire or a determination through interaction with the elements [16].
Hallifax et al. indicate that the motivational impact of gamification varies in different contexts of use [157]. Based on the example of the analysis of the way of implementing an NPC (section 3.2.2) and the request (section 3.3), specific requirements for elements have been indicated for the use in rehabilitation. Furthermore, other gamification elements should also be explored and deepened in terms of individual requirements for use and implementation in relation to the specific target group. This could a) support the tailoring of the elements to the context of rehabilitation and the needs of the patients, and b) provide more concrete support and schemas for implementation, and should c) be integrated into tools like the 'Gamification Guide'.

Implementation

The patient requests analyzed in section 3.3 can be used to guide the implementation of patient motivation elements.

Regarding the implementation in industry, among others, Morschheuser et al. [262], Boendermaker [47], and Pereira [292] pointed out the problem of the limited development time, financial resources and complexity of integration. Among others, Tamayo-Serrano et al. [361] and Perry et al. [294] highlight the tendency to use low-cost versions in rehabilitation. This conflicts with the high degree of tailoring possible through various user types and components. A needed balance between development and complement was also noted in section 3.4.

For the selection of elements in practice, differences in the complexity of the implementation could be used [234], such as between rewards as elements that can be partly easier to implement in the basic usage and story as a more complex form of wrapping a training in game form [47]. Following Lopez and Tucker [234], a factor for suitability for implementation in practice can be calculated in the future, following a future evaluation of the complexity of the individual elements in relation to the user type. This can be integrated into, e.g., the 'Gamification Guide' and provide guidance for the selection process. In this way, a compromise can be made, as suggested by Lopez and Tucker [234], between elements that are easy to implement [75, 219, 271] and those that generate highly positive effects and/or are particularly requested.

To address the balance between tailoring, complexity, and cost, the tailoring method of grouping characteristics in the mean and assigning them to the most appropriate gamified version / elements is an interesting approach (see section 4.2). This might be used in different situations in the future:

a) Assigning users to an existing solution. This can be used to determine the suitability of the solution(s) tailored to the users and to select or not use them accordingly.
b) Planning of the implementation: Through existing relationships between user type and element, e.g., based on the analyzed table in section 3.3 (Figure 11), according to Tondello et al. [372] or Orji et al. [284], and combinations of elements [183], e.g., according to Upshall [384], gamification solutions can be planned that address differently grouped types. Thus, as Santos et al. also suggest [328], different characteristics, such as multiple primary user types, can be included and addressed. However, in this work, only a version for two gamification options was considered (section 4.2). Further research is needed for more in-depth consideration.

Further consideration is needed, on the one hand, for the required level of the mean value for an effect on motivation, and on the other hand, for the effects of individual low or high scales. Additionally, it should be analyzed how many different versions are necessary for a balance between implementation effort and effect [234]. The method used offers an approach, but requires more in-depth analysis of the individual impact factors. Furthermore, this approach could also be considered for the devices, design and implementation of reminder systems (e.g., section 4.3, see RQ 3) in further steps.
The time available for training is also relevant for development. In clinical use, this is limited due to the prescribed duration of the sessions. In home training, more time may be available if desired. Here, further consideration can be given to whether there is a need for different versions to address motivation and, if so, which duration is suitable for which users. This may be another factor in selection or in change from clinic to home training.

The 'Gamification Guide' prototype (section 3.4) offers support for the transfer of knowledge and networking of research and industry for the implementation of tailored gamification. Within this work, approaches for the future steps of the prototype related to the application in cognitive rehabilitation were identified in the course of the other steps of this work:

- Integration of concrete implementation recommendations for individual elements beyond examples. Those are shown in section 3.2.2 in the example of the NPC in cognitive rehabilitation and can be extended accordingly for other elements.
- Indication of the level of complexity of the implementation of the elements or examples presented in line with assessments by Lopez and Tucker [234] to support the competence of designers and developers for the selection of elements.
- Tailoring recommendations and combination between browser-based and mobile/complementing applications. Here, potential different effects of the elements and suitabilities should be considered in the future.
- Concrete positive and negative effects in use of individual elements or combinations [183, 392].
- Automation of the selection of suitable elements for combination for user types in mean based on requirements to be specified to generate a simplified selection basis. The selection was carried out by hand in section 4.2.

- Extensibility of tailoring options for reminder functions, meaningful support, and mobile use.

Due to possible individual effects and new effects through the combination of elements, [292, 325], such tools should only provide orientation, and further evaluations of the effect of the designed system should be carried out [82].

Implications for Design and Development in Cognitive Training

- Besides a development in one system, motivational methods and medical cognitive training can also be developed independently of each other and be linked.
- Individual decisions should be supported for the sense of autonomy, but the level of responsibility transferred to the user should be chosen with caution.
- For the in-depth use of specific elements, possible corresponding aspects arising from the context of rehabilitation and should be considered, such as for the NPC (section 3.2.2).
- Additional goals can be generated through motivation-supporting methods.
- Some elements / categories are generally requested, others need to be tailored to the user type (see Figure 11, Table 9).
- Progression and assistance are more generally requested and relevant as a basis for the design, development, and conduct of training.
- By grouping in the means, several user characteristics can be included, implementation in practice may be simplified and effects on the user can be generated.
- The elements should be used specifically according to the planned effects [202, 373].
- In practice, guiding tools such as the 'Gamification Guide' can support the selection of suitable elements for individual target groups.
- The interconnection of science and practice may support the application of tailored gamification for the patient.

5.2.2 Thesis Research Question 2 - Effects in Perception and Training Duration

The results of the studies of the work indicate, in line with other works, the different effects of gamification elements [247, 284, 309] and effects on patients in cognitive rehabilitation [44, 239, 329, 361, 392]. Within this work, perceived emotions and behavior during training based on training duration were considered as indicators of motivation, as well as user ratings.

Perception

Vermeir et al. have shown in their review that the gamification integration in cognitive training leads to higher engagement / motivation, which includes interest and enjoyment [392]. In general and in detail, the results on perceived enjoyment varied in this work. While in section 3.3 of the overall evaluation and for socialiser, a higher enjoyment was found, this was not evident for achiever and was also in section 4.2 only on the verge to significance. This can have different reasons: a) difference in perception between user types [284], b) different influence of single characteristics, their combination [157] and the consideration of several types in mean, c) different implementation [157], d) lack of/reduced focus on meaningful progress/goals to address intrinsic motivation and personal connection [271] or learning goal [83], or e) different effects of different elements [82, 325, 326].

According to the health belief model, behavior change is associated with, among other things, expectations of the intervention [109]. Thus, an important effect found is the higher belief in the effect of training after a browser-based training with tailored gamification as well as for training on the computer and on the smartphone, as the belief in this is an aspect to the willingness to perform [161], as well as a higher perceived usefulness, which are therefore relevant aspects in considering the effect of gamification [219]. Both were generated by the training in section 4.2, which supports the use of tailored gamification in mean for use in cognitive training.

The results support addressing autonomy of the user [323]. This can be observed in section 3.2.1 in the request to choose the target and to have the say, in section 4.2 in the requested flexible use in terms of time and place, the different demand in the use of the devices and in section 4.3 through the everyday behavior and demand for mobile transfer.

In other domains, the possibility of negative effects / side effects of individual gamification elements on perception has also been demonstrated [54, 334]. Although this effect was not significant in this work, there were corresponding indications in the detailed examination of some users, e.g., of the interactive storytelling / quest (e.g., responsibility transferred to the patient as very unpleasant), in the case of non-socializers, the lower interest to support the NPC, and the use of the FBO (e.g., pressure, bad conscience, making the plant dependent).

Behavior

Interestingly, in line with other work [205, 239], in the studies (section 3.3 and 4.2), there was no general difference in performance respectively in this work specifically in training duration between gamified and non-gamified training. Here, however, different results have been reported: This was increased in a study by Boendermaker [45], and performance in scores by Ninaus et al. [275] for example.
Differences in training duration [29, 30, 217] as well as negative effects when using inappropriate elements [44, 234, 304, 392] have been shown in other work. Here, the detailed consideration is shown to be relevant in the consideration of training duration. For deeper consideration, further methods for addressing the remaining low performers should also be considered, such as from other work through instructions and suggestions [385], the level of belief in the effect [161]. motives, and individual goals [190, 227, 233] in rehabilitation. However, in line with Bräuer and Mazarakis [54], this work shows different effects in the gamified solutions between the perceived emotions and performance.

Implications for Design and Development in Cognitive Training

Overall, the results for the use of gamification in cognitive training with respect to the effects indicate, partly in line with other work (see brackets) that in cognitive training

- Effects in emotions and behavior can be achieved through the use of (tailored) gamification in cognitive training [45, 192, 234, 275, 392, 361].
- The possibility exists to influence the training duration [45].
- Effects of different elements can vary between different user types [14, 283, 284] and in the general consideration and do not always produce the same effect.
- Elements and their effects should be targeted to the different types [281, 372].
- Positive effects can be achieved and should be planned specifically [202, 373].
- Despite low demand of an element for suitable types, no disadvantage has to arise, but, if suitable for the type, positive emotions could be supported.
- The lack of certain elements, such as progression, is given as a reason for drop-out of training after a period of time [120].

5.2.3 Thesis Research Question 3 - Training Complement

Cognitive training is often conducted on a computer / laptop. In home training, however, the users' life situation and environment is different. Therefore, in TRQ 3 (Training complementation), complementation and combination options of training on the computer for user-needs-oriented application were considered:

- The connection of a reminder for feedback about the training in the home environment, because the continuation of the training on the computer/laptop may be necessary to use its strengths, e.g., to avoid distraction stimuli or the large screen (e.g., in case of limitations of the field of view). With the feedback object, a device unknown to the user is connected to the training, which focuses on presence in the room and the functionality to support the user.
- A complementary mobile training, as this might address accessibility and frequency. With the smartphone, a familiar device is used, which in use combines various functionalities of different areas of life in everyday life.

The results thus support and extend the concepts and ideas of the previous work [129] on complemented training on the computer through the devices.

Interestingly, in the results, on the one hand, is the high variation in different needs for the implementation of training and, on the other hand, that this deviates from the most reasonable assessed way of use. The results not only indicate the relevance of tailoring elements, but also support White et al. in the different application of implementation and devices tailored to the intended use or usage case [408]. This points to the need for tailored combinations of services. Here, further clustering of use types for categorization and potential links with motivational methods might be explored in more depth. The possibility of grouped tailoring (section 4.2) for complementary elements should also be considered further.

Further consideration of the results can also lead not only to compare which kind of training is more beneficial [44], or which kind of training is best suited for which user, but also for which targeted result [202]. Here the question arises, whether the belief in the effect [161], the suitability for the situation or the addition of further objectives might show differences in the frequency or regularity of conduct in the future. This should be considered further in long term use. Thereby, the level of the effects of the different methods should be considered. For design and development for use in home training, the potentials and limitations of different devices should be included in tools such as the 'Gamification Guide' and the difference in use for different tasks [194], depending on the intended goal for the user in therapy.

This work shows the opportunities, possibilities and limitations for users, implementation and application. However, due to the abilities and limitations, the suitability of mobile versions should be decided individually for the user in the corresponding situation on a therapeutic level.

Implications for Design and Development in Cognitive Training

- The browser-based training complementary methods should be tailored to the needs and characteristics, possibilities and therapeutic situation of the user [228].
- In the independent use, there are needs for autonomous conduct in e.g., time and place of training.
- A previous gamified training on the browser supports the belief in the effect of training on the computer and mobile device.
- A feedback object can be connected to a browser-based training and provide feedback on the next training in independent use, as well as present the feedback according to the user's interaction with the training.
- To support the meaningfulness and tailored additionally / secondary goals, tailored approaches to the user type should be considered in depth.

5.2.4 General Discussion

According to Yoshida et al., patient motivation in the clinic is based more on extrinsic factors such as personal (e.g., patients' goals, success/failure etc.) and social relationship than intrinsic (e.g., enjoyment) [417]. In this work, the motivational methods show effects in both areas.
Extrinsic elements such as rewards [250], however, are used most frequently according to Vermeir et al. [392] and primarily point systems according to Tamayo-Serrano [361]. Interestingly, however, rewards are only moderately requested by patients (section 3.3). External motivators can reduce intrinsic motivation [89, 110], and according to Ferreira-Brito et al. it threatens adherence to interventions in the long run [123]. This indicates that the way gamification elements are used in cognitive training should be reconsidered for independent long-term use in home training.
In section 4.2, the relevance of fun in training, as an intrinsic aspect, was rated comparably high as its effectiveness by users. Further consideration should be given to a possible difference in use between clinic and home for the effects and suitability of individual elements extending the results of, e.g., Hung et al. [178]. Boendermaker et al. propose different stages for the integration of gamification elements from the basic task to the complete game [47]. These include the possibility of combining extrinsic and intrinsic elements. The question here is to what extent this combination is suitable for cognitive training and whether the focus should be changed from extrinsic to intrinsic elements after a certain period of use or from the transition from training in the clinic to home training. This may result in the development of a combination of extrinsic and intrinsic elements, as questioned by Boendermaker et al. [47]. The effectiveness of these elements for rehabilitation according to Barrett should be examined in depth in the future [32]. Furthermore, on the software side, it should be considered to find factors explaining, whether and when different elements are needed and whether dynamic adjustment is possible.

The item rated most relevant in the results of this work is a combination of the goal in training and the aspect of meaningfulness. This supports the relevance of meaningfulness to rehabilitation mentioned by Burke et al. [60] and the suggestion by Gerling and Masuch that gamification should include meaningful value for increased user engagement rather than just prolonging it [146].
Thus, the gamification or game-based implementation used in this work is predominantly based on the meaningfulness proposed by Nicholson, as a basis for addressing long-term motivation and positive experience for addressing intrinsic motivation [271]. It was, e.g., established in the interactive storytelling (section 3.2.1) and presentation of the metaphor of the hiking trail (section 3.3) as a basis for the development process, as well as a tailored approach for a feedback object (section 4.3.6) proposed to create an additional goal for the user.

Although 'Meaning/Purpose' was requested as the most important element, and in section 3.2.1 different goals were mentioned with the training goal, but also with the solving of the quest, the development of the FBO for the expanding integrated meaningful goal shows, however, that:

a) the element used was not perceived as a primarily relevant aspect and can be perceived secondarily, complementarily, indirectly, or not and
b) here, a tailoring to the user could also be relevant [271].

The question arises whether the cognitive performance enhancement or an own goal is perceived as the most meaningful (see section 4.3). This might be reinforced by motivating methods or can be replaced in case of a lack thereof (gamified, screen-based, mobile and physical, but also content). However, in the implementation of the method of extended goals, it should be taken into account that, on the one hand, Sardi et al. suggest a combination of several elements for use, since effectiveness may be reduced if only one element is used [329]. and, on the other hand, it is pointed out that the use of similar strategies does not have an additional behavior-changing effect [201]. Here, the relevance of

the suitability of the combination [384], but also the effect should be considered.

In addition to supportive factors, examples of limiting internal (e.g., lost interest, repetitive, concentration waned) or external factors (e.g., lack of time or health limitations) that lead to non-performance or drop-out of training are also revealed. These offer additional starting points for further addressing motivation or reducing amotivation.

The results of such further consideration can be integrated into tools such as the 'Gamification Guide' to support development for tailoring or relevant implementation information.

Elements

Feedback loops are the most frequently used elements in computer-based cognitive training after rewards according to Vermeir et al. [392]. Colzato and Hommel suggest feedback for the future of cognitive training to prevent a high drop-out rate [79]. Its relevance is reflected in different parts of the work, such as the request of patients for progression or 'Progress feedback', the deepening of the presentation of the performance curve (section 3.3), as one of the reasons to drop out (section 4.2), that no progress / goal was indicated, giving feedback as requirements for an accompanying NPC (section 3.2.2), and as a primarily relevant aspect of the FBO. Here, a further comparison of the different feedback scenarios in connection with the implementation of cognitive training should be conducted. The results may allow conclusions to be drawn about which or how the feedback in combination [384] is most appropriate to be implemented in software-based cognitive training. Perry points out different types of feedback in neurorehabilitation, such as summary or average feedback, which can be given during or at the end of the training task, but also the possible relevance of multi-sensory feedback [294]. Tuah et al. suggest that visual feedback in rehabilitation addresses achieving progress and also fun [379]. Burgers et al. have considered different types of feedback and their results indicate that positive feedback is relevant for increasing intrinsic and long-term motivation in brain-training games [59]. The future deepening of the consideration of feedback through software-based motivational methods and their types and effects is in line with the proposals for gamification by Koivisto and Hamari and supports them [219]. Furthermore, the effects of the different implementation methods should be compared.

In-depth consideration should also be given to the relevance shown in this work for the further possibilities of the requested assistance in home training. Besides the use of an NPC (section 3.2.2) or the integration of devices (section 4.3), other needs and software-based solutions can be considered in home training and optimized for patient requests. However, Perry et al. point out that assistance should be implemented as a 'helping hand' in rehabilitation rather than a completely automated process [294].

Rehabilitation usually implies the goal of improving or fully regaining individual abilities [175]. Therefore, the presented approaches include the presentation of overall (e.g., hiking trail) or partial goals of the process (e.g., FBO). Within training, however, patients sometimes reach a performance plateau for a time when performance stagnates [205, 301]. Further consideration should be given to whether and which elements or combinations could be particularly suitable in this situation. These could be used dynamically as soon as a plateau is detected by the training software. Day describes in the fitness domain that for a continuous performance improvement with increasing goals and performance tracking the, fun of the conduct is relevant and the use of storytelling instead of competition, which could also be the case in plateau and emphasize intrinsic motivation [85]. This should be further explored.

Interesting to note in the data of this work is that, on the one hand, trends are evident, but, on the other hand, some users partly show deviations from the mean value. This supports and shows the individuality of the effects in the development of motivation [215, 294, 309]. Cugelman points out that each gamification scenario requires individual testing [82]. The results presented here are therefore a rele-

vant guideline for orientation in addressing motivation, but individual needs should always be kept in mind as well.
To address the basis of preventing negative effects or addressing positive ones [199, 281, 320], it may therefore be reasonable to deviate from the resulting recommendations in individual cases. These deviating cases and dynamic individualizations, especially in the case of missing or negative effects, should be considered further in the future.

In the future, the comparison of the different motivational methods should be considered, as well as the possibility of ranking the relevance for implementation in practice.

Overall, the results of this work support the tailoring of motivational methods and gamification, as in other domains [158, 215, 372], for software-based cognitive training and in the combination and use of different devices. For this, it offers an orientation and methods for the selection and implementation of the elements. It supports the availability in line with other work and interlocking [129, 194] implementations and deepens the combination of complementary devices. It points out and confirms the relevance in software-based training for cognitive rehabilitation, not only to tailor according to the user types [372, 388], but to pre-define the meaningful goals [339, 388], to be achieved, especially in the differentiation of behavior and perception.

Critical Aspects

In the use of motivational methods, various aspects should be critically considered.
The aim is to increase motivation in emotion and training duration, adherence, and in the end, the effect of the training. In the application, however, it should be critically questioned whether, in addition to the possible reduction of training time, people who are classified as medium or high performers may overperform or overstrain in cognitive training from a therapeutic point of view. Overuse was also analyzed as a potential negative side effect in the use of gamificaion for health behavior change by Schmidt-Kraepelin et al. [334]. Software-based analysis and development of methods for restriction may be required as a counterpart to the detection of underperformance.

In the methodology of the studies, it would be useful for the comparison to consider how elements affect when they are used contrary to the type, for example by Altmeyer et al. [15]. The results of the exploratory study in section 3.3 indicate that the use of gamification can lead to significant differences in the duration of use. Targeted contrary use with patients who need training for their health condition should be critically questioned.

It is also critical to note that, as Voit et al. show, different implementation methods (e.g., lab. online or in-situation) lead to different study results [394]. Direct comparability is therefore not given and evaluations should be as close to the final application situation as possible, as aimed for in this work.

Implications for Design and Development in Cognitive Training

With regard to the Thesis Research Questions, the analysis, development steps, and results show, in this work and in conjunction with other work complementary or in-depth, various indications in the considered methods emerge to support the development and design of software-based cognitive training for patients in cognitive rehabilitation:

Implied recommendations:

- Software-based wrapping [47] of the training is suitable for the development of motivational methods independent from the training. Development of motivational implementation and cognitive training can be carried out independently of each other and then combined.
- Implementing aspects of the requested progression and assistance, as well as feedback or reminder (sections 3.3, 4.2 and 4.3) and strengthening perceived meaningfulness [60] as the basis of design and development.
- Tailoring the elements to the user [15, 215, 372] to address motivation in emotional perception and behavior and to the context of patients in cognitive rehabilitation, as well as taking into account the situation of the patients and their personal goal. Due to the different effects, it is relevant to plan specifically in the conception which effect is to be achieved by which element [281, 372].
- Setting and development, as well as the perception of additional goals through the elements used is possible and should be supported, suitable for the individual user.
- Possible usage of grouped tailored gamification in browser-based training to support motivation and potentially user behavior
    1. for a possible simplified implementation of tailored approaches and assignment to gamification options for application in practice in the future and
    2. to support the perception in belief of the effect and the overall effect of the training, as well as potentially in the behavior to address the increase of the training duration in some of the users.

- When implementing an NPC, a younger male or middle-aged female NPC with friendly, but also guiding characteristics should be used.
- Probably careful use of responsibility transferred to the user through gamification should be considered (see section 3.2.1 and 4.3).
- The use of the mobile serious games on the smartphone should be targeted to the situation of the users.
- Use of a preceding gamified training in the browser may promote positive effects in the additional possible use of a mobile device.
- Linking smart home feedback for independent use to cognitive training and presentation of duration until next training, according to user input as a software based possibility for assisted can be realized. The support of meaningful perception and secondary/additional goal through tailored realizations and further tailoring options for complementary methods should be considered further.
- Supporting methods such as simplified presentation of scientific results on the use of gamification for fast profound selection of suitable (tailored) gamification elements and networking, proposed here using the example of the 'Gamification Guide' tool, the visualization of user requests (Figure 11) or assignment of gamification due to grouping characteristics in mean may be used.

For future approaches in the development within the software, it can be proposed and considered as a complement of medically validated software based trainings in
step 1) a complement by generally requested motivation elements like progress and assistance (for elements which are not rejected by any type and are most requested) and in
step 2) a complement of tailored gamification (grouped in mean or individually).

The distinction between fully and partially adapted gamification is also made among others by Böckle et al. in their analysis of research papers [43].

For element selection purposes, Figure 11 can be used. Complementing elements could be integrated and further developed according to this approach. It should be further evaluated for a) suitability for design and development and b) effects on patients.

5.3. Limitations

Several limitations of the work should be considered.
The studies were conducted in Germany and participants were mainly recruited from Germany. Statements of the participants were mostly translated from German to English and therefore do not represent the original wording. Included patients had mild to moderate acquired brain damage and were primarily in outpatient therapy or home training. Generalization to other countries and cultural groups, as well as other types or levels of cognitive impairment or phases of rehabilitation, cannot be guaranteed. Likewise, the results refer only to the use in cognitive therapy and cannot be transferred to other types of rehabilitation, cognitive training, or other fields of application.
In some cases, healthy subjects were also included or recruited for the studies. This makes it possible to examine an initial effect, but it is not possible to guarantee that this effect will be transferable to patients. Questionnaires were partly adapted to the rehabilitation situation, used in a shortened form, or individual new ones were created. This has to be considered when comparing the results.

The prototypes developed do not claim to represent a medical product, but are to be regarded as prototypical approaches for use in studies. An existing software for cognitive training in rehabilitation [162] was used as a basis for the training software, and some of the designs that were further developed were based on it.
The therapeutic effect of the training is not considered. Furthermore, no comparisons are made with the integration of other existing training software. The transfer of the effects can therefore not be guaranteed.
For tailoring, the user type was considered based on the Player and User Types Hexad [244] and kept within the different steps for comparability of results. Other models may lead to different results. In addition, further factors should be included for more detailed tailoring that influence preferences such as age [243], gender [372], or, according to Lavoué et al., the individual engagement behavior [229]. Likewise, possible influencing factors such as cognitive impairment or progress in rehabilitation should be considered.

In the conduct of the studies, due to practicality, various evaluations were combined or deepened in collected data. Thus, some steps were combined and several research questions were considered in a combined study, or in partial data of overarching studies, instead of in individual studies. In this way, a compromise was made in the evaluations between the feasibility of evaluation with patients or users in home training and research questions to be asked. This is also a reason why at various points, exploratory and/or only individual partial aspects from the entirety of the data collected were considered. Other aspects collected were not further included. Therefore, no further connections or conclusions are drawn from these. Individual evaluations or further in-depth studies or a different study design could lead to different or further results.
The evaluations were based on the evaluation and interpretation of partly one person. In other systems or by other evaluators, other interpretations or a different focus in the evaluation may result. The steps and evaluations were carried out to the best of knowledge and conscience, nevertheless potential errors cannot be ruled out.

The evaluations consist in some parts of qualitative approaches as well as in-depth explorative approaches and partly include only a small number of patients / users. A higher number would support generalizability and promote the stability of the results.

The results represent trends and guidance. Nevertheless, the intended effect may not occur during application. Overarching groups, such as user types, can be defined to create ways for application in practice, but individual motivation may differ from this. This may vary for different reasons depending on the individual user, such as life circumstances, needs, requirements in therapy, different goals, method of implementing the motivational elements and/or other factors. In the implementation for practical use, only some individual elements and combination variants were considered in this work. In practice, the individual user with individual needs should always be kept in mind, and thus, deviations from the systems should be made possible. This also includes the activation or deactivation of individual components [256].
The results provide methods and deepen knowledge for the use of motivational aspects in software-based training, but further steps are needed and additional in-depth research questions are raised (see section 6.2).

6 Conclusion

6.1. Conclusion
6.2. Future Work: Research Agenda

This chapter summarizes the results of this work and draws conclusions for their meanings.
Based on this, further emerging research questions and research steps are proposed.

Note:
The conclusion and approaches for future work are partly related to and / or extend the background and results of this work.

6.1 Conclusion

6.1.1 Thesis Research Question 1 - Implementation of Elements to Support Motivation
6.1.2 Thesis Research Question 2 - Effects in Perception and Training Duration
6.1.3 Thesis Research Question 3 - Training Complemen
6.1.4 Overall

The long-term overarching goal of the reseach in this work is to support patients with acquired brain damage in the conduct of software-based training and to reach resulting positive outcomes in cognitive rehabilitation. To address this, software-based methods were considered in the present work to address the motivation, the knowledge of their (tailored) use and application and support for development and design in practice, and new development approaches were presented or deepened.
For the connection of development and design with the therapy, therapeutic trainings were used as a basis and complemented based on gamification and further motivating methods. To remain close to the intended training situation, the evaluations were mainly conducted in the independent use in the home training. Methods and implications for providing support for practical use are presented.

In the thesis, the following aspects and research questions were considered: 1) ways of implementing gamification elements to support motivation, 2) effects on motivation in terms of perception and usage behavior in training duration through gamification, and 3) external complementary possibilities for (tailored gamified) browser-based training on the computer.

Basically, this work, in line with other work, supports the feasibility and suitability of combining gamification and motivational methods and therapy and their suitability for patients for cognitive training [392] in rehabilitation, but individual needs and tailoring [158, 215, 290, 294, 309] should be considered.

6.1.1 Thesis Research Question 1 - Implementation of Elements to Support Motivation

This work contributes to the way of implementing motivational and gamification elements (TRQ 1) in a) deepening the consideration of individual elements and element combinations, which allows to specifically address them to the usage requirements and context of patients in rehabilitation. Furthermore, b) it contributes to overarching comparison of requests for different gamification elements in relation to the user types for tailoring, and also c) methods to support the application of research results in practice.

The results confirm the use of elements from the areas of progression and also the frequently used feedback [392]. They also indicate the use of assistance and a meaningful goal, but also the cautious use of transferred responsibility. Assistance is used more by patients than by healthy players, while progression is used more and socialization less by both.

The individual analysis shows that some elements are requested by all types, others only by some or none of them. The results offer an orientation for the application in practice for the use of elements which are a) generally suitable, b) individually tailored, or c) grouped tailored.
Furthermore, the possibility of integrating new goals through the use of methods to address motivation becomes apparent.
By proposing the method of a knowledge transfer tool and considering grouped tailoring for the assignment of users to existing gamified training, a simple access to the application of suitable elements may be supported in practice. In addition, a combination may be further considered in the future with the implementation of suitable elements for all as a basis and, in addition, tailored elements to achieve or deepen individual effects. This focuses a compromise in the detailed view of the research and the possibilities for implementation in practice.

6.1.2 Thesis Research Question 2 - Effects in Perception and Training Duration

This work further shows positive motivational effects in terms of perception and behavior in the training duration, which result from the implementation of motivational methods and gamification in combination with a software-based cognitive training, but are partly individually dependent on the user type or needs. This has shown that extrinsic aspects (such as the integration of a further goal for the user), but also intrinsic aspects (such as enjoyment or competence) can be addressed.

The use of tailored grouped gamification, could lead
a) regarding perception, among others, to higher belief in the training effect and
b) regarding behavior, to the hypothesis of partially higher training durations in the medium training duration range.

This is to be further evaluated in relation to basic behavior and motivation factors. Such an effect might contribute to the simplification of implementation in practice in the long term. Possible effects on the effectiveness of training for rehabilitation are to be further considered in relation to therapy.

6.1.3 Thesis Research Question 3 - Training Complement

Furthermore, this work contributes complementary methods for browser-based cognitive training on the computer/laptop. Within the possibilities considered, potentials for the use of serious games on smartphones become apparent, especially in the combination of the previous use of a browser-based gamified training. For different users, however, there is a wide range of required training situations, which indicates a diverse and tailored use of single or combined use. This supports the current range of different possible uses for devices from the practice. However, it also points to the relevance of considering how these are to be combined to be able to benefit from motivational effects.

In the connection and further development of an existing prototype of a feedback object as a reminder, the feasibility of the implementation as a complement to an existing cognitive training via a training server as a smart home device is shown. Further proposed approaches for tailored implementations as complementary support through tailored goals, possible effects and the combination through grouped tailoring should be considered in the future.

6.1.4 Overall

Overall, this work confirms, in the context of cognitive rehabilitation, that the use of motivational methods and gamification can have an effect on motivation. However, like the request for the different approaches, these are dependent on the character and needs of the user. To address motivational methods, guidance for development and design, effects, and complementary possibilities are presented and considered in detail. Thus, this work supports, enables and promotes development of software-based training in practice and enables tailoring to the characteristics of the user and the usage situation in independent training.

Based on the research results, the tool, and the methods presented, this work provides support, as well as implications for the application of the results for development and design in practice. The elements considered can thus be planned, tailored and developed with more focus on the goal to be achieved. Thus, the work contributes to improved development and design of methods to support motivation in the specific context of software-based cognitive rehabilitation training.

6.2 Future Work: Research Agenda

In the future, in addition to the aspects addressed in the previous sections and chapters, various possible approaches summarized below should be considered.

1. For transfer to industry and easier access and application, the following might be addressed: a) In research papers, in addition to summarizing the results, implications for practice could be made even clearer and strengthened (e.g., in a separate subsection such as by How et al. [178]), or b) research results could be included in tools such as the 'Gamification Guide'. Appropriate focus, writing styles, and options should be considered, following e.g., Tondello et al. [370] and Millar, Moore and Nutt [255].
2. The user behavior and the potentials of game elements when used for high and low performers [involving 29, 30, 217] might be considered, in addition to the possibilities and risks of over-motivation [334] through different software-based methods.
3. The possibility of differences in the effect, use, and implementation of different methods for different phases of cognitive rehabilitation or between training in the clinic and home training might be analyzed in more detail.
4. In possible negative effects, indications of possible, e.g., too highly transferred responsibility (section 3.2.1) or development of dependencies by the plant of the FBO have emerged. Here, in addition to recommendations for action, recommendations for avoidance might be analyzed and prepared for practice, and related software-based dynamic tailoring should be considered. Negative effects have also been shown in other works [e.g., 54, 234, 304, 334, 392] and should be addressed accordingly in tools like the 'Gamification Guide'.
5. The possibilities to optimize the implementation of meaningful approaches in (physical) feedback and (physical) gamification based on software-based interaction and impact on different users and situations might be deepened.

Appendix

I Further Notes
II List of own Publications
III Bibliography
IV Questionnaires and Graphics

I Further Notes

- In some cases only partial aspects of the studies / papers are included in this work, e.g., through cooperation with other departments or to focus the questions of the individual chapters on specific aspects.
- In the development of the approaches of this work, feedback from therapists and / or developers of cognitive training was repeatedly incorporated to ensure the suitability for the intended purpose.
- The studies were conducted in a way that they were as close as possible to the realistic usage situation / at home or in the known environment of the patients / participants to obtain a realistic assessment.
- This work expands and deepens the author's previous master thesis [129]. In it, an interlocking system of initial concepts and approaches for complementary gamification and devices for cognitive training were shown, which are partly taken up in this work.
- Among others, the following tools and sources were used: Unity, Adobe Creative Suite, Microsoft Office, InVision, XAMPP, Tasmota, MQTT, https://pixabay.com (graphics: free commercial use), https://www.pexels.com/de-de (graphics: free commercial use), https://statistikguru.de, https://www.socscistatistics.com, https://www.limesurvey.org/de, Zoom
- Projects were partly realized within the given lectures 'Visual Communication - Digital Media' at the Magdeburg-Stendal University of Applied Sciences, or within supervised projects at the Otto von Guericke University Magdeburg.

II List of own Publications

Only non-indented publications are integrated into this work.

P. 1. **M. Gabele,** A. Thoms, S. Schroeer, S. Husslein, C. Hansen, „Effects and Combination of Tailored Browser-Based and Mobile Cognitive Software Training" in *Proceedings of International Conference on Multimedia Modeling (MMM)*, Quy Nhon, Vietnam, Springer Nature, Jun. 2022, pp. 279–291. The final authenticated version is available online at https://doi.org/10.1007/978-3-030-98355-0_24.

P. 2. **M. Gabele,** and V. T. Fischer, M. Steinbrügge, D. Thiemke, S. Hußlein, C. Hansen, „Potentials of a Web-based Gamification Guide for Knowledge Transfer between Research and Industry" in *Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Austria (Virtual Event), Oct. 2021, pp. 301-307, doi: 10.1145/3450337.3483458.

P. 3. **M. Gabele**, J. Weicker, S. Wagner, A. Thoms, S. Husslein, C. Hansen, "Effects and Ways of Tailored Gamification in Software-Based Training in Cognitive Rehabilitation" in *Proceedings of the 29th ACM Conference on User Modeling, Adaptation and Personalization (UMAP)*, Utrecht, Netherlands Jun. 2021, pp. 158-168, doi: 10.1145/3450613.3456828.

P. 4. J. Weicker, **M. Gabele**, A. Thöne-Otto, "Motivation und Verhalten während eines selbstständig absolvierten Onlinetrainings", Abstract and Presentation: *35. Jahrestagung der Gesellschaft für Neuropsychologie*, Aug. 2020

P. 5. D. Schott, B. Hatscher, F. Joeres, **M. Gabele,** S. Husslein, C. Hansen, „Lean Interaction: Passive Image Manipulation in Concurrent Multitasking", in *Graphics Interface*, Toronto, Canada, 2020, pp. 404 412

P. 6. A. Schmid, M. Fuchs, D. Anhorn, **M. Gabele,** S. Hußlein, „Evaluating Character Embodiment and Trust Towards AI Based on a Sleep Companion" in *Proceedings of HCI International 2020 - Posters*, Copenhagen, Denmark (Virtual Event), 2020, pp. 470–479

P. 7. **M. Gabele,** C. Schubert, A. Alomar, S. Husslein, C. Hansen, „ADHD Neurofeedback: Gameful Gestures as a Transfer into Daily Life" in *Book of Proceedings: IEEE Engineering in Medicine & Biology ISC 2019*, Magdeburg, Germany, 2019, p.44. Available: http://dx.doi.org/10.25673/31720.

P. 8. **M. Gabele,** A. Thoms, S. Husslein, C. Hansen, "Strategies:Include Cognitive Rehabilitation Training in Daily Life", in *Book of Proceedings: IEEE Engineering in Medicine & Biology ISC 2019*, Magdeburg, Germany, 2019, p.22. Available: http://dx.doi.org/10.25673/31720.

P. 9. A. Endler, **M. Gabele,** T. Heidel, S. Husslein, C. Hansen, C., „To go: Gameful Extension for Cognitive Rehabilitation Software", in *Book of Proceedings: IEEE Engineering in Medicine & Biology ISC 2019*, Magdeburg, Germany, 2019, p.43. Available: http://dx.doi.org/10.25673/31720.

P. 10. K. Arrambinde, **M. Gabele,** L. Freiman Cormier, S. Wagner, R. R. Wehbe, C. Hansen, L. E. Nacke, „The Development Of "Orbit" - The Collaborative BCI Game For Children With AD(H)D", in *Proceedings of the 2019 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY)*, Barcelona, Spain, Oct. 2019, pp. 341–348, doi: 10.1145/3341215.3356301.

P. 11. **M. Gabele,** A. Thoms, D. Schumacher, S. Husslein, C. Hansen, "Light as a Long-term Visualization Method of the Training Status for Patients in Hometraining in Rehabilitation" in Proceedings of *International Conference on Interfaces and Human Computer Interaction (IHCI)*, Porto, Portugal, Jul. 2019, pp.313-316. (Honored with the Encouragement Award)

P. 12. V. Batz, H. Riess, **M. Gabele,** D. Schumacher, M. Herzog, M., „Cuckoo – Facilitating Communication for People with Mental and Physical Disabilities in Residential Communities" in *Proceedings of International Conference on Interfaces and Human Computer Interaction (IHCI),* Porto, Portugal, Jul. 2019.

P. 13. **M. Gabele,** S. Schroeer, S. Husslein, C. Hansen, „An AR Sandbox as a Collaborative Multiplayer Rehabilitation Tool for Children with ADHD", in *Proceedings of Mensch & Computer 2019 (MuC), Workshop Virtual and Augmented Reality for Health and Wellbeing*, Hamburg, Germany 2019, doi: 10.18420/muc2019-ws-632.

P. 14. S. Wagner, F. Joeres, **M. Gabele,** C. Hansen, B. Preim, P. Saalfeld, „Difficulty Factors for VR Cognitive Rehabilitation Training - Crossing a Virtual Road". in *Computers & Graphics*, vol. 83, no. C, pp. 11 - 22, Oct. 2019, doi: 10.1016/j.cag.2019.06.009

P. 15. **M. Gabele,** A. Thoms, J. Alpers, S.Hußlein, C. Hansen, "Non-player character as a companion in cognitive rehabilitation for adults - Characteristics and representation", in *Proceedings of the 3rd International GamiFIN Conference*, Levi, Finland, 2019, pp. 130–141

P. 16. **M. Gabele,** A. Thoms, J. Alpers, S. Husslein, C. Hansen, C., „Effects of Interactive Storytelling and Quests in Cognitive Rehabilitation for Adults", in *Proceedings of the 3rd International GamiFIN Conference*, Levi, Finland, 2019, pp. 118-129.

This work includes content and texts from the thesis proposal and the presentation at the 'Doktorandentag' of the faculty of computer science (Otto von Guericke University of Magdeburg).

P. 17. **M. Gabele**, Development and Design of software-based methods to promote motivation of patients in rehabilitation", FIN Doktorandentag, Otto von Guericke University of Magdeburg, Magdeburg, Germany, 14. Juli 2020.

P. 18. **M. Gabele**, „Development and Design of software-based methods to promote motivation of patients in rehabilitation, Thesis Proposal, Otto von Guericke University of Magdeburg, Magdeburg, Germany, 24. October 2019.

Some approaches from the prior master's thesis [129] were taken up and further developed within this work. Within the doctoral studies, publications considered different contexts beyond the focus on cognitive rehabilitation after aquired brain damage presented in this work (e.g., children with AD(H)D). Due to the different characteristics of the target groups, the results are not related to each other. Differences and possible overlaps due to cognitive conspicuities of the target groups can be considered further. The other approaches presented might contribute to designing new interaction formats.

III Bibliography

1. A. Achtziger, P. Gollwitzer, "Rubikonmodell der Handlungsphasen", in *Handbuch der Allgemeinen Psychologie: Motivation und Emotion*, V. Brandstätter, Göttingen, Germany, Hogrefe, 2009, pp. 150-156.
2. ACM - Association for Computing Machinery. "ACM Digital Library.". ACM Digital Library. Available: https://dl.acm.org/ Accessed: 27/03/2021 (Accessed: May-12-2022).
3. M. A. Adams, J. F. Sallis, G. J. Norman, M. F. Hovell, E. B. Hekler, E. Perata, "An adaptive physical activity intervention for overweight adults: a randomized controlled trial", *PloS one*, vol. 8, no. 12, p. e82901, Dec. 2013, doi: 10.1371/journal.pone.0082901
4. I, Afyouni, F. U. Rehman, A. M. Qamar, S. Ghani, S. O. Hussain, B. Sadiq, A. Rahman, A. Murad, S. Basalamah, "A therapy-driven gamification framework for hand rehabilitation", *User Modeling and User-Adapted Interaction,* vol. 27, no. 2, pp. 215-265, Jun. 2017, doi: 10.1007/s11257-017-9191-4
5. H. Agopyan, J. Griffet, C. Ginon, M. Bruno, J. Bredin, "Personalized and parametrized AVATAR for interacting with post-stroke action-perception loop during rehabilitation", *Neurophysiologie Clinique/Clinical Neurophysiology*, vol. 46, no. 4-5, p. 240, Nov. 2016, doi: 10.1016/j.neucli.2016.09.011
6. G. Alankus, R. Proffitt, C. Kelleher, J. Engsberg, "Stroke therapy through motion-based games: a case study", *ACM Transactions on Accessible Computing (TACCESS)*, 2011, vol 4, no.1, pp. 1–35. doi: 10.1145/2039339.2039342.
7. A. Alexiou, M. C. Schippers, I. Oshri, S. Angelopoulos, "Narrative and aesthetics as antecedents of perceived learning in serious games", *Information Technology & People*, vol. 35, no. 8, pp. 142-161, 2020, doi: 10.1108/ITP-08-2019-04352020
8. A. Allaa, K. Nafila, "Gamification in IoT Application: A Systematic Mapping Study", in *10th International Conference on Ambient Systems, Networks and Technologies (ANT)*, Apr. 2019, pp. 455-462, doi: 10.1016/j.procs.2019.04.062
9. A. Allam, Z. Kostova, K. Nakamoto, P. Johannes Schulz, "The effect of social support features and gamification on a Web-based intervention for rheumatoid arthritis patients: randomized controlled trial", *Journal of medical Internet research*, vol. 17, no. 1, p. e3510, 2015, doi: 10.2196/jmir.3510
10. F. E. Allen. "Disneyland Uses ‚Electronic Whip' on Employees". Forbes. Available: https://www.forbes.com/sites/frederickallen/2011/10/21/disneyland-uses-electronic-whip-on-employees/#77487d1151b3 (Accessed: May-12-2022).
11. Altifarm Enverde. "Pico – Plant Parenting Made Simple". Altifarm Enverde. Available: https://altifarm.com/pico/ (Accessed: Dec-27-2021).
12. M. Altmeyer, "Understanding Personal and Contextual Factors to Increase Motivation in Gamified Systems", Ph.D. dissertation, Saarland University, 2021. Available file:///C:/Users/marei/Downloads/dissertation_sulb_final.pdf (Accessed: Aug-09-2022).
13. M. Altmeyer, D. Degraen, T. Sander, F. Kosmalla, A. Krüger, "Does Physicality Enhance the Meaningfulness of Gamification? Transforming Gamification Elements to their Physical Counterparts", in *Proceedings of the Australian Conference on Human-Computer Interaction (OzCHI-2021)*, Jan. 2021
14. M. Altmeyer, P. Lessel, S. Jantwal, L. Muller, F. Daiber, A. Krüger, A., "Potential and effects of personalizing gameful fitness applications using behavior change intentions and Hexad user types", in *User Modeling and User-Adapted Interaction*, vol. 31, no. 4, pp. 675-712, 2021
15. M. Altmeyer, M. Schubhan, A. Krüger, A., P. Lessel, "A long-term investigation on the effects of (personalized) gamification on course participation in a gym", in *Proceedings of the 5th International GamiFIN Conference*, Apr. 2021, pp. 60-69.
16. M. Altmeyer, G. F. Tondello, A. Krüger, L. E. Nacke, "Hexarcade: Predicting hexad user types by using gameful applications" in *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Nov. 2020, pp. 219-230, doi: 10.1145/3410404.3414232.
17. Amazon. "Alexa". Amazon. Available: https://www.amazon.de/gp/browse.html?node=14100226031 (Accessed: Jun-06-2022).
18. American Psychological Association. "brain plasticity". APA Dictionary of Psychology. Available: https://dictionary.apa.org/brain-plasticity (Accessed: Mar-27-2022).
19. American Psychological Association. "cognitive rehabilitation". APA Dictionary of Psychology. Available: https://dictionary.apa.org/cognitive-rehabilitation (Accessed: Oct-27-2021).
20. American Psychological Association. "divided attention". APA Dictionary of Psychology. Available: https://dictionary.apa.org/divided-attention (Accessed: Oct-27-2021).
21. American Psychological Association. "extrinsic motivation". APA Dictionary of Psychology. Available: https://dictionary.apa.org/extrinsic-motivation (Accessed: Nov-05-2021).
22. American Psychological Association. "intrinsic motivation". APA Dictionary of Psychology. Available: https://dictionary.apa.org/intrinsic-motivation (Accessed: Nov-05-2021).
23. American Psychological Association. "verbal memory". APA Dictionary of Psychology. Available: https://dictionary.apa.org/verbal-memory (Accessed: Oct-27-2021).
24. J. A. Anguera, J. Boccanfuso, J. L. Rintoul, O. Al-Hashimi, F. Faraji, J. Janowich, E. Kong, Y. Larraburo, C. Rolle, E. Johnston, A. Gazzaley, "Video game training enhances cognitive control in older adults", *Nature*, vol- 501, no. 7465, pp. 97-101, Sept. 2013, doi: 10.1038/nature12486
25. Apache Friends. "XAMPP Apache + MariaDB + PHP + Perl". Apache Friends. Available: https://www.apachefriends.org/de/index.html (Accessed: Apr-09-2022)
26. D. Bakker, N. Rickard, "Engagement with a cognitive behavioural therapy mobile phone app predicts changes in mental health and wellbeing: MoodMission", *Australian Psychologist*, vol. 54, no. 4, pp. 245-260, 2019, doi: 10.1111/ap.12383
27. M. Bannert, W Schnotz, "Vorstellungsbilder und Imagery-Strategien" in *Handbuch Lernstrategien*, H. Mandl, H. F. Friedrich, Hogrefe, 2006, pp. 72.
28. T. Baranowski, R. Buday, D. I. Thompson, J. Baranowski, "Playing for real: vi-

deo games and stories for health-related behavior change", *American journal of preventive medicine*, vol. 34, no. 1, pp. 74-82, Jan. 2008, doi: 10.1016/j.amepre.2007.09.027

29. G. Barata, S. Gama, J. Jorge, D. Gonçalves, "Gamification for smarter learning: tales from the trenches", *Smart Learning Environments*, vol. 2, no. 1, pp. 1-23,May 2015, doi: 10.1186/s40561-015-0017-8
30. G. Barata, S. Gama, J. Jorge, D. Gonçalves, "Early prediction of student profiles based on performance and gaming preferences", *IEEE Transactions on Learning Technologies*, vol. 9, no. 3, pp. 272-284, July-Sept. 2016, doi: 10.1109/TLT.2016.2541664.
31. J. E. Bardram, "Pervasive Healthcare as a Scientific Discipline", *Methods of Information in Medicine*, vol. 47, no. 3, pp. 178-85, 2008, doi: 10.3414/ME9107
32. N. Barrett, I. Swain, C. Gatzidis, C. Mecheraoui, C., "The use and effect of video game design theory in the creation of game-based systems for upper limb stroke rehabilitation", *Journal of Rehabilitation and Assistive Technologies Engineering*, vol. 3, May 2016, doi: 10.1177/2055668316643644
33. R. Bartle, *Designing Virtual Worlds*. Indianapolis, IN, USA: New Riders Publishing, 2003.
34. R. Bartle, "Hearts, clubs, diamonds, spades: Players who suit MUDs", *Journal of MUD research*, vol. 1, no. 1, p. 19, 1996
35. A. L. Baylor, PALS (Pedagogical Agent Learning Systems) Research Group, "The impact of three pedagogical agent roles", in *Proceedings of the second international joint conference on Autonomous agents and multiagent systems (AAMAS ,03)*, Jul. 2003, pp. 928–929, doi: 10.1145/860575.860729.
36. H. Beck, C. Meyer zu Reckendorf, S. Anastasiadou, *Faszinierendes Gehirn: Eine bebilderte Reise in die Welt der Nervenzellen*. Berlin Heidelberg. Germany: Springer, 2015, p.2
37. H. Beck, C. Meyer zu Reckendorf, S. Anastasiadou, "*Faszinierendes Gehirn: Eine bebilderte Reise in die Welt der Nervenzellen*, Berlin Heidelberg. Germany: Springer, 2015, p.11
38. H. Beck, C. Meyer zu Reckendorf, S. Anastasiadou, *Faszinierendes Gehirn: Eine bebilderte Reise in die Welt der Nervenzellen.* Berlin Heidelberg. Germany: Springer, 2015, p.34-36
39. G. Beenen, K. Ling, X.Wang, K. Chang, D. Frankowski, P. Resnick, R. E. Kraut, "Using social psychology to motivate contributions to online communities", in *Proceedings of the 2004 ACM conference on Computer supported cooperative work*, vol. 10. no. 4, pp. 212–221, 2004, doi: 10.1145/1031607.1031642.
40. J. Bennett, O. Rokas, L. Chen, "Healthcare in the smart home: A study of past, present and future", *Sustainability*, vol. 9, no. 5, p. 840, May 2017, doi: 10.3390/su9050840.
41. M. V. Birk, M. A.Friehs, R. L. Mandryk, "Age-based preferences and player experience: a crowdsourced cross-sectional study", in *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Oct. 2017, pp. 157-170, doi: 10.1145/3116595.3116608.
42. D. Z. Blandón, J. E. Muñoz, D. S. Lopez and O. H. Gallo, „Influence of a BCI neurofeedback videogame in children with ADHD. Quantifying the brain activity through an EEG signal processing dedicated toolbox," in *Proceedings of 2016 IEEE 11th Colombian Computing Conference (CCC)*, 2016, pp. 1-8, doi: 10.1109/ColumbianCC.2016.7750788.
43. M. Böckle, J. Novak, M. Bick, "Towards adaptive gamification: a synthesis of current developments" in *Proceedings of the 25th European Conference on Information Systems (ECIS),* Jun. 2017.
44. W.J. Boendermaker, M. Boffo, R. W. Wiers, "Exploring elements of fun to motivate youth to do cognitive bias modification", *Games for Health Journal*, vol. 4, no. 6, pp. 434–443, Sep. 2015, doi: 10.1089/g4h.2015.0053
45. W.J. Boendermaker, T. E. Gladwin, M. Peeters, P. J. Prins, R. Wiers, "Training working memory in adolescents using serious game elements: pilot randomized controlled trial", *JMIR serious games*, vol. 6, no. 2, p. e8364, May. 2018, doi: 10.2196/games.8364
46. W. J. Boendermaker, S. S. Maceiras, M. Boffo, R. W., "Attentional bias modification with serious game elements: evaluating the shots game", *JMIR serious games*, vol. 4, no. 2, Dec. 2016, doi: 10.2196/games.6464
47. W. J. Boendermaker, P. Prins, R. Reinout, "Cognitive Bias Modification for Adolescents with Substance Use Problems – Can Serious Games Help?", *Journal of Behavior Therapy and Experimental Psychiatry*, p.228, Mar. 2015, doi: 10.1016/j.jbtep.2015.03.008
48. Y. Bogdanova, M. K. Yee, V. T. Ho, K. D. Cicerone, "Computerized cognitive rehabilitation of attention and executive function in acquired brain injury: a systematic review", *The Journal of head trauma rehabilitation*, vol. 31, no. 6, p. 419, 2016, doi: 10.1097/HTR.0000000000000203
49. B. Bostan, T. Marsh, "Fundamentals of interactive storytelling", *AJIT-e Online Academic Journal of Information Technology*, vol 3, no. 8, p.19, 2012
50. E. Bouquet, V. Mäkelä, A. Schmidt, "Exploring the Design of Companions in Video Games", in *Academic Mindtrek*, 2021, pp. 145-153, doi: 10.1145/3464327.3464371.
51. A. Boyd. "iPhone X and Apple Watch Series 3 Mockup". Anthony Boyd Graphics. Available: https://www.anthonyboyd.graphics/mockups/iphone-x-and-apple-watch-series-3-mockup/ (Accessed: Nov-22-2021).
52. Brainer. " Fisioterapia per la mente". Brainer. Available: https://www.brainer.it/ (Accessed: May-12-2022).
53. Brain Train. "Captain's Log MindPower Builder". Brain Train. Available: https://www.braintrain.com/captains-log-mindpower-builder/ (Accessed: May-12-2022).
54. P. Bräuer, A. Mazarakis, "Badges or a leaderboard? How to gamify an augmented reality warehouse setting" in *Proceedings of the 3rd International GamiFIN Conference*, 2019, pp. 229–240.
55. P. Bräuer, A. Mazarakis ""Alexa, can we design gamification without a screen?"-Implementing cooperative and competitive audio-gamification for intelligent virtual assistants", *Computers in Human Behavior,* vol. 135, 2022, doi: 10.1016/j.chb.2022.107362
56. M. Brown, N. O'Neill, H. van Woerden, P. Eslambolchilar, M. Jones, A. John, "Gamification and Adherence to Web-Based Mental Health Interventions: A Systematic Review", *JMIR Mental Health*, vol. 3, no.3, Aug. 2016, doi: 10.2196/mental.5710
57. M. Brumana, L. Cassia, D. Gamba, T. Minola, "Perception Gaps in International Corporate Entrepreneurship: The Role of Knowledge Transfer Tools", *Industry 4.0,* pp.

315-332, 2017, doi: 10.1007/978-3-319-49604-7_16

58. Bundesministerium für Gesundheit. "E-Health". Bundesministerium für Gesundheit. Available: https://www.bundesgesundheitsministerium.de/service/begriffe-von-a-z/e/e-health.html (Accessed: Oct-15-2021).

59. C. Burgers, A. Eden, M. D. van Engelenburg, S. Buningh, "How feedback boosts motivation and play in a brain-training game", *Computers in Human Behavior*, vol. 48, pp. 94-103, 2015, doi: 10.1016/j.chb.2015.01.038

60. J. W. Burke, M. D. J. McNeill,D. K. Charles, P. J. Morrow, J. H. Crosbie, S. M. McDonough, "Optimising engagement for stroke rehabilitation using serious games", *The Visual Computer*, vol. 25, no. 12, pp. 1085-1099, 2009

61. J. W. Burke, M. D. J. McNeill,D. K. Charles, P. J. Morrow, J. H. Crosbie, S. M. McDonough, "Serious Games for upper limb Rehabilitation following Stroke", in *2009 Conference in Games and Virtual Worlds for Serious Applications*, 2009, pp. 103-110, doi: 10.1109/VS-GAMES.2009.17.

62. Y. Caliskan, R. Entezari, M. Eßer, U. Ezold, D. Gelfart, H. Mariami, L. Beutelspacher, „Spielend heilen: Ein systematisches Review zum Einsatz von Gamification in Therapie und Rehabilitation", *Information - Wissenschaft & Praxis*, vol. 69, no. 1, pp. 47-54, 2018, doi:10.1515/iwp-2018-0001

63. D. Calvaresi,J. P. Calbimonte, "Real-time compliant stream processing agents for physical rehabilitation", *Sensors,* vol. 20, no. 3, p. 746, Jan. 2020, doi: 10.3390/s20030746

64. G. Calzolari, M. Nardotto, "Effective Reminders", Management Science, vol. 63, no. 9, pp. 2915-2932, 2016, doi: 10.1287/mnsc.2016.2499

65. L. P. Carlstrom, E. F. M. Wijdicks, "Traumatic Brain Injury" in *Mayo Clinic Neurology Board Review,* Mayo Clinic Scientific Press, 2021, pp. 489-500, doi: 10.1093/med/9780197512166.003.0060.

66. S. Cham, A. Algashami, J. McAlaney, A. Stefanidis, K. Phalp, R. Ali, "Goal setting for persuasive information systems: five reference checklists" in *International Conference on Persuasive Technology*, Apr. 2019, pp. 237-253, doi: 10.1007/978-3-030-17287-9_20.

67. V. Chan, B. Zagorski, D. Parsons, A.Colantonio. "Older adults with acquired brain injury: a population based study". *BMC Geriatrics*, vol. 13, no. 97, 2013, doi: 10.1186/1471-2318-13-97

68. P. Chandrashekar, "Do mental health mobile apps work: evidence and recommendations for designing high-efficacy mental health mobile apps" *Mhealth*, vol. 4, no. 6, Mar. 2018, doi: 10.21037/mhealth.2018.03.02.

69. F. Charles, M. Lozano, S. Mead, A. F. Bisquerra, M. Cavazza, "Planning formalisms and authoring in interactive storytelling", in *Proceedings of Technologies for interactive digital storytelling and entertainment (TIDSE)*, Jan. 2003.

70. Y. Chen, P. Pu, "HealthyTogether: exploring social incentives for mobile fitness applications", in *Proceedings of the second international symposium of chinese chi (Chinese CHI),* 2014, pp. 25-34, doi: 10.1145/2592235.2592240.

71. A. D. Cheok, R. T. Kok, C. Tan, O. N. Newton Fernando, T. Merritt, J. Y. P. Sen, "Empathetic living media", in *Proceedings of the 7th ACM conference on Designing interactive systems (DIS),* Feb. 2008, pp. 465-473, doi: 10.1145/1394445.1394495.

72. G. Chevance, N. Heraud, A. Varray, J.Boiché, "Change in Explicit and Implicit Motivation Toward Physical Activity and Sedentary Behavior in Pulmonary Rehabilitation and Associations With Postrehabilitation Behaviors", *Rehabilitation Psychology*, vol. 62, no. 2, 2017, doi: 10.1037/rep0000137

73. Y.-K. Chou, "The Octalysis Framework for Gamification & Behavioral Design". Gamification & Behavioral Design. Available: https://yukaichou.com/gamification-examples/octalysis-complete-gamification-framework/ (Accessed: May-09-2022).

74. K. J. Ciuffreda, N. Kapoor, "Acquired Brain injury", in *Visual Diagnosis and Care of the Patient with Special Needs*, M. B. Taub, M. Bartuccio, D. M. Maino, Wolters Kluwer Health, 2012, pp. 95 - 100

75. D. Clement, "The transtheoretical model: An exploratory look at its applicability to injury rehabilitation", *Journal of Sport Rehabilitation*, vol. 17, no. 3, pp. 269-282, 2008, doi: 10.1123/jsr.17.3.269

76. Cogmed. "Cogmed". Cogmed. Available: https://app.cogmed.com/ (Accessed: May-09-2022).

77. CogniFit. "CogniFit". CogniFit. Available: https://www.cognifit.com/de (Accessed: May-12-2022).

78. J. E. Colman, "Multi-player online video games for cognitive rehabilitation for the brain injured", Ph.D. dissertation, University of Portsmouth, Sep. 2016. Available: https://pure.port.ac.uk/ws/portalfiles/portal/7077937/jcolman_thesis_final.pdf (Accessed: Jun-28-2022).

79. L. Colzato, B. Hommel, Bernhard, "The Future of Cognitive Training", in *Cognitive Training*, T. Strobach, J, Karbach, J., 2016, doi: 10.1007/978-3-319-42662-4_19

80. V. T. Cruz, J. Pais, V. Bento, C. Mateus, M. Colunas, I. Alves, P. Coutinho, N. P. Rocha, "A Rehabilitation Tool Designed for Intensive Web-Based Cognitive Training: Description and Usability Study", *JMIR research protocols.*, vol. 2, no. 2, p. e59, 2013, doi: 10.2196/resprot.2899

81. M. Csikszentmihalyi, *Flow*. Harper Collins Publ. USA, 2008.

82. B. Cugelman, "Gamification: what it is and why it matters to digital health behavior change developers", *JMIR Serious Games*, vol. 1, no. 1, p. e3139, Dec. 2013, doi: 10.2196/games.3139

83. A. Darzi, T. Wondra, S. McCrea, D. Novak, "Classification of multiple psychological dimensions in computer game players using physiology, performance, and personality characteristics", *Frontiers in neuroscience*, p. 1278, Nov.2019, doi: 10.3389/fnins.2019.01278

84. N. O. Davis, J. Bower, S. H. Kollins, "Proof-of-concept study of an at-home, engaging, digital intervention for pediatric ADHD", *PloS one*, vol. 13, no. 1, p. e0189749, Jan. 2018, doi: 10.1371/journal.pone.0189749

85. D. Day. "Exercise Without Failure: Building Fitness Apps As Narrative Games". Model View Culture. Available: https://modelviewculture.com/pieces/exercise-without-failure-building-fitness-apps-as-narrative-games (Accessed: May-11-2022).

86. M. de Castro-Cros, M. Sebastian-Romagosa, J. Rodríguez-Serrano, E. Opisso, M.Ochoa, R. Ortner, C. Guger, D.Tost, "Effects of gamification in BCI functional rehabilitation", *Frontiers in neuroscience*, vol. 14p, 882, Aug. 2020, doi: 10.3389/fnins.2020.00882

87. E. Deci, R. Koestner, R. Ryan, "Extrinsic rewards and intrinsic motivations in educa-

tion: Reconsidered once again", *Review of Educational Research*, vol. 71, no. 1, pp. 1-27, Mar. 2001, doi: 10.3102/00346543071001001

88. E. Deci, R. Ryan, Intrinsic motivation and self-determination in human behavior, New York: Springer US, 1985.

89. E. Deci, R. Ryan, *Handbook of Self-Determination Research*. Rochester, NY: University of Rochester Press: 2014, nach S. Nicholson, "A recipe for meaningful gamification" in *Gamification in education and business*, 2015, pp. 1-20.

90. E. Deci, M. Vansteenkiste, ""Self-determination theory and basic need satisfaction: Understanding human development in positive psychology", *Ricerche di Psicologia*, vol. 27, no. 1, pp. 23-40, 2004

91. D. Degraen, F. Kosmalla, A. Krüger, A., "Overgrown: Supporting plant growth with an endoskeleton for ambient notifications", in *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems (CHI)*, May 2019, pp. 1-6, doi: 10.1145/3290607.3312833.

92. D. Degraen, M. Schubhan, M. Altmeyer, M., A. Krüger, "Hakoniwa: Enhancing Physical Gamification using Miniature Garden Elements" in *Academic Mindtrek*, 2021, pp. 117-127, doi: 10.1145/3464327.3464362

93. D. Degraen, M. Schubhan, K. Mushkina, A. Makhsadov, F. Kosmalla, A.Zenner, A. Krüger, "AmbiPlant - Ambient Feedback for Digital Media through Actuated Plants", in *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (CHI EA-2020),* 2020, pp. 1-9, doi: 10.1145/3334480.3382860.

94. T. de la Hera Conde-Pumpido, "Persuasive gaming: Identifying the different types of persuasion through games", *International Journal of Serious Games*, vol. 4, no. 1, pp. 31–39, 2017, doi: 10.17083/ijsg.v4i1.140

95. T. A. Dennis, L. O'Toole, "Mental Health on the Go: Effects of a Gamified Attention Bias Modification Mobile Application in Trait Anxious Adults", *Clinical psychological science: a journal of the Association for Psychological Science*, vol. 2, no. 5, pp. 576 - 590, 2014, doi: 10.1177/2167702614522228

96. Desire2Learn (D2L). "Gamification Guide". Desire2Learn (D2L). Available: https://www.d2l.com/resources/assets/gamification-guide/ (Accessed: Mar-03-2021).

97. S. Deterding, R. Khaled, L. E. Nacke, D. Dixon, "Gamification: Toward a definition", in *Conference on Human Factors in Computing Systems gamification workshop proceedings (CHI)*, 2011, vol. 12, pp. 12-15.

98. Deutsche Rentenversicherung. "Leitlinie zur sozialmedizinischen Beurteilung bei neurologischen Krankheiten". Deutsche Rentenversicherung. Available: https://www.deutsche-rentenversicherung.de/SharedDocs/Downloads/DE/Experten/infos_fuer_aerzte/begutachtung/leitlinie_sozialmed_beurteilung_neurologie.html (Accessed: May-09-2022).

99. Deutsche Rentenversicherung. "Reha-Bericht 2019". Deutsche Rentenversicherung. Available: https://www.deutsche-rentenversicherung.de/SharedDocs/Downloads/DE/Statistiken-und-Berichte/Berichte/rehabericht_2019.html (Accessed: Nov-02-2021).

100. A. W. De Vries, J. H. Van Dieën, V. Van Den Abeele, S. M. P. Verschueren, "Understanding motivations and player experiences of older adults in virtual reality training", *Games for health journal*, vol. 7, no. 6, pp. 369–376, Oct. 2018, doi. 10.1089/g4h.2018.0008

101. E. De Wit-de Vries, W. A. Dolfsma, H. J. van der Windt, M. P Gerkema, "Knowledge transfer in university–industry research partnerships: a review", *The Journal of Technology Transfer,* vol. 44, no. 4, pp. 1236–1255, 2019, doi: 10.1007/s10961-018-9660-x

102. B. Dicianno, B. Parmanto, A. Fairman, T. Crytzer, D. Yu, G. Pramana, D. Coughenour, A. Petrazzi, "Perspectives on the Evolution of Mobile (mHealth) Technologies and Application to Rehabilitation", *Physical therapy*, vol. 95, no.3, pp. 397-405, 2014, doi: 10.2522/ptj.20130534

103. K. Dobosz, M. Dobosz, T. Fiolka, M. Wojaczek, T. Depta, "Tablets in the rehabilitation of memory impairment", in *International Conference on Computers for Handicapped Persons*, Jul. 2014, pp. 399-402, doi: 10.1007/978-3-319-08596-8_61.

104. K. Dobosz, M. Dobosz M. Wojaczek, "Gamification of Cognitive Rehabilitation", in *Proceedings of Computers Helping People with Special Needs (ICCHP)*, Jul. 2018, pp. 280-283, doi: 10.1007/978-3-319-94277-3_44.

105. K. Dobosz, M. Wojaczek, M.D obosz, A. Drzastwa, "Rehabilitation of cognitive impairment with the RehaMob", *Journal of Medical Informatics & Technologies*, vol. 24, pp. 239–245, 2015

106. A. R. Dores, A. Geraldo, H. Martins, H. "The role of gamification in neurocognitive rehabilitation." in *Handbook of research on solving modern healthcare challenges with gamification*, Medical Information Science Reference, 2021, pp. 80-99.

107. S. Dörrenbächer, P. M. Müller, J. Tröger, J. Kray, "Dissociable effects of game elements on motivation and cognition in a task-switching training in middle childhood", *Frontiers in psychology*, vol. 5, p. 1275, Nov. 2014, doi: 10.3389/fpsyg.2014.01275

108. Dorsch - Lexikon der Psychologie, "Erwartung-Wert-Theorien", Dorsch - Lexikon der Psychologie. Available: https://dorsch.hogrefe.com/stichwort/erwartung-wert-theorien (Accessed: May-09-2022).

109. Dorsch - Lexikon der Psychologie, "health belief model", Dorsch - Lexikon der Psychologie. Available: https://dorsch.hogrefe.com/stichwort/health-belief-model#search=6e0aa6deb3f20ddff14c5e74b08ec792&offset=0 (Accessed: Feb-02-2021).

110. Dorsch - Lexikon der Psychologie, "Korrumpierungseffekt", Dorsch - Lexikon der Psychologie. Available: https://dorsch.hogrefe.com/stichwort/korrumpierungseffekt#search=a1716c2bde4e9ddf41049786d103ce10&offset=0 (Accessed: Nov-05-2021).

111. Dorsch - Lexikon der Psychologie, "Motiv", Dorsch - Lexikon der Psychologie. Available: https://dorsch.hogrefe.com/stichwort/motiv (Accessed: May-09-2022).

112. L. A. Dwyer, M. J. Hornsey, L. G. Smith, T. P. Oei, G. A. Dingle, "Participant autonomy in cognitive behavioral group therapy: An integration of self-determination and cognitive behavioral theories", *Journal of Social and Clinical Psychology*, vol. 30, no. 1, pp. 24-46, 2011, doi: 10.1521/jscp.2011.30.1.24

113. Elevate Labs. "Elevate". Elevate. Available: https://elevateapp.com/ (Accessed: May-12-2022).

114. K. Emmerich, P. Ring, M. Masuch, "I'm Glad You Are on My Side: How to Design Compelling Game Companions", in *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Oct. 2018, pp. 141-152, doi: 10.1145/3242671.3242709.

115. EndeavorRx. “The only doctor prescribed video game treatment for kids with ADHD”. EndeavorRx.Available: https://www.endeavorrx.com/ (Accessed: May-11-2022).

116. A. Endler, M. Gabele, T. Heidel, S. Husslein, C. Hansen, “To go: Gameful Extension for Cognitive Rehabilitation Software”, in *Book of Proceedings: IEEE Engineering in Medicine & Biology ISC 2019*, 2019, p.43. Available: http://dx.doi.org/10.25673/31720.

117. S. Engl, “Mobile gaming - Eine empirische Studie zum Spielverhalten und Nutzungserlebnis in mobilen Kontexten”, Magister thesis, Universität Regensburg, 2010.

118. M. Erez, “Feedback: A necessary condition for the goal setting performance relationship”, *Journal of Applied psychology*, vol 62, no. 5, pp. 624-627, 1977, doi: 10.1037/0021-9010.62.5.624.

119. K. S. Erler, V. Sullivan, S. Mckinnon, R. Inzana, “Social support as a predictor of community participation after stroke”, *Frontiers in Neurology*, vol. 10, p. 1013, Sept. 2019, doi: 10.3389/fneur.2019.01013

120. G. Eysenbach, “The law of attrition”, *Journal of medical Internet research*, vol. 7, no.1, Mar 2005, doi: 10.2196/jmir.7.1.e11

121. A. L. Faria, A. Andrade, L. Soares, “Benefits of virtual reality based cognitive rehabilitation through simulated activities of daily living: a randomized controlled trial with stroke patients”, *Journal of neuroengineering and rehabilitation*, vol. 13, no. 1, pp. 1-12, 2016, doi: 10.1186/s12984-016-0204-z

122. E. Fernandez, J. A. Bergado Rosado, D. Rodriguez Perez, S. Salazar Santana, M. Torres Aguilar, M. L. Bringas, “Effectiveness of a Computer-Based Training Program of Attention and Memory in Patients with Acquired Brain Damage”, *Behavioral sciences*, vol. 8. no. 4, 2017, doi: 10.3390/bs8010004

123. F. Ferreira-Brito, M. Fialho, A. Virgolino, I. Neves,A. C. Miranda, N. Sousa-Santos, C. Caneiras, L. Carriço, A. Verdelho, O. Santos, “Game-based interventions for neuropsychological assessment, training and rehabilitation: Which game-elements to use? A systematic review”. *Journal of biomedical informatics*, vol. 98, Oct. 2019, doi: 10.1016/j.jbi.2019.103287

124. V. T. Fischer, M. A. C. Steinbrügge, D. Thiemke, “Gamification Guidance: Eine interaktive Website-basierte Methode zur Erleichterung der Verfügbarkeit wissenschaftlicher Erkenntnisse zu Taylored Gamification”, Team Project, Faculty of Computer Science, Otto von Guericke University, Magdeburg, Germany, 2021.

125. G.G. Fluet, Q. Qiu, J. Patel, A. Cronce, A S Merians, S. V. Adamovich, “Autonomous use of the home virtual rehabilitation system: A feasibility and pilot study”, *Games for health journal,* vol. 8, no. 6, pp. 432–438, Dec. 2019, doi: 10.1089/g4h.2019.0012.

126. For the Win. “For the Win: Serious Gamification”. For the Win. Available: http://gamifyforthewin.com (Accessed: Mar-27-2021).

127. S. Fraser, L. Bherer, “Age-related decline in divided-attention: from theoretical lab research to practical real-life situations”, *WIREs Cognitive Science*, vol. 4, no. 6, pp. 623-640. Sept. 2013, doi: 10.1002/wcs.1252

128. Fresh Minder. “Fresh Minder”. Fresh Minder. Available: https://freshminder.de/#Produkte (Accessed: May-12-2021).

129. M. Gabele, „Vorwärts kommt von innen - Elemente zur Förderung des Einsatzes der Therapie von Schlaganfallpatienten mit kognitiven Einschränkungen“, Masterthesis, Hochschule Magdeburg-Stendal, Magdeburg, Germany, 2017.

130. M. Gabele and V. T. Fischer, M. Steinbrügge, D. Thiemke, S. Hußlein, C. Hansen, „Potentials of a Web-based Gamification Guide for Knowledge Transfer between Research and Industry“, in *Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Austria (Virtual Event), Oct. 2021, pp. 301-307, doi: 10.1145/3450337.3483458.

131. M. Gabele, A. Thoms, J. Alpers, S. Husslein, C. Hansen, C., „Effects of Interactive Storytelling and Quests in Cognitive Rehabilitation for Adults“, in *Proceedings of the 3rd International GamiFIN Conference*, 2019, pp. 118-129.

132. M. Gabele, A. Thoms, J. Alpers, S.Hußlein, C. Hansen, “Non-player character as a companion in cognitive rehabilitation for adults - Characteristics and representation”, in *Proceedings of the 3rd International GamiFIN Conference*, 2019, pp. 130–141.

133. M. Gabele, A. Thoms, S. Husslein, C. Hansen, “Strategies:Include Cognitive Rehabilitation Training in Daily Life”, in *Book of Proceedings: IEEE Engineering in Medicine & Biology ISC 2019*, 2019, p.22. Available: http://dx.doi.org/10.25673/31720.

134. M. Gabele, A. Thoms, S. Schroeer, S. Husslein, C. Hansen, „Effects and Combination of Tailored Browser-Based and Mobile Cognitive Software Training“ in *Proceedings of International Conference on Multimedia Modeling (MMM)*, Quy Nhon, Vietnam, Springer Nature, Jun. 2022, pp. 279–291. The final authenticated version is available online at https://doi.org/10.1007/978-3-030-98355-0_24 / reproduced with permission from SNCSC.

135. M. Gabele, A. Thoms, D. Schumacher, S. Husslein, C. Hansen, “Light as a Long-term Visualization Method of the Training Status for Patients in Hometraining in Rehabilitation” in *International Conference on Interfaces and Human Computer Interaction (IHCI),* Jul. 2019, pp.313-316.

136. M. Gabele, J. Weicker, S. Wagner, A. Thoms, S. Husslein, C. Hansen, “Effects and Ways of Tailored Gamification in Software-Based Training in Cognitive Rehabilitation” in *Proceedings of the 29th ACM Conference on User Modeling, Adaptation and Personalization (UMAP)*, Jun. 2021, pp. 158-168, doi: 10.1145/3450613.3456828.

137. S. Gabrielli, R. Maimone, L. Pannese, B. Giancarlo, M. Pompa, “Designing Meaningful Game Experiences for Rehabilitation and Sustainable Mobility Settings”, *EAI Endorsed Transactions on Ambient Systems*, vol. 1, no. 3, Mar. 2014, doi: 10.4108/amsys.1.3.e3

138. S. Gago, N. A. Benjamin, D. J. Reinkensmeyer, I. Irvine, "A Virtual Agent to Provide Feedback and Motivate Patients During Rehabilitation Training of the Hand", in *Medicine 2.0 Conference*, 2014.

139. Gamification Co."Gamification Co". Gamification Co. Available: https://www.gamification.co/ (Accessed: Mar-27-2021).

140. Gamification Research Network. “Gamification Research Network”. Gamification Research Network. Available: http://gamification-research.org/ (Accessed: Mar-27-2021).

141. J. A. García-Casal., A. Loizeau, E. Csipke, M. Franco-Martín, M. V. Perea-Bartolomé, M. Orrell, “Computer-based cognitive interventions for people living with dementia: a systematic literature review and meta-analysis”, *Aging & mental health*, vol. 21, no. 5, pp. 454-467, 2017, doi: 10.1080/13607863.2015.1132677

142. J.E. Garrido, V.M.R. Penichet, M. D. Lozan, “Improving Context-Awareness in Healthcare Through Distributed Interactions”, in *International Conference on Web Engineering*, Jun. 2016, pp. 162-166, doi: 10.1007/978-3-319-46963-8_14

143. S. Ge, Z. Zhu, B. Wu, E. S. McConnell, "Technology-based cognitive training and rehabilitation interventions for individuals with mild cognitive impairment: a systematic review", *BMC geriatrics*, vol. 18, no. 1, pp. 1-19, 2018, doi: 10.1186/s12877-018-0893-1

144. C. Gellner, I. Buchem, „Narratives in Gamification: Considerations for Support of Digital Literacy of the Elderly.", in ECEL 2021 *20th European Conference on e-Learning*, 2021, doi: 10.34190/EEL.21.042.

145. K. M. Gerling, F. Schulte, M. Masuch, "Designing and Evaluating Digital Games for Frail Elderly Persons", in *Proceedings of the 8th International Conference on Advances in Computer Enter-tainment Technology (ACE'11)*, Nov. 2011, p. 1-8, doi: 10.1145/2071423.2071501.

146. K. M. Gerling, M. Masuch, M., "Exploring the potential of gamification among frail elderly persons", in *Proceedings of the CHI 2011 workshop gamification: using game design elements in non-game contexts*, May 2011, May.

147. F. L. Giesel, M. Wetzke, C. Happle, C. M. Zechmann, S. Biedenstein. *BASICS Bildgebende Verfahren*. Urban & Fischer / Elsevier, 2019

148. T. Glass, D. Matchar, M. Belyea, J. Feussner, "Impact of Social Support on Outcome in First Stroke", *Journal of the American Heart Association*, vol. 24, pp. 64-70, 1993

149. Y. Gong, B. Wang, P. L. P. Rau, D. Huang, "What makes for successful game storytelling? A model for evaluating game-adaptability of stories in China", in *International Conference on Cross-Cultural Design*. Jul. 2018, pp. 30-45, doi: 10.1007/978-3-319-92252-2_3.

150. Google. "Die Google Nest-Familie im Vergleich". Google Store. Available: https://store.google.com/de/magazine/compare_speakers?hl=de (Accessed: Jun-06-2022).

151. Google. "Google Scholar". Google scholar. Available: https://scholar.google.de/ (Accessed: Mar-27-2021).

152. C. Groening, C. Binnewies, ""Achievement unlocked!" - The impact of digital achievements as a gamification element on motivation and performance", *Computers in Human Behavior*, vol. 97, pp. 151-166, Aug. 2019, doi: 10.1016/j.chb.2019.02.026

153. C. Guckelsberger, C. Salge and S. Colton, „Intrinsically motivated general companion NPCs via Coupled Empowerment Maximisation," in *2016 IEEE Conference on Computational Intelligence and Games (CIG)*, 2016, pp. 1-8, doi: 10.1109/CIG.2016.7860406.

154. Y. Ha, M. Karyda, A. Lucero, "Exploring virtual rewards in real life: A gimmick or a motivational tool for promoting physical activity?" in *Proceedings of the 2020 ACM Designing Interactive Systems Conference (DIS)*, Jul. 2020, pp. 1847-1858, doi: 10.1145/3357236.3395477.

155. S. Hallifax, A.Serna, J.-C. Marty, E. Lavoué, "Adaptive gamification in education: A literature review of current trends and developments", in *Transforming Learning with Meaningful Technologies: 14th European Conference on Technology Enhanced Learning*, Sept. 2019, pp. 294-307, doi: 10.1007/978-3-030-29736-7_22.

156. S. Hallifax, A.Serna, J.-C. Marty, E. Lavoué, "Dynamic gamification adaptation framework based on engagement detection through learning analytics", in *Companion Proceedings of the 11th International Conference on Learning Analytics & Knowledge LAK21*, Apr. 2021.

157. S. Hallifax, A.Serna, J.-C. Marty, G. Lavoué, E. Lavoué, "Factors to Consider for Tailored Gamification", in *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Oct. 2019, pp. 559–572, doi: 3311350.3347167

158. S. Hallifax, E. Lavoué, A. Serna, "To tailor or not to tailor gamification? An analysis of the impact of tailored game elements on learners' behaviours and motivation", in *Proceedings of International Conference on Artificial Intelligence in Education*, Jul. 2020, pp. 216-227, doi: 10.1007/978-3-030-52237-7_18

159. J. Hamari, J.Koivisto, "Why do people use gamification services?", *International Journal of Information Management*, vol. 35, no. 4, pp. 419–431, Aug. 2015, doi: 10.1016/j.ijinfomgt.2015.04.006

160. J. Hamari, J. Koivisto and H. Sarsa, „Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification.", in *2014 47th Hawaii International Conference on System Sciences*, 2014, pp. 3025-3034, doi: 10.1109/HICSS.2014.377.

161. E. R.Harrell, B. Kmetz, W. R. Boot, "Is cognitive training worth it? Exploring individuals' willingness to engage in cognitive training", *Journal of Cognitive Enhancement*, vol. 3, no. 4, pp. 405-415, 2019, doi: 10.1007/s41465-019-00129-4

162. Hasomed. "RehaCom - Cognitive Therapy". Hasomed. Available: https://hasomed.de/en/products/rehacom/ (Accessed: Jun-22-2022).

163. Hasomed. "RehaCom - Calculations". Hasomed. Available:https://hasomed.de/wp-content/uploads/hasomed-fileadmin/RehaCom/Mediathek/Handbuecher/Englisch/RehaCom_UserManual_Calculations.pdf (Accessed: Nov-02-2021).

164. Hasomed. "RehaCom - Divided Attention 2". Hasomed. Available:https://hasomed.de/wp-content/uploads/hasomed-fileadmin/RehaCom/Mediathek/Handbuecher/Englisch/RehaCom_UserManual_Divided_Attention_2.pdf (Accessed: Jul-26-2021).

165. Hasomed. "RehaCom - Logical Reasoning". Hasomed. Available:https://hasomed.de/wp-content/uploads/hasomed-fileadmin/RehaCom/Mediathek/Handbuecher/Englisch/RehaCom_UserManual_Logical_Reasoning.pdf (Accessed: Nov-12-2021).

166. Hasomed. "RehaCom - Reaction Behavior". Hasomed. Available: https://hasomed.de/wpstaging/wp-content/uploads/2019/12/REVEen.pdf. (Accessed: Dez-22-2021).

167. Hasomed. "Working Memory ". Hasomed. Available: https://hasomed.de/wp-content/uploads/hasomed-fileadmin/RehaCom/Mediathek/Handbuecher/Englisch/RehaCom_UserManual_Working_Memory.pdf (Accessed: Dec-22-2021).

168. Hasomed. "RehaComesHome für Patienten". Hasomed. Available: https://hasomed.de/rehacomeshome-patienten/. (Accessed: Jan-08-2022).

169. Hasomed. "RehaCom - Plan a Vacation". Hasomed. Available: https://hasomed.de/wp-content/uploads/2020/02/PLANen.pdf (Accessed: May-11-2022)

170. Hasomed. "Verbal Memory". Hasomed. Available https://hasomed.de/wp-content/uploads/hasomed-fileadmin/RehaCom/Mediathek/Handbuecher/Englisch/RehaCom_UserManual_Verbal_Memory.pdf (Accessed: Jul-30-2021).

171. Z. Hassani, "Telerehabilitation for Stroke Patient; Advantages and Challenges", *Journal of Vessels and Circulation*, vol. 2, no. 1, pp. 6-6, 2021

172. Headapp. "Headapp". Headapp. Available: https://www.headapp.com/en/computer-based-cognitive-rehabilitation-therapy/ (Accessed: May-11-2022).

173. R. Hervás, D. Ruiz-Carrasco, T. Mondéjar, T., J. Bravo, "Gamification mechanics for behavioral change: a systematic review and proposed taxonomy", in *Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare*, May 2017, pp. 395-404, doi: 10.1145/3154862.3154939.

174. N. Hill, L. Mowszowski, S. Naismith, V. Chadwick, M. Valenzuela, A, Lampit, "Computerized Cognitive Training in Older Adults With Mild Cognitive Impairment or Dementia: A Systematic Review and Meta-Analysis", A*merican Journal of Psychiatry*, vol. 174, no. 4, pp. 329-340, 2016, doi:10.1176/appi.ajp.2016.16030360

175. V. Hömberg, "Neurologische Rehabilitation [Neurological rehabilitation]", *Internist (Berl)*, vol. 51, no.10, pp.1246-1253, Oct. 2010, doi: 10.1007/s00108-010-2624-3

176. J. K. Hong, S. Song, J. Cho, A. Bianchi, "Better posture awareness through flower-shaped ambient avatar", in *Proceedings of the ninth international conference on tangible, embedded, and embodied interaction (TEI)*, Jan. 2015, pp. 337-340, doi: 10.1145/2677199.2680575.

177. Hopelab. "ReMission 2". Hopelab. Available: http://www.re-mission2.org/ (Accessed: Dec-01-2018).

178. T. V. How, A. S. Hwang, R. E. Green, A. Mihailidis, "Envisioning future cognitive telerehabilitation technologies: a co-design process with clinicians.", *Disability and Rehabilitation: Assistive Technology*, vol. 12, no. 3, pp. 244-261, 2017, doi: 10.3109/17483107.2015.1129457

179. Y. X. Hung, P. C. Huang, K. T. Chen, W. C. Chu, "What do stroke patients look for in game-based rehabilitation: a survey study.", *Medicine*, vol. 95, no. 11, 2016, doi: 10.17083/ijsg.v5i1.224

180. K. Huotari, J. Hamari, J., "A definition for gamification: anchoring gamification in the service marketing literature". *Electronic Markets*, vol. 27, no. 1, pp.21-31, Feb. 2017, doi: 10.1007/s12525-015-0212-z

181. E. Irazoki, L.M. Contreras-Somoza., J.M. Toribio-Guzmán, C. Jenaro-Río, H. Van der Roest, M.A. Franco-Martín, "Technologies for cognitive training and cognitive rehabilitation for people with mild cognitive impairment and dementia. A systematic review.", *Frontiers in psychology*, vol. 11, p. 648. Apr. 2020, doi: 10.3389/fpsyg.2020.00648

182. S. M. Jaeggi, M .Buschkuehl, J. Jonides, W.J. Perrig, "Improving fluid intelligence with training on working memory", in *Proceedings of the National Academy of Sciences*, Apr. 2008, pp. 6829-6833 2008, doi: 10.1073/pnas.0801268105

183. T. Jagušt, I. Botički, H.-J. So, "Examining competitive, collaborative and adaptive gamification in young learners' math learning", *Computers & education*, vol. 125, pp. 444–457, Oct. 2018, doi: 10.1016/j.compedu.2018.06.022

184. M. Jamieson, B. Cullen, M. Lennon, S. Brewster, J. Evans, J., "Designing ApplTree: usable scheduling software for people with cognitive impairments", *Disability and Rehabilitation: Assistive Technology*, vol. 17, no 3, pp.338-348, 2022, doi: 10.1080/17483107.2020.1785560

185. M. Jamieson, R. Jack, B. O'Neill, B. Cullen, M. Lennon, S. Brewster, J. Evans, "Technology to encourage meaningful activities following brain injury", *Disability and Rehabilitation: Assistive Technology*, vol. 15, no. 4, pp. 453-466, 2020, doi: 10.1080/17483107.2019.1594402

186. M. Jamieson, M., Monastra, G. Gillies, R. Manolov, B. Cullen, M. McGee-Lennon, M., S. A. Brewster, J. Evans, "The use of a smartwatch as a prompting device for people with acquired brain injury: a single case experimental design study", *Neuropsychological rehabilitation*, vol. 29, no. 4, pp. 513-533, 2019, doi: 10.1080/09602011.2017.1310658.

187. C. Jeffery, J. Al-Gharaibeh, *Writing Virtual Environments for Software Visualization.* Springer, 2014, p. 130.

188. H. Jenkins, "Game design as narrative Architecture" in *First person: new media as story, performance, and game*, Cambridge: MIT Press, 2004, pp. 118-130.

189. Y. Jia, B. Xu, Y. Karanam, S. Voida, "Personality-targeted gamification: a survey study on personality traits and motivational affordances" in *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, May 2016, pp. 2001–2013, doi: 10.1145/2858036.2858515.

190. S. Johannes, S. Hellweg, "Motivation als Grundlage für den Therapieerfolg", *neuroreha*, vol. 2, pp. 70–78, 2010, doi: 10.1055/s-0030-1254342

191. M. Johansson "Do non-player characters dream of electric sheep?", Ph.D. dissertation, Stockholms Universitet, 2013.

192. D. Johnson, S. Deterding, K.-A. Kuhn, A.Staneva, S. Stoyanov, L. Hides, "Gamification for health and wellbeing: A systematic review of the literature", *Internet interventions*, vol. 6, pp.89–106, 2016

193. D. Johnson, E. Horton, R. Mulcahy, M. Foth, M., "Gamification and serious games within the domain of domestic energy consumption: A systematic review", *Renewable and Sustainable Energy Reviews*, vol. 73, pp.249-264, Jan 2017, doi: 10.1016/j.rser.2017.01.134

194. T. Jokela, J. Ojala, T. Olsson, "A Diary Study on Combining Multiple Information Devices in Everyday Activities and Tasks", in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI)*, April 2015 Pages 3903–3912, Apr. 2015, pp. 3903-3912. doi:10.1145/2702123.2702211.

195. P. Julayanont, S.n Tangwongchai, S. Hemrungrojn, C. Tunvirachaisakul, K. Phanthumchinda, J. Hongsawat, P. Suwichanarakul, S. Thanasirorat, Z. S. Nasreddine, "The montreal cognitive assessment—basic: A screening tool for mild cognitive impairment in illiterate and low-educated elderly adults", *Journal of the American Geriatrics Society*, vol. 63, no. 12, pp. 2550–2554, Dec. 2015, doi: 10.1111/jgs.13820

196. I. Jung, J. Lee, J. Kim, C. Choi, "Ubiquitous gamification framework for stroke rehabilitation treatment based on the web service" in *Proceedings of the 4th Workshop on ICTs for improving Patients Rehabilitation Research Techniques*, Oct. 2016, pp. 117-120, doi: 10.1145/3051488.3051511.

197. A. Kampa, S. Haake, P. Burelli,."Storytelling in serious games", *Entertainment Computing and Serious Games*, pp. 521-539, Oct. 2016. doi: 10.1007/978-3-319-46152-6_19.

198. F. H. Kanfer, "Implications of a self-regulation model of therapy for treatment of addictive behaviors", *Treating addictive behaviors*, vol 13, pp. 29–47, 1986, doi: 10.1007/978-1-4613-2191-0_2

199. K. M. Kapp, L. Blair, R. Mesch, *The gamification of learning and instruction fieldbook: Ideas into practice*. John Wiley & Sons, 2013

200. M. Kaptein, B. De Ruyter, P. Markopoulos, E. Aarts, "Adaptive persuasive systems: a study of tailored persuasive text messages to reduce snacking", *ACM*

Transactions on Interactive Intelligent Systems (TiiS), vol.2, no. 2, Jun. 2012, doi: 10.1145/2209310.2209313

201. M. Kaptein, S.Duplinsky, P.Markopoulos, “Means based adaptive persuasive systems”, in *Proceedings of the SIGCHI conference on human factors in computing systems (CHI)*, May 2011, pp. 335–344, doi: 10.1145/1978942.1978990.

202. M. Kaptein, P. Markopoulos, B. de Ruyter, E, Aarts, “Can you be persuaded? individual differences in susceptibility to persuasion”, in *IFIP conference on human-computer interaction*, 2009, pp. 115–118, doi: 10.1007/978-3-642-03655-2_13

203. K. Karrer, C. Glaser, C. Clemens, C. Bruder, “Technikaffinität erfassen – der Fragebogen TA-EG”, *Der Mensch im Mittelpunkt technischer Systeme*, vol. 8, pp. 196-201, 2009

204. E. Kasten. *Einführung in die Neuropsychologie*. Reinhard-Verlag, 2007

205. B. Katz, S. Jaeggi, M. Buschkuehl, A. Stegman, P. Shah, “Differential effect of motivational features on training improvements in school-based cognitive training”, *Frontiers in human neuroscience*, vol. 8, p. 242, Apr. 2014, doi: 10.3389/fnhum.2014.00242

206. E. Kearney, S. Shellikeri, R. Martino, Y. Yunusova, “Augmented visual feedback-aided interventions for motor rehabilitation in Parkinson's disease: a systematic review”, *Disability and rehabilitation*, vol. 41, no. 9, pp. 995–1011, May 2019, doi: 10.1080/09638288.2017.1419292

207. M. Kelly, S. McDonald, Matthew H. J. Frith, “Assessment and rehabilitation of social cognition impairment after brain injury: surveying practices of clinicians”, *Brain Impairment*, vol. 18, no. 1, Feb. 2017, pp. 11–35, doi: 10.1017/BrImp.2016.34.

208. K. Kelly-Hayes, “Influence of Age and Health Behaviors on Stroke Risk: Lessons from Longitudinal Studies”, *Journal of the American Geriatrics Society*, vol. 58, no. 2, pp. 325-328, 2010, doi: 10.1111/j.1532-5415.2010.02915.x

209. A. L. Kervellec, E. Jamet, V. Dardier, S., Erhel, G. L., Maner-Idrissi, E. Michinov, “A Study of Gender Similarity Between Animated Pedagogical Agents and Young Learners”, in *International Conference on Learning and Collaboration Technologies*, Jul. 2016, pp. 510-517; doi: 10.1007/978-3-319-39483-1_46.

210. R. Khaled, P. Barr, J. Noble, R. Fischer, R. Biddle, “Fine tuning the persuasion in persuasive games”, in *International conference on persuasive technology*, 2007, pp. 36–47, doi: 10.1007/978-3-540-77006-0_5.

211. A. Khaleghi, Z. Aghaei, M. A. Mahdavi, “A Gamification Framework for Cognitive Assessment and Cognitive Training: Qualitative Study”, *JMIR Serious Games*, vol. 9, no.2, June 2021, doi: 10.2196/21900

212. C. Killikelly, Z. He, Zhimin, C. Reeder, Clare, “Improving adherence to online and mobile technologies for people with psychosis: a systematic review of new potential predictors of adherence”, *JMIR mHealth and uHealth*, vol. 5., no.7, Jul. 2017,doi: 10.2196/mhealth.7088.

213. J. Kim, E. Shin, K. Han, S. Park, J. H. Youn, G. Jin, J. Lee, “Efficacy of Smart Speaker–Based Metamemory Training in Older Adults: Case-Control Cohort Study”, *Journal of medical Internet research*., vol. 23, no. 2, p. :e20177, Feb. 2021, doi: 10.2196/20177

214. J. Kleim, and T. Jones, “Principles of experience-dependent neural plasticity: implications for rehabilitation after brain damage”, *Journal of speech, language, and hearing research*, vol. 51, no 1, pp. 225-239, 2008, doi: 10.1044/1092-4388(2008/018)

215. A. C. T. Klock, I. Gasparini, M. S. Pimenta, J. Hamari, “Tailored gamification: A review of literature”, *International Journal of Human-Computer Studies*, vol. 144, p. 102495, Dec. 2020, doi: 10.1016/j.ijhcs.2020.102495

216. M. Knauff, G. Knoblich, “Logisches Denken”, in *Allgemeine Psychologie*, J. Müsseler, M. Rieger, Springer, 2017, doi: 10.1007/978-3-642-53898-8_15

217. A. Knop, „Hometraining kognitiver Störungen mit RehaCom“, Hasomed.de, 2014. Available: https://hasomed.de/wp-content/uploads/2019/12/RehaCom-Hometraining-Anwendungsbeobachtung2014.pdf. (Accessed: May-06-2022).

218. KoCo. “KoCo - Kognitives Training am Computer”. KoCo. Available: http://koco.schacherl.info/ (Accessed: May-12-2022).

219. J. Koivisto, J. Hamari, “The rise of motivational information systems: A review of gamification research”, *International Journal of Information Management*, vol. 45, 2019, pp. 191–210, 2019, doi: 10.1016/j.ijinfomgt.2018.10.013

220. M. Kolahdoz , D.Hamedi, S. RahimiZadeh, B. Naghibi, “Telerehabilitation for Stroke Patients”, *Journal of Vessels and Circulation*, vol. 2, no. 1, pp. 11-11, 2021

221. J. Krath, L. Schürmann, H. F.O. von Korflesch, “Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning”, Computers in Human Behavior, vol. 125, 2021, doi: 10.1016/j.chb.2021.106963

222. O. Krasizkaja, M. Fox. “[sci]mmary - When science makes sense”. UX Design Awards. Available: https://ux-design-award.com/en/gewinner/sci-mmary-when-science-makes-sense (Accessed: Mar-24-2022).

223. S. Kumar, W. J. Nilsen, A. Abernethy, A. Atienza, K. Patrick, M. Pavel, W. T. Riley, A. Shar, B. Spring, D. Spruijt-Metz, D. Hedeker, V. Honavar, R. Kravitz, R. C.Lefebvre, D. C. Mohr, S. A. Murphy, C. Quinn, V. Shusterman, D. Swendeman, “Mobile health technology evaluation: the mHealth evidence workshop”, *American journal of preventive medicine*, vol. 45, no. 2, pp. 228-236, 2013, doi: 10.1016/j.amepre.2013.03.017.

224. A. Kusec, D. Velikonja, C. DeMatteo, J. E. Harris, “Motivation in rehabilitation and acquired brain injury: can theory help us understand it?”, *Disability and rehabilitation*, vol. 41, no. 19, pp. 2343–2349, 2019, doi: 10.1080/09638288.2018.1467504

225. R. N. Landers, M. B. Armstrong, A. B. Collmus, “How to use game elements to enhance learning: Applications of the theory of gamified learning”, *Serious games and edutainment applications*, pp. 457-483, 2017, doi: 10.1007/978-3-319-51645-5_21

226. P. Lankoski, S. Björk, “Gameplay Design Patterns for Believable Non-Player Characters”, in *Proceedings of DiGRA International Conference Digital Games Research Association*, Sept. 2007, pp. 416-423.

227. G. P. Latham, E. A. Locke, E. A., “Self-regulation through goal setting”, *Organizational behavior and human decision processes*, vol. 50, no.2, pp. 212-247, 1991. doi: 10.1016/0749-5978(91)90021-K

228. S. Y. J. Lau, H. Agius, “A framework and immersive serious game for mild cognitive impairment”, *Multimedia Tools and Applications*, vol. 80, no 20, pp.31183-31237, 2021, doi: 10.1007/s11042-021-11042-4

229. E. Lavoué, Q. Ju, S. Hallifax, A. Serna, “Analyzing the relationships between learners' motivation and observable engaged behaviors in a gamified learning environment”, *International Journal of Human-Computer Studies*, vol. 154, p. 102670, Oct. 2021, doi: 10.1016/j.ijhcs.2021.102670

230. A. J. Lentferink, H. K. Oldenhuis, M. de Groot, L. Polstra, H. Velthuijsen, J. E. van Gemert-Pijnen, "Key components in eHealth interventions combining self-tracking and persuasive eCoaching to promote a healthier lifestyle: a scoping review", *Journal of medical Internet research*, vol. 19, no. 8, p. e7288, 2017, doi: 10.2196/jmir.7288

231. P. Lessel, M. Altmeyer, L. V. Schmeer, A. Krüger, "„Enable or Disable Gamification?" Analyzing the Impact of Choice in a Gamified Image Tagging Task", in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI),* May 2019, pp. 1–12, doi: 10.1145/3290605.3300380.

232. J. J. Lin, L. Mamykina, S. Lindtner, G. Delajoux, H. B. Strub, "Fish'n'Steps: Encouraging physical activity with an interactive computer game", in *International conference on ubiquitous computing (UbiComp),* 2006, pp. 261–278, doi: 10.1007/11853565_16.

233. E. A. Locke, G, P, Latham, *A theory of goal setting & task performance*. Prentice-Hall, Inc, 1990.

234. C. E. Lopez, C. S. Tucker, "A quantitative method for evaluating the complexity of implementing and performing game features in physically-interactive gamified applications", *Computers in Human Behavior*, vol. 71, pp. 42-58, Jun. 2017, doi: 10.1016/j.chb.2017.01.036

235. E. Loria, S. Hallifax, M. Altmeyer, L. E. Nacke, A. Marconi, A., "Turning Users' In-Game Behaviours into Actionable Adaptive Gamification Strategies using the PEAS Framework", in Proceedings of the 55th Hawaii International Conference on System Sciences, Jan. 2022, doi: 10.24251/HICSS.2022.202.

236. M.-H Lu, W. Lin, H.-P. Yueh, "Development and Evaluation of a Cognitive Training Game for Older People: A Design-based Approach", *Frontiers in Psychology*, vol. 8, p. 1837, Oct. 2017, doi: 10.3389/fpsyg.2017.01837

237. A. Lugmayr, E. Sutinen, J. Suhonen, C. I. Sedano, H.Hlavacs, C. S. Montero, "Serious storytelling–a first definition and review", *Multimedia tools and applications*, vol. 76, no. 14, pp. 15707-15733, Jul. 2017, doi: 10.1007/s11042-016-3865-5

238. Lumos Labs. "Discover what your mind can do". Lumosity. Available: https://www.lumosity.com/en/ (Accessed: Nov-19-2021).

239. J. Lumsden, A. Skinner, A. T. Woods, N. S. Lawrence, M. Munafò, "The effects of gamelike features and test location on cognitive test performance and participant enjoyment", *PeerJ,* vol. 4, p. e2184, Jul. 2016, doi: 10.7717/peerj.2184

240. W. W. Mak, A. C. Tong, S. Y. Yip, W. W. Lui, F. H. Chio, A. T. Chan, C. C. Wong, "Efficacy and Moderation of Mobile App–Based Programs for Mindfulness-Based Training, Self-Compassion Training, and Cognitive Behavioral Psychoeducation on Mental Health: Randomized Controlled Noninferiority Trial", *JMIR Mental Health*, vol. 5, no 4, p. e60, 2018, doi: 10.2196/mental.8597

241. T. W. Malone, "Toward a Theory of Intrinsically Motivating Instruction", *Cognitive Science*, vol. 5, pp. 333–369, Oct. 1981, doi: 10.1207/s15516709cog0504_2

242. Y. B. Manavalan, V. Bulitko, "Appraisal of emotions from resources" in *Proceedings of International Conference on Interactive Digital Storytelling*, Nov. 2014, pp. 224-227, doi: 10.1007/978-3-319-12337-0_26.

243. A.Marczewski. "Considering Age and other factors in Gamification". Gamified UK. Available: https://www.gamified.uk/2018/06/20/considering-age-and-other-factors-in-gamification/ (Accessed: May-10-2022).

244. A. Marczewski, User Types. In *Even Ninja Monkeys Like to Play: Gamification, Game Thinking and Motivational Design*, London: Blurb Inc.: 2015

245. Marker Software. "Cogpack". Marker Software. Available: http://www.markersoftware.com/D/frames.htm (Accessed: May-10-2022).

246. D. Matusiewicz. "Mobile Health" Gabler Wirtschaftslexikon. Available: https://wirtschaftslexikon.gabler.de/definition/mobile-health-54125 (Accessed: May-09-2022).

247. A. Mazarakis and P. Bräuer, "Welche Gamification motiviert? Ein Experiment zu Abzeichen, Feedback, Fortschrittsanzeige und Story", in *GeNeMe'17-Gemeinschaften in Neuen Medien*, 2017, pp. 246–255.

248. A. H. Mazorodze, S. Buckley, S., "A review of knowledge transfer tools in knowledge-intensive organisations", *South African Journal of Information Management*, vol. 22, no. 1, pp. 1-6, 2020, doi: 10.4102/sajim.v22i1.1135

249. D. C. McClelland, R. Koestner, J.Weinberger, "How do self-attributed and implicit motives differ?", *Psychological review*, vol. 96, pp. 690–702, 1989, doi:10.1037/0033-295X.96.4.690

250. J. McGonigal. "We don't need no stinkin' badges: How to re-invent reality without gamification". Slideshare. Available: https://de.slideshare.net/avantgame/we-dont-need-no-stinkin-badges-how-to-reinvent-reality-without-gamification (Accessed: Jul--29-2021).

251. M. Meder, T. Plumbaum, A. Raczkowski, B. Jain, S. Albayrak, "Gamification in e-commerce: tangible vs. intangible rewards" in *Proceedings of the 22nd International Academic Mindtrek Conference*, Oct. 2018, pp. 11-19, doi: 10.1145/3275116.3275126.

252. O. Meidl, *Globales Webdesign: Anforderungen und Herausforderungen an Globale Webseiten*. Wiesbaden, Germany: Springer Fachmedien, 2014, doi: 10.1007/978-3-658-04088-8.

253. Meister Cody GmbH. "Die motivierenden Lernspiele aus der aktuellsten Lernforschung". Meister Cody. Available: https://www.meistercody.com/ (Accessed: May-11-2022).

254. D. Michael, S. Chen. *Serious Games: Games That Educate, Train, and Inform*. Thomson Course Technology, 2005.

255. C.Millar, J.Moore, T.Nutt. "Breaking down barriers: perspectives on why good research communication is a must". Elsevier Connect. Available: https://www.elsevier.com/connect/authors-update/breaking-down-barriers-perspectives-on-why-good-research-communication-is-a-must?utm_campaign=STMJ_147054_AUTSERV_OTR&utm_medium=email&utm_acid=135153589&SIS_ID=&dgcid=STMJ_147054_AUTSERV_OTR&CMX_ID=&utm_in=DM204626&utm_source=AC_ (Accessed: May-12-2022).

256. S. Mohammed, L. Flores, J. Deveau, R. Cohen Hoffing, C. Phung, C. M. Parlett, E. Sheehan, D. Lee, J. Au, M. Buschkuehl, V. Zordan, S. M. Jaeggi, A. R. Seitz, "The Benefits and Challenges of Implementing Motivational Features to Boost Cognitive Training Outcome", *Journal of Cognitive Enhancement*, vol.1, pp. 491–507, 2017, doi: 10.1007/s41465-017-0047-y

257. B. Monterrat, M. Desmarais, E. Lavoué, S.George. "A player model for adaptive gamification in learning environments", in *International conference on artificial intelligence in education*, Jun. 2015, pp. 297–306, doi: 10.1007/978-3-319-19773-9_30.

258. A. Mora, C. González, J. Arnedo-Moreno, A. Álvarez, "Gamification of cognitive training: a crowdsourcing-inspired approach for older adults" in *Proceedings of the*

XVII International Conference on Human Computer Interaction, Sept. 2016, pp. 1-8, doi: 10.1145/2998626.2998663

259. A. Mora, D. Riera, C. Gonzalez, J. Arnedo-Moreno, "A literature review of gamification design frameworks", in *7th International Conference on Games and VirtualWorlds for Serious Applications IEEE (VS-Games)*, 2015, pp.1–8, doi: 10.1109/VS-GAMES.2015.7295760.
260. A. Mora, D. Riera, C. González, J. Arnedo-Moreno, "Gamification: a systematic review of design frameworks", *Journal of Computing in Higher Education*, vol. 29, no. 3, pp. 516–548, 2017, doi: 10.1007/s12528-017-9150-4
261. A. B. Morrison, J. M. Chein, "Does working memory training work? The promise and challenges of enhancing cognition by training memory", *Psychonomic Bulletin & Review*, vol. 18, no. 1, pp. 46-60, 2011, doi: 10.3758/s13423-010-0034-0
262. B. Morschheuser, L. Hassan, K. Werder, J. Hamari, "How to design gamification? A method for engineering gamified software", *Information and Software Technology*, vol. 95, pp.219–237, 2018
263. S. Muangsrinoon, P. Boonbrahm, "Game elements from literature review of gamification in healthcare context", *JOTSE: Journal of Technology and Science Education*, vol. 9, np. 1, pp. 20-31, 2019
264. S. Muangsrinoon, P. Boonbrahm, "Game elements from literature review of gamification in healthcare context", *JOTSE: Journal of Technology and Science Education*, vol. 9, np. 1, pp. 20-31, 2019, nach: K. Werbach, D. Hunter, *For the Win: How game thinking can revolutionize your business*. Wharton Digital Press: 2012.
265. L. Muskens, R. van Lent. A. Vijfvinkel, P. van Cann, S. Shahid, "Never too Old to Use a Tablet: Designing Tablet Applications for the Cognitively and Physically Impaired Elderly" in *International Conference on Computers for Handicapped Persons*, Jul. 2014, pp. 391-398, doi: 10.1007/978-3-319-08596-8_60
266. L. E. Nacke, C. Bateman, R. L. Mandryk, "BrainHex: A neurobiological gamer typology survey", *Entertainment computing*, vol. 5, no. 1, 55–62, Jab. 2014, doi: 10.1016/j.entcom.2013.06.002
267. M. D. Navarro, R. Llorens, A. Borrego, M. Alcañiz, E. Noé, J. Ferri, "Competition enhances the effectiveness and motivation of attention rehabilitation after stroke. A randomized controlled trial", *Frontiers in human neuroscience*, p. 385, Sep. 2020, doi: 10.3389/fnhum.2020.575403
268. L. Neumann-Zielke, S. Bahlo, A. Diebel, J. Riepe, R. Roschmann, P. Schötzau-Fürwentsches, L. Wetzig, "Leitlinie - Neuropsychologische Begutachtung" in *Zeitschrift für Neuropsychologie*, vol. 26, no. 4, pp. 289 – 306, 2015.
269. Neurocare. "MyBrainTraining®: kognitives Training - online, modern, wirksam". Neurocare. Available: https://www.neurocaregroup.com/de/kognitives-training (Accessed: May-09-2022).
270. NeuroNation. "Fitness für Ihren Kopf". NeuroNation. Available: https://www.neuronation.com/?lang=de (Accessed: Nov-19-2021).
271. S. Nicholson, "A recipe for meaningful gamification" in *Gamification in education and business*, 2015, pp. 1-20.
272. S. Nicholson, "A User-Centered Theoretical Framework for Meaningful Gamification", in *Games+Learning+Society 8.0*, Jun. 2012
273. J. Nielsen, "Mental Models and User Experience Design". Nielsen Norman Group. Available: http://www.nngroup.com/articles/mental-models/ (Accessed: Mar-17-2021).
274. A. Nijholt, "Towards Social Companions in Augmented Reality: Vision and Challenges", in *International Conference on Human-Computer Interaction*, 2022, pp. 304-319, doi:10.1007/978-3-031-05431-0_21.
275. M. Ninaus, G. Pereira, R. Stefitz, R. Prada, A. Paiva, C. Neuper, G. Wood, "Game elements improve performance in a working memory training task", *International journal of serious games*, vol. 2, no. 1, pp. 3-16, 2015 doi: 10.17083/ijsg.v2i1.60.
276. R. Nübling, F. Muthny , J. Bengel, "Die Bedeutung von Reha-Motivation und Behandlungserwartung für die Praxis der medizinischen Rehabilitation" in *Reha-Motivation und Behandlungserwartung*, Huber, Jan 2006.
277. R. C. Y. Nuijten, "Energize: Exploring the impact of gamification strategies on engagement with mobile health apps". Ph.D. dissertation, Eindhoven University of Technology, 2022.
278. M. Oliver, M. A. Terue, J. P.l Molina, D. Romero-Ayuso, P. González, "Ambient Intelligence Environment for Home Cognitive Telerehabilitation", *Sensors*, vol. 18, no. 11, p. 3671, Oct. 2018, doi: 10.3390/s18113671.
279. J. Opiła, "Role of Visualization in a Knowledge Transfer Process", *Business Systems Research: International journal of the Society for Advancing Innovation and Research in Economy*, vol. 10, no.1, pp. 164–179, 2019.
280. R. Orji, R. L. Mandryk, J. Vassileva, "Improving the efficacy of games for change using personalization models", *ACM Transactions on Computer-Human Interaction (TOCHI)*, Oct. 2017, vol. 24, no. 5, pp. 1–22, doi: 10.1145/3119929
281. R. Orji, R. L. Mandryk, J. Vassileva, K. M. Gerling, "Tailoring persuasive health games to gamer type", in *Proceedings of the sigchi conference on human factors in computing systems (CHI)*, Apr. 2013, pp. 2467–2476, doi: 10.1145/2470654.2481341
282. R. Orji, K. Moffatt, "Persuasive technology for health and wellness: State-of-the-art and emerging trends", *Health informatics journal*, vol.24, no.1, 66–91, 2018
283. R. Orji, L. E. Nacke, C. Di Marco, "Towards personality-driven persuasive health games and gamified systems", in *Proceedings of the 2017 Conference on Human Factors in Computing Systems (CHI)*, May, 2017, pp. 1015-1027, doi: 10.1145/3025453.3025577
284. R. Orji, G. F. Tondello, L. E. Nacke, L. E, "Personalizing persuasive strategies in gameful systems to gamification user types" in *Proceedings of the 2018 CHI conference on human factors in computing systems (CHI)*, Apr. 2018, April, pp. 1-14, doi: 10.1145/3173574.3174009.
285. A. Ortiz, M. del Puy Carretero, D. Oyarzun, J. Javier Yanguas, C. Buiza, M. F.Gonzalez, I. Etxeberria, "Elderly users in ambient intelligence: Does an avatar improve the interaction?" in *Proceedings of Universal access in ambient intelligence environments*, 2007, pp. 99–114, doi: 10.1007/978-3-540-71025-7_8.
286. O. Oyebode, C. Ndulue, D. A. Mulchandani, A. Zamil Adib, M. Alhasani, R. Orji, "Tailoring Persuasive and Behaviour Change Systems Based on Stages of Change and Motivation", in *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, May 2021, pp. 1-19.
287. A. Pajitnov, Tetris (Game). 1984.
288. P. T. Palomino, A. M. Toda, W. Oliveira, A. I. Cristea, S. Isotani, "Narrative for gami-

fication in education: why should you care?", in *2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT)*, 2019, pp. 97-99, doi: 10.1109/ICALT.2019.00035.

289. R. Paradeda, M. J. Ferreira, R. Oliveira, C. Martinho, A. Paiva, "The role of assertiveness in a storytelling game with persuasive robotic non-player characters", in *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Oct. 2019, pp. 453-465, doi: 10.1145/3311350.3347162.

290. M. Passalacqua, S. Senecal, M. Fredette, L. E. Nacke, R. Pellerin, P.-M. Léger, "Should Gamification be Personalized? A Self- deterministic Approach", *AIS Transactions on Human-Computer Interaction*. vol. 13, no. 3, pp. 265-286, 2021, doi: 10.17705/1thci.00150

291. N. Pelling. "The (short) prehistory of "gamification"…", Funding Startups (& other impossibilities). Available: https://nanodome.wordpress.com/2011/08/09/the-short-prehistory-of-gamification/ (Accessed: Nov-16-2021).

292. P. Pereira, E. Duarte, F. Rebelo, P. Noriega, "A review of gamification for health-related contexts", in *International conference of design, user experience, and usability*, Jun. 2014, pp. 742-753, doi: 10.1007/978-3-319-07626-3_70

293. C. Pettey, R. van der Meulen. "Gartner says by 2014, 80 percent of current gamified applications will fail to meet business objectives primarily due to poor design." Meticul Solutions, Nov. 2012. Available: https://meticul.com/blog/gartner-says-by-2014-80-percent-of-current-gamified-applications-will-fail-to-meet-business-objectives-primarily-due-to-poor-design/ (Accessed: May-08-2022).

294. J. C. Perry, J. Andureu, F. I.Cavallaro, J.Veneman, S. Carmien, T.Keller, "Effective game use in neurorehabilitation: user-centered perspectives" in *Handbook of research on improving learning and motivation through educational games: multidisciplinary approaches*, P. Felicia, 2011, IGI Global, pp. 683-725.

295. M. Pfammatter, U. Junghan, W. Tschacher, "Common factors of psychotherapy: concepts, contradictions and a synthesis", *Psychotherapie in Psychiatrie, Psychotherapeutischer Medizin und Klinischer Psychologie*, vol. 17, no. 1, pp. 17-31, 2012

296. M Pham, Y. Mengistu, H. M. Do, W. Sheng, W., „Cloud-Based Smart Home Environment (CoSHE) for home healthcare," *2016 IEEE International Conference on Automation Science and Engineering (CASE)*, 2016, pp. 483-488, doi: 10.1109/COASE.2016.7743444.

297. Philips. "Setze Deinen Garten in Szene". Philips Hue. Available: https://www.philips-hue.com/de-de (Accessed: Dec-24-2021).

298. R. F. Polak, A. Bistritsky, Y. Gozlan, S. Levy-Tzedek, "Novel gamified system for post-stroke upper-limb rehabilitation using a social robot: Focus groups of expert clinicians", in *Proceedings of the International Conference on Virtual Rehabilitation (ICVR)*, July 2019; pp. 1–7, doi: 10.1109/ICVR46560.2019.8994657.

299. A. M. Politis, R.S Norman, "Computer-based cognitive rehabilitation for individuals with traumatic brain injury: a systematic review", *Perspectives of the ASHA Special Interest Groups*, vol. 1, no. 2, pp. 18-46, 2016, doi: 10.1097/JNN.0000000000000298

300. J. O. Prochaska, C. C DiClemente, "Transtheoretical therapy: Toward a more integrative model of change", *Psychotherapy: theory, research & practice*, vol. 19, no. 3, pp. 276-288, 1982, doi: 10.1037/h0088437

301. R. Proffitt, "Gamification in Rehabilitation: Finding the "just-Right-Challenge", in *Handbook of Research on Holistic Perspectives in Gamification for Clinical Practice*, in IGI Global, 2015, p. 132.

302. K. Radlanski, M. Kipp. *Neuroanatomie: Nachschlagen | Lernen | Verstehen*. KVM-Der Medizinverlag, 2020

303. D. Rand, R. Kizony, P. L. Weiss, "Virtual reality rehabilitation for all: Vivid GX versus Sony PlayStation II EyeToy", in *5th Intl. Conf. On Disability, Virtual Environments and Assoc. Technologies*, Sept. 2004, pp. 87-94.

304. K. Rapti, "Increasing Motivation Through Gamification in E-Learning", ***Διεθνές Συνέδριο για την Ανοικτή & εξ Αποστάσεως Εκπαίδευση***, vol. 7., Jun. 2016, doi: 10.12681/icodl.640

305. A. L. Rathbone, L. Clarry, J. Prescott, "Assessing the Efficacy of Mobile Health Apps Using the Basic Principles of Cognitive Behavioral Therapy: Systematic Review", *Journal of medical Internet research*, vol. 19, no.11, p. e399, Nov. 2017, doi: 10.2196/jmir.8598

306. M. Rawolle, M. Schultheiss, O. C. Schultheiss, "Relationships between implicit motives, self-attributed motives, and personal goal commitments", *Frontiers in psychology*, vol. 4, p. 923, 2013, doi: 10.3389/fpsyg.2013.00923

307. G. W. Rebok, M. C. Carlson, J. B. Langbaum, "Training and maintaining memory abilities in healthy older adults: traditional and novel approaches", *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, vol. 62 (Special Issue 1), pp. 53-61, 2007, doi: 10.1093/geronb/62.special_issue_1.53

308. Rehability. "Rehabilitation". Rehability. Available: http://www.rehability.me/#athome (Accessed: May-09-2022).

309. S. Reyssier, S. Hallifax, A. Serna, J. C. Marty, S. Stephane, E. Lavoué, "The impact of game elements on learner motivation: influence of initial motivation and player profile", *IEEE Transactions on Learning Technologies*, Feb. 2022, doi: 10.1109/TLT.2022.3153239

310. H. Rieß, P. Klein, M. Ecker, S.Hintz, "Reminder Objects: Greifbare Interaktion im alltäglichen Leben", in *Mensch und Computer 2015–Usability Professionals*, 2015, pp. 252 - 260, doi: 10.1515/9783110443882-027.

311. F. Rheinberg. *Motivation (Grundriss der Psychologie - Band 6).* M. v. Salisch, H. Selg, D. Ulig, Kohlhammer Urban Taschenbücher, 2006

312. D.L.Rimmele, G.Thomalla, "Langzeitfolgen von Schlaganfällen". Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz, vol. 65, pp. 498–502, 2022, doi: 10.1007/s00103-022-03505-2

313. K. Robson, K. Plangger, J. H. Kietzmann, I. McCarthy, L. Pitt,"Is it all a game? Understanding the principles of gamification", *Business horizons*, vol. 58, no. 4, pp. 411-420, 2015, doi: 10.1016/j.bushor.2015.03.006

314. L. Rodrigues, A. M. Toda, W. Oliveira, P.T. Palomino, J. Vassileva, S. Isotani, "Automating Gamification Personalization to the User and Beyond", IEEE Transactions on Learning Technologies, vol. 15, no.2, pp. 199-212, April 2022, doi: 10.1109/TLT.2022.3162409.

315. C. Rogers, "Client-centered Therapy", *Journal of Clinical Psychology*, vol. 7, no. 3, p. 560, 1951

316. K. Rogers, M. Aufheimer, M. Weber, L. E. Nacke, "Towards the Visual Design of Non-Player Characters for Narrative Roles", in *Proceedings of the 44th Graphics Interface Conference (GI ,18)*, May 2018, pp. 154–161, doi: 10.20380/GI2018.21.

317. L. Rokach, O. Maimon, “Clustering Methods”, in *Data Mining and Knowledge Discovery Handbook*, O. Maimon, L. Rokach, Bosten, MA: Springer US, 2005, doi: 10.1007/0-387-25465-X_15,

318. R. V. Roy, B. Zaman, “Why gamification fails in education and how to make it successful: Introducing nine gamification heuristics based on self-determination theory”, in *Serious Games and edutainment applications*, Springer, Cham, 2017, ch. 22, pp. 485-509.

319. W. Ruberman. E. Weinblatt, J. Goldberg, B. Chaudhary, “Psychosocial influences on mortality after myocardial infarction”, *The New England Journal of medicine*, vol. 311, no. 9, pp. 552-559, 1984

320. U. Rudolph, 2013, *Motivationspsychologie kompakt*, 3.Auflage, Beltz Verlag, Oct. 2013

321. R. M. Ryan, E. L. Deci, “Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being”, *American Psychologist*, Vol. 55, no.1, pp. 68-78, 2000, doi: 10.1037/0003-066X.55.1.68

322. R. M. Ryan and E. L. Deci, *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*, New York: The Guilford Press, 2017.

323. R. M. Ryan, C. S. Rigby, C. S.,A. Przybylski, “The motivational pull of video games: A self-determination theory approach”, *Motivation and emotion*, vol. 30, no. 4, pp. 344-360, 2006, doi: 10.1007/s11031-006-9051-8

324. M. Sabbagh. “Out of Character: how to design good game characters”. Game Developer. Available: https://www.gamedeveloper.com/design/out-of-character-how-to-design-good-game-characters (Accessed: May-11-2022).

325. M. Sailer, J. U. Hense, J. Mandl, M. Klevers, M., “Psychological perspectives on motivation through gamification”, *Interaction Design and Architecture Journal*, vol. 19, pp. 28-37, Feb. 2014

326. M. Sailer, J. U. Hense, S. K. Mayr, H. Mandl, “How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction”, *Computers in human behavior,* vol. 69, pp. 371-380, Apr. 2017, doi: 10.1016/j.chb.2016.12.033

327. M. Sailer L. Homner, “The gamification of learning: A metaanalysis”, *Educational Psychology Review*, vol. 32, no. 1, pp. 77-112 2020, doi: 10.1007/s10648-019-09498-w.

328. A. C. G. Santos, W. Oliveira, J. Hamari, S. Isotani, S., “Do people's user types change over time? An exploratory study”, *arXiv preprint* arXiv:2106.10148, 2021

329. L. Sardi, A. Idri, J. L. Fernández-Alemán, J. L, “A systematic review of gamification in e-Health”, *Journal of biomedical informatics*, vol. 71, pp. 31-48, 2017, doi: 10.1016/j.jbi.2017.05.011

330. F. S Sarfo, U. Ulasavets, O.K. Opare-Sem, B. Ovbiagele, “Tele-rehabilitation after stroke: an updated systematic review of the literature”, *Journal of stroke and cerebrovascular diseases*, vol. 27, no. 9, pp. 2306-2318, 2018, doi: 10.1016/j.jstrokecerebrovasdis.2018.05.013

331. SBT Group. “Happy Neuron”. Happy Neuron. Available: https://www.happy-neuron.com/ (Accessed: Aug-03-2021).

332. SBT Group. “Memory - Cocktails ”. Happy Neuron. Available: https://www.happy-neuron.com/ (Accessed: Jul-30-2021).

333. D. Schlosser, T. Campellone, D. Kim, B. Truong, S. Vergani, C. Ward, S. Vinogradov, “Feasibility of PRIME: a cognitive neuroscience-informed mobile app intervention to enhance motivated behavior and improve quality of life in recent onset schizophrenia”, *JMIR research protocols*, vol. 5, no. 2, p. e5450, Apr. 2016, doi: 10.2196/resprot.5450

334. M. Schmidt-Kraepelin, S., Thiebes, S., Stepanovic, T. Mettler, A. Sunyaev, “Gamification in health behavior change support systems-A synthesis of unintended side effects”, in *Proceedings of the 14th International Conference on Wirtschaftsinformatik*, Feb. 2019, pp. 1032-1046.

335. N. L. Schroeder, O. O. Adesope, and R. B. Gilbert, „How effective are pedagogical agents for learning? A meta-analytic review“, *Journal of Educational Computing Research*, vol. 49, no. 1, pp. 1-39, 2013

336. F. Schröder, T. Döring, H. Rieß, R. Malaka, P. Klein, “Lebendige Daten Ambient Shape-Changing Interface als Datenrepräsentation in Unternehmen”, in *Mensch und Computer 2017 - Usability Professionals*, 2017, doi: 10.18420/muc2017-up-0138

337. Schuhfried. “CogniPlus”. Schuhfried. Available: https://www.schuhfried.com/de/cogniplus/ (Accessed: May-09-2022).

338. J. A. Serrano, “Care in the clouds”, *International Innovation*, vol. 172, 2015, doi: 10.13140/2.1.3954.5128.

339. A. Shapi'i, N. A. Mat Zin, A. M. Elaklouk, “A game system for cognitive rehabilitation”, *BioMed research international*, vol 5., ppp. 1-7, Mar. 2015, doi: 10.1155/2015/493562

340. F. Shen, V. C. Sheer, R. Li, “Impact of narratives on persuasion in health communication: A meta-analysis”, *Journal of Advertising*, vol. 44, no. 2, pp. 105-113, May 2015, doi: 10.1080/00913367.2015.1018467

341. Y. Shiban, I. Schelhorn, V. Jobst, A. Hörnlein, F. Puppe, P. Pauli, A. Mühlberger, “The appearance effect: Influences of virtual agent features on performance and motivation”, *Computers in Human Behavior,* vol. 49, pp. 5-11, 2015, doi:10.1016/j.chb.2015.01.077.

342. Six to Start. “The Walk: Fitness Tracker Game”. Google Play. Available: https://play.google.com/store/apps/details?id=com.sixtostart.thewalk2&hl=de&gl=US (Accessed: May-11-2021).

343. Six to Start. “Zombies, Run! 10”. Google Play. Available: https://play.google.com/store/apps/details?id=com.sixtostart.zombiesrunclient&hl=de&gl=US (Accessed: May-11-2022)

344. J. Snyder, M. Matthews, J. Chien, P. F. Chang, E. Sun, S. Abdullah, G. Gay, G., “Moodlight: Exploring personal and social implications of ambient display of biosensor data”, in *Proceedings of the 18th ACM conference on computer supported cooperative work & social computing,* Mar. 2015, pp. 143-153, doi: 10.1145/2675133.2675191.

345. A. R. B. Soutter, M. Hitchens, “The relationship between character identification and flow state within video games”, *Computers in Human Behavior*, vol. 55, pp. 1030–1038, Feb. 2016, doi: 10.1016/j.chb. 2015.11.012

346. E. Spelke, W. Hirst, U. Neisser, “Skills of divided attention”, *Cognition*, vol. 4, no. 3, 1976, pp. 215-230, doi: 10.1016/0010-0277(76)90018-4

347. U. M. Spierling, “Implicit creation non-programmer conceptual models for authoringin interactive digital storytelling”. Ph.D. dissertation, University of Plymouth, 2010.

348. Splendid research. „Studie: Wie und was lesen die Deutschen?". Splendid research. Available: https://www.splendid-research.com/de/studie-buecher (Accessed: Jul-30-2021).

349. Springer Lehrbuch Psychologie. "Implizite und explizite Motive". Springer Lehrbuch Psychologie. Available: https://lehrbuch-psychologie.springer.com/content/implizite-und-explizite-motive (Accessed: Nov-05-2021).

350. W. Stangl. "Tokensystem". Online Lexikon für Psychologie und Pädagogik. Available: https://lexikon.stangl.eu/4760/tokensystem (Accessed: May-19-2022).

351. Statistisches Bundesamt. "Datenreport 2018 - Sozialbericht für Deutschland, Gesamtausgabe". Statistisches Bundesamt, 2018, pp. 300-301, Available: https://www.destatis.de/DE/Service/Statistik-Campus/Datenreport/Downloads/datenreport-2018.html (Accessed: Jul-22-2021).

352. Statista. "Anzahl der Patienten in Vorsorge- und Rehabilitationseinrichtungen in Deutschland nach Alter in den Jahren von 2003 bis 2019". Statista. Available: https://de.statista.com/statistik/daten/studie/324015/umfrage/vorsorge-und-rehabilitationseinrichtungen-anzahl-der-patienten-nach-alte/ (Accessed: Nov-02-2021).

353. Statista. "Beliebteste Hobbys, Freizeitaktivitäten und Sportarten in Deutschland nach häufiger Ausübung in den Jahren 2019 bis 2021". Statista. Available: https://de.statista.com/statistik/daten/studie/171168/umfrage/haeufig-betriebene-freizeitaktivitaeten/ (Accessed: Nov-16-2021).

354. Statista. "Most common gamification elements in business in the United States as of 2019". Statista. Available: https://www.statista.com/statistics/1100506/gamificationelements-business/ (Accessed: Mar-27-2021).

355. Statista. „Vorsorge- und Rehabilitationseinrichtungen - Anzahl der Patienten nach Alter bis 2019", Statista. Available: https://de.statista.com/statistik/daten/studie/324015/umfrage/vorsorge-und-rehabilitationseinrichtungen-anzahl-der-patienten-nach-alte/. (Accessed: Nov-02-2021).

356. Statista. „What types of books have you read in the past year?", Statista. Available: https://www.statista.com/statistics/470709/favorite-book-genres-age-usa/ch-alte/. (Accessed: Jul-30-2021).

357. H. Steiner, P. Johns, S. Gupta, J. Lester, C. Meek, A. Roseway. "Projekt Florence". Helene Steiner. Available: https://helenesteiner.webflow.io/project/project-florence (Accessed: Dec-27-2021).

358. W. Sturm, S. George, H.Hildebrandt, P. Reuther, K. Schoof-Tams, Cl.-W. Wallesch, "Leitlinie Diagnostik und Therapie von Aufmerksamkeitsstörungen", *Zeitschrift für Neuropsychologie*, vol. 20, no. 1, pp. 59-67, Jun. 2009, doi: 10.1024/1016-264X.20.1.59

359. T. Susi, M. Johannesson, P. Backlund, "Serious games: An overview", *Elearning*, vol. 73, no. 10, 2007

360. A. Talaei-Khoei, J. Daniel, "How younger elderly realize usefulness of cognitive training video games to maintain their independent living", *International Journal of Information Management*, vol. 42, pp. 1-12, Oct. 2018, doi: 10.1016/j.ijinfomgt.2018.05.001

361. P. Tamayo-Serrano, S. Garbaya, P. Blazevic, "Gamified in-home rehabilitation for stroke survivors: analytical review", *International Journal of Serious Games*, vol. 5., no. 1, pp. 2384-8766, Mar 2018

362. V. Tan, S. A. Varghese, "IoT-enabled health promotion" in *Proceedings of the first workshop on IoT-enabled healthcare and wellness technologies and systems*, Jun 2016, pp. 17-18, doi: 10.1145/2933566.2933571.

363. W. Tang, D. Kreindler, "Supporting Homework Compliance in Cognitive Behavioural Therapy: Essential Features of Mobile Apps", *JMIR Mental Health*, vol. 4, no. 2, p. e20, Jun. 2017, doi: 10.2196/mental.5283

364. Tasmota. "Tasmota". Tasmota. Available: https://www.tasmota.info/ (Accessed: Apr-09-2022)

365. I.F Tatsumi, M. Watanabe, "Verbal Memory." in Encyclopedia of Neuroscience, M. D Binder, N. Hirokawa, U. Windhorst, Springer, 2009, doi: 10.1007/978-3-540-29678-2_6266, Available: https://link.springer.com/referenceworkentry/10.1007/978-3-540-29678-2_6266

366. D. Tăut, S. Pintea, J. P. W. Roovers, M. A. Mananas, A. Băban, A., "Play seriously: Effectiveness of serious games and their features in motor rehabilitation. A meta-analysis", *NeuroRehabilitation*, vol. 41, no. 1, pp. 105-118, 2017, doi: 10.3233/NRE-171462

367. A. To, J. McDonald, J. Holmes, G. Kaufman, J. Hammer, "Character Diversity in Digital and Non-Digital Games", *Transactions of the Digital Games Research Association*, vol. 4, no. 1, 2018, doi: 10.26503/todigra.v4i1.84.

368. A. Thöne-Otto, A. et al., "Diagnostik und Therapie von Gedächtnisstörungen bei neurologischen Erkrankungen, S2e-Leitlinie", Deutsche Gesellschaft für Neurologie (Hrsg.), Leitlinien für Diagnostik und Therapie in der Neurologie, 2020, Available: www.dgn.org/leitlinien (Accessed: Oct-27-2021)

369. A. M. Toda, W. Oliveira, A. C. Klock, P. T. Palomino, M. Pimenta, I. Gasparini, L. Shi, I. Bittencourt, S. Isotani, A. I. Cristea, „A taxonomy of game elements for gamification in educational contexts: Proposal and evaluation." in *IEEE 19th International Conference on Advanced Learning Technologies (ICALT)*, 2019, vol. 2161, doi: 10.1109/ICALT.2019.00028.

370. G. F. Tondello, "How to publish research results for academic and non-academic audiences", XRDS: Crossroads, *The ACM Magazine for Students*, vol. 25, no. 1, pp. 16-17, 2018, doi: 10.1145/3265921

371. G. F. Tondello, K. Arrambide, G. Ribeiro, A. J. Cen, L. E. Nacke, "I Don't Fit into a Single Type": A Trait Model and Scale of Game Playing Preferences", in *IFIP Conference on Human-Computer Interaction (INTERACT 2019)*, 2019, pp. 375-395, doi: 10.1007/978-3-030-29384-0_23

372. G. F. Tondello, A. Mora, L. E. Nacke, "Elements of gameful design emerging from user preferences", in *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Oct. 2017, pp. 129-142.

373. G. F. Tondello, L. E. Nacke, "Validation of User Preferences and Effects of Personalized Gamification on Task Performance" in *Frontiers in Computer Science*, Aug. 2020, doi: 10.3389/fcomp.2020.00029

374. G. F. Tondello, R. Orji, R., L. E. Nacke, L. E., "Recommender systems for personalized gamification", in *Adjunct publication of the 25th conference on user modeling, adaptation and personalization*, Jul. 2017, pp. 425-430, doi: 10.1145/3099023.3099114.

375. G. F. Tondello, R. R. Wehbe, L. Diamond, M. Busch, A. Marczewski, L. E. Nacke, "The gamification user types hexad scale", in *Proceedings of the 2016 annual symposium on computer-human interaction in play (CHI Play)*, Oct. 2016, pp. 229–243, doi:

10.1145/2967934.2968082.

376. Toronto ABI Network. "Definition", Toronto ABI Network, 2020. Available: https://abinetwork.ca/individuals-families/about-brain-injury/definition/ (Accessed: Oct-25-2021)

377. M. K. P. Tran, P. Robert, F. Bremond, "A Virtual Agent for enhancing performance and engagement of older people with dementia in Serious Games" in *Workshop Artificial Compagnon-Affect-Interaction*, Dec. 2016.

378. P. Tropea, H. Schlieter, I. Sterpi, E. Judica, K. Gand, M. Caprino, M., I. Gabilondo, J. C. Gomez-Esteban, S. Busnatu, C. Sinescu, S. Kyriazakos, S. Anwar, M. Corbo, "Rehabilitation, the great absentee of virtual coaching in medical care: scoping review", *Journal of medical Internet research*, vol. 21, no. 10, p. e12805, Oct. 2019, doi: 10.2196/12805

379. N. M. Tuah, F. Ahmedy, A. Gani, L.N. Yong, "A survey on gamification for health rehabilitation care: Applications, opportunities, and open challenges." Information, vol. 12, no.2, p.91, 2021, doi: 10.3390/info12020091

380. UEQ. "User Experience Questionnaire". UEQ. Available: https://www.ueq-online.org/ (Accessed: Dec-12-2021).

381. M. Uhlig, H. Rieß, P. Klein, "Reminder Objects in the Connected Home of the Future and Beyond", *Technologies*, vol. 6, no. 1, 2018, doi: 10.3390/technologies6010001

382. R. Ulrich, "Health Benefits of Gardens in Hospitals, Plants for People", *International Exhibition Floriade*, 2002

383. Unity. "Unity". Unity. Available: https://unity.com/ (Accessed: Apr-14-2022).

384. D. Upshall, "Developing a Taxonomy of Gamification Elements That Facilitate User Motivation", M. Sc. thesis, Tallinn University, School of Digital Technologies Digital Learning Games, Jul. 2020, doi: 10.13140/RG.2.2.32806.96327

385. A. Y. Utomo, H. B. Santoso, "Development of gamification-enriched pedagogical agent for e-learning system based on community of inquiry" in *Proceedings of the International HCI and UX Conference in Indonesia (CHIuXiD)*, Apr. 2015, pp. 1-9, doi: 10.1145/2742032.2742033.

386. M. Välimäki, K. Mishina, J.K. Kaakinen, S. K. Holm, J. Vahlo, M. Kirjonen, V. Pekurinen, O. Tenovuo, J. Korkeila, H. Hämäläinen, J. Sarajuuri. P. Rantanen, T. Orenius, A. Koponen, "Digital gaming for improving the functioning of people with traumatic brain injury: randomized clinical feasibility study", *Journal of medical Internet research*, vol. 20, no. 3. 2018, doi: 10.2196/jmir.7618

387. S. C. van de Weijer SC, M. L. Kuijf, N.M. de Vries, B.R. Bloem, A. A. Duits, "Do-It-Yourself Gamified Cognitive Training: Viewpoint", *JMIR Serious Games*, vol. 7, no. 2, 2019, doi: 10.2196/12130

388. M. van Dooren, "Personalized gamification to enhance implementation of eHealth therapy in youth mental healthcare", Ph.D. dissertation, Delft University of Technology, 2020.

389. G. F. X. D. Vasconcelos, W. O. D. Santos, A. C. G. Santos, J.Hamari, "ReGammend: A method for personalized recommendation of gamification designs", in *Proceedings of 6th International GamiFIN Conference*, Apr. 2022, pp. 85-94.

390. K. Vella, N. Peever, M. Klarkowski, B. Ploderer, J. Mitchell, D. Johnson, "Using applied games to engage mHealth users: a case study of MindMax", in *Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI Play)*, Oct. 2018, pp. 511-522.

391. Verband Deutscher Rentenversicherungsträger, "Phaseneinteilung in der neurologischen Rehabilitation", *Rehabilitation*, vol. 34, pp. 119–127, 1995.

392. J. Vermeir, M. White, D. Johnson, G. Crombez, D. Ryckeghem, Dimitri, "The Effects of Gamification on Computerised Cognitive Training: A Systematic Review and Meta-Analysis", *JMIR Serious Games*, vol. 8, no. 3, Aug. 2020, doi: 10.2196/18644

393. S. Vishnu, S.R. Jino Ramson, R. Jegan, "Internet of Medical Things (IoMT) - An overview" in *2020 5th International Conference on Devices, Circuits and Systems (ICDCS)*, 2020, pp. 101-104.

394. A. Voit, S. Mayer, V. Schwind, N. Henze, "Online, VR, AR, Lab, and In-Situ: Comparison of Research Methods to Evaluate Smart Artifacts" in *Proceedings of the 2019 chi conference on human factors in computing systems (CHI)*, May 2019, pp. 1-12, doi: 10.1145/3290605.3300737.

395. G. Volkmar, J. Pfau, R. Teise, R., Malaka, "Player Types and Achievements–Using Adaptive Game Design to Foster Intrinsic Motivation", in *Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts (CHI Play)*, pp. 747-754, Oct. 2019, doi: 10.1145/3341215.3356278.

396. A. Vourvopoulos, A. Faria, K. Ponnam, S. Badia, "RehabCity: design and validation of a cognitive assessment and rehabilitation tool through gamified simulations of activities of daily living", in *Proceedings of the 11th Conference on Advances in Computer Entertainment Technology*, pp. 1-8, Nov. 2014, doi: 10.1145/2663806.2663852.

397. P. Wardono, F. N. Soelami, "Effects of luminous furniture on mood", in *Procedia-Social and Behavioral Sciences*, vol. 222, pp. 342-350, 2016, doi: 10.1016/j.sbspro.2016.05.178

398. H. Warpefelt, H. "The Non-Player Character: Exploring the believability of NPC presentation and behavior.", Ph.D. dissertation, Stockholm: Department of Computer and Systems Sciences, Stockholm University, 2016.

399. H. Warpefelt, "Cues and insinuations: Indicating affordances of non-player character using visual indicators" in *Proceedings of the 2015 DiGRA International Conference Digital Games Research Association*, May, 2015, vol. 12.

400. J. Waschke, F. Paulsen, T. Böckers. *Sobotta Lehrbuch Anatomie*. Urban & Fischer. 2019, S.637-638.

401. J. Weicker, M. Gabele, A. Thöne-Otto, "Motivation und Verhalten während eines selbstständig absolvierten Onlinetrainings", Abstract and Presentation: *35. Jahrestagung der Gesellschaft für Neuropsychologie*, Aug. 2020

402. J. Weicker, A.Villringer, A.Thöne-Otto, "Can impaired working memory functioning be improved by training? A meta-analysis with a special focus on brain injured patients", *Neuropsychology*, vol. 30, no. 2, 2016, doi: 10.1037/neu0000227.

403. J. Weicker, N.Hudl, H.Hildebrandt, H.Obrig, M. Schwarzer, A.Villringer, A. Thöne-Otto, "The effect of high vs. low intensity neuropsychological treatment on working memory in patients with acquired brain injury", *Brain Injury*, vol. 34, no. 8., pp. 1051-1060, Jul. 2020), doi: 10.1080/02699052.2020.1773536

404. M. Weiser, "The Computer for the 21st Century", *Scientific American*, vol. 265, no. 3, pp. 94–104, Sep. 1991

405. C. H. Wen, H.Y. Hsien, H.C. Huang, "A survey of gamification for healthcare system", in *2015 International Conference on Orange Technologies (ICOT),* Dec 2015, pp. 117-

121.

406. K. Werbach, "(Re)Defining Gamification: A Process Approach", in *International conference on persuasive technology,* May 2014, pp. 266-272, doi: 10.1007/978-3-319-07127-5_23

407. K. Werbach, D. Hunter, *For the Win: How game thinking can revolutionize your business*. Wharton Digital Press: 2012.

408. R. W. White, A. Fourney, A. Herring, P. N. Bennett, N. Chandrasekaran, R. Sim, E. Nouri, M. J. Encarnación, "Multi-device digital assistance", *Communications of the ACM*, vol. 62, no. 10, pp. 28-31, Oct. 2019, doi: 10.1145/3357159

409. K. Wiley, S. Vedress, R. L. Mandryk, „How points and theme affect performance and experience in a gamified cognitive task." in *Proceedings of the 2020 Conference on Human Factors in Computing Systems (CHI)*, April 2020, doi: 10.1145/3313831.3376697.

410. M. Wittmann, B. Morschheuser, "What do games teach us about designing effective human-AI cooperation?-A systematic literature review and thematic synthesis on design patterns of non-player characters", in *Proceedings of the 6th International GamiFIN Conference*, Apr. 2022, pp. 95-104.

411. World Health Organization. "Global strategy on digital health 2020-2025", World Health Organization, 2021. Available; https://apps.who.int/iris/bitstream/handle/10665/344249/9789240020924-eng.pdf (Accessed: May-09-2022)

412. World Health Organization, European Respiratory Society. "Digital health for the end TB strategy: an agenda for action. World Health Organization." World Health Organization. Available: https://apps.who.int/iris/handle/10665/205222 (Accessed: Nov-16-2021).

413. R. Xiao, Z. Wu, J. Hamari, "Internet-of-Gamification: A Review of Literature on IoT-enabled Gamification for User Engagement", *International Journal of Human–Computer Interaction*, vol. 38, no. 12, pp. 1113-1137, Dec. 2021, doi: 10.1080/10447318.2021.1990517

414. R. Yang, V. Chen, "Gamification: Influencing Value-Perception of Target Behaviors" in *CEUR Workshop Proceedings*. May 2017, pp. 120-128

415. N. Yee, N. Ducheneaut, L. Nelson, P. Likarish, "Introverted elves & conscientious gnomes: the expression of personality in world of warcraft" in *Proceedings of the SIGCHI conference on human factors in computing systems (CHI)*, pp.753–762, May 2011, doi: 10.1145/1978942.1979052.

416. C. Yoo, M.Yong, J.Chung, Y. Yang, "Effect of computerized cognitive rehabilitation program on cognitive function and activities of living in stroke patients", *Journal of Physical Therapy Science*, vol. 27, no.8, pp.2487–2489, 2015, doi: 10.1589/jpts.27.2487

417. T. Yoshida, Y. Otaka, R. Osu, M. Kumagai, S. Kitamura, J. Yaeda, "Motivation for rehabilitation in patients with subacute stroke: a qualitative study", *Frontiers in Rehabilitation Sciences*, vol. 2, Jun. 2021, doi: 10.3389/fresc.2021.664758

418. Z. Zhao, A. Arya, R. Orji, R., G. Chan, "Effects of a personalized fitness recommender system using gamification and continuous player modeling: System design and long-term validation study", *JMIR serious games*, vol. 8, no. 4, p. e19968, May 2020, doi: 10.2196/preprints.19968

419. C. Zhou, A. Occa, S. Kim, S. Morgan, "A meta-analysis of narrative game-based interventions for promoting healthy behaviors", *Journal of health communication*, vol. 25. no. 1, pp. 54-65, 2020, doi: 10.1080/10810730.2019.1701586

420. O. Zuckerman, A. Gal-Oz, "To TUI or not to TUI: Evaluating performance and preference in tangible vs. graphical user interfaces", *International Journal of Human-Computer Studies*, vol. 71, pp. no. 7-8, pp. 803-820, Jul.-Aug. 2013, doi: 10.1016/j.ijhcs.2013.04.003

IV Questionnaires and Graphics

An enlarged version of Figure 11 and the questionnaires based on Tondello et al. [244, 337] are presented in a version translated and / or adapted to the rehabilitation situation. Further excerpts of the used questionnaires relevant for this work can be found in the digital appendix on the attached storage medium (printed version) or in the following (digital version)

Figure 27. Adjusted questionnaire based on Tondello et al. [337] to assess the level of request for different game elements by patients in cognitive rehabilitation. (Language: German)

Welche Funktionen oder Elemente würden Ihnen gefallen?
Welche würden Sie im Training motivieren?

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich darf die komplizierten Aufgaben erst machen, wenn ich die einfachen geschafft habe.	☐	☐	☐	☐	☐
Ich bekomme mehr Verantwortung übertragen und helfe anderen Patienten.	☐	☐	☐	☐	☐
Ich habe die Freiheit ohne Regeln zu trainieren wie ich möchte.	☐	☐	☐	☐	☐
Ich kann mir aussuchen, ob ich lieber die Trainingsaufgaben erledige, um im Schwierigkeitsgrad aufzusteigen oder ob ich Geld bezahle (echt oder virtuell) um damit im Schwierigkeitsgrad aufzusteigen.	☐	☐	☐	☐	☐
Ich bleibe während des Trainings anonym, das bedeutet, dass weder dem Programm noch anderen Patienten angezeigt wird, wer ich bin.	☐	☐	☐	☐	☐
Durch die Vorarbeit von Anderen, kann das Training für mich einfacher werden. (Zum Beispiel gesammelte Punkte von einer anderen Person mit nutzen.)	☐	☐	☐	☐	☐
Ich werde im Programm durch eine virtuelle Figur, die ich selbst gestalte, präsentiert.	☐	☐	☐	☐	☐
Ich bekomme eine Anerkennung für das Erreichen wichtiger Ziele innerhalb des Trainings.	☐	☐	☐	☐	☐
Ich werde bei den ersten Aufgaben vom Programm unterstützt, damit ich im Training erfolgreich bin.	☐	☐	☐	☐	☐
Alles, was ich trainiert habe, wird in einer abschließenden Aufgabe getestet. Diese Abschlussaufgaben sind oft schwieriger als normale Aufgaben.	☐	☐	☐	☐	☐
Ich erhalte Auszeichnungen für die Bewältigung besonderer Herausforderungen.	☐	☐	☐	☐	☐
Ich bewältige schwierige Aufgaben, um meine Fähigkeiten zu testen.	☐	☐	☐	☐	☐
Ich sammle Belohnungen für Trainings, die ich durchgeführt habe und kann sie mir ansehen.	☐	☐	☐	☐	☐
Ich kann eigene Inhalte im Training erstellen und aussuchen.	☐	☐	☐	☐	☐
Ich kann selber aussuchen, wie das Training optisch aussehen soll.	☐	☐	☐	☐	☐
Ich kann im Training selber neue Funktionen hinzuzufügen.	☐	☐	☐	☐	☐
Ich entdecke neue überraschende Inhalte, die im Training versteckt sind.	☐	☐	☐	☐	☐
Ich entdecke das Training (z.B. Abläufe, Funktionen oder Lösungswege) selber und kann neue Wege herausfinden, um das Training durchzuführen.	☐	☐	☐	☐	☐
Ich werde mit zusätzlichen Möglichkeiten belohnt, die meine Ergebnisse im Training verbessern und kann mich dadurch kompetenter fühlen.	☐	☐	☐	☐	☐
Das Programm erlaubt mir mit anderen Personen zu trainieren. Die Personen kann ich mir aussuchen.	☐	☐	☐	☐	☐
Ich teile im Training etwas mit anderen Patienten, um ihnen zu helfen, ihre Ziele zu erreichen.	☐	☐	☐	☐	☐
Wenn ich nicht weiterkomme, gibt mir das Training Anregungungen oder Hinweise, die mir helfen.	☐	☐	☐	☐	☐
Ich arbeite im Training mit kleinen oder großen Teams zusammen.	☐	☐	☐	☐	☐
Ich bekomme im Training das Gefühl, dass ich etwas mache, das für alle wichtig ist.	☐	☐	☐	☐	☐
Ich kann neue Funktionen für das Training vorschlagen und mit anderen darüber reden.	☐	☐	☐	☐	☐
Ich teile mein Wissen mit anderen Personen in einem speziellen Bereich für Fragen und Antworten.	☐	☐	☐	☐	☐
Ich vergleiche meine Leistung mit anderen.	☐	☐	☐	☐	☐
Ich werde angeregt, Fähigkeiten zu lernen, die im wirklichen Leben nützlich sein können.	☐	☐	☐	☐	☐
Ich bekomme angezeigt, wie weit ich im Training fortgeschritten bin und wie weit ich noch kommen kann, um die höchste Schwierigkeitsstufe zu erreichen.	☐	☐	☐	☐	☐
Ich entwickle Motivation durch den Druck, dass ich etwas verlieren kann (z.B. Status, Freunde, Punkte, Belohnungen, Fortschritt).	☐	☐	☐	☐	☐
Ich erhalte Belohnungen für mein Training, die auf Glück basieren.	☐	☐	☐	☐	☐
Ich sehe, dass mein Training ein sinnvolles Ziel erfüllt.	☐	☐	☐	☐	☐

Ich kann mir aussuchen auf welche Art ich mein Training erledige. Dadurch kann ich den weiteren Verlauf meines Trainings beeinflussen.	☐	☐	☐	☐	☐
Innerhalb des Trainings bleiben einige Aufgaben offen. Dadurch wird meine Neugier geweckt und ich versuche die Antworten darauf selbstständig zu finden.	☐	☐	☐	☐	☐
Innerhalb des Trainings wird eine Handlung erzählt und ich habe die Möglichkeit durch mein Verhalten und meine Entscheidungen ein Teil der Handlung zu sein.	☐	☐	☐	☐	☐
Ich kann ein Ziel auf verschiedenen Wegen erreichen.	☐	☐	☐	☐	☐
Das Trainingsprogramm lernt mich mit der Zeit kennen und empfiehlt mir Dinge, die mir helfen könnten.	☐	☐	☐	☐	☐
Ich erhalte Punkte zur Erledigung bestimmter Aufgaben. Punkte können zum Beispiel für Belohnungen verwendet werden.	☐	☐	☐	☐	☐
Ich bekomme für eine begrenzte Zeit die Möglichkeit, dass das Training leichter wird. Dadurch kann ich höhere Level erreichen, die ich sonst nicht geschafft hätte.	☐	☐	☐	☐	☐
Ich habe ein klares Bild davon, wie weit ich im Training fortgeschritten bin und was ich tun muss, um das nächste Level zu erreichen.	☐	☐	☐	☐	☐
Ich erhalte die Fähigkeit, etwas (z.B. eine virtuelle Figur oder einen anderen Patienten) vor Schaden zu schützen.	☐	☐	☐	☐	☐
Ich bekomme die Möglichkeit, besondere Aufgaben zu erledigen, um für mich bedeutsame Ziele zu erreichen.	☐	☐	☐	☐	☐
Ich erhalte Belohnungen, indem ich bestimmte Aufgaben erfülle bzw. Leistungen erbringe.	☐	☐	☐	☐	☐
Einige Belohnungen sind sehr selten oder schwer zu bekommen.	☐	☐	☐	☐	☐
Das Trainingsprogramm zeigt anderen Patienten an, wenn ich auf einer Schwierigkeitsstufe nicht weiter komme und spornt mich so an weiterzumachen.	☐	☐	☐	☐	☐
Ich bekomme durch direkte Hinweise gezeigt, was ich als nächstes machen kann.	☐	☐	☐	☐	☐
Ich kann meine Leistung mit anderen vergleichen und herausfinden, wie ich im Vergleich zu anderen Patienten oder Gesunden stehe.	☐	☐	☐	☐	☐
Ich fordere mich selbst und beweise mich im Training vor mir selbst.	☐	☐	☐	☐	☐
Ich kann andere Patienten im Programm durch ihre Namen oder unsere gleichen Trainings finden.	☐	☐	☐	☐	☐
Ich verbinde mich über ein Netzwerk im Programm mit so vielen anderen Patienten wie ich will.	☐	☐	☐	☐	☐
Ich bekomme Aufmerksamkeit, indem ich meinen Fortschritt anderen Patienten zeige.	☐	☐	☐	☐	☐

Die Trainingsaufgabe wird in eine thematisch passende Situation eingebettet.	☐	☐	☐	☐	☐
Im Training muss ich bestimmte Aufgaben in einer vorgeschriebenen Zeit erledigen.	☐	☐	☐	☐	☐
Ich kann von mir gesammelte Belohnungen für das Training mit anderen Patienten tauschen.	☐	☐	☐	☐	☐
Ich bekomme von einem Tutor eine Einführung in das Programm und er erklärt mir die Funktionen.	☐	☐	☐	☐	☐
Ich kann besondere Inhalte im Training benutzen, wenn ich verschiedene Lösungswege im Training gefunden habe.	☐	☐	☐	☐	☐
Ich verdiene im Training eine virtuelle Währung, um damit Güter (virtuell oder real) zu kaufen.	☐	☐	☐	☐	☐
Das Training findet in einer eigenen virtuellen Welt statt, in der ich selbstständig handeln kann.	☐	☐	☐	☐	☐
Ich kann innerhalb des Trainings über dessen Veränderungen mit abstimmen.	☐	☐	☐	☐	☐

Figure 28. German translation of the questionnaire by Tondello et al. [374] for analyzing the type according to the Player and User Hexad [244].

Inwieweit stimmen Sie den Aussagen zu? Bitte geben Sie Ihre persönliche Meinung an.

	stimme überhaupt nicht zu	stimme nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme zu	stimme völlig zu	Type
Es macht mich glücklich, wenn ich anderen helfen kann.	☐	☐	☐	☐	☐	☐	☐	P1
Ich mag es nicht, Regeln zu befolgen.	☐	☐	☐	☐	☐	☐	☐	D4
Ich meistere gerne schwierige Aufgaben.	☐	☐	☐	☐	☐	☐	☐	A4
Das Wohlergehen anderer ist mir wichtig.	☐	☐	☐	☐	☐	☐	☐	P4
Selbständigkeit ist mir wichtig.	☐	☐	☐	☐	☐	☐	☐	F4
Ich überwinde gerne Hindernisse.	☐	☐	☐	☐	☐	☐	☐	A1
Ich sehe mich als Rebell.	☐	☐	☐	☐	☐	☐	☐	D3
Ich helfe gerne anderen, sich in neuen Situationen zu orientieren.	☐	☐	☐	☐	☐	☐	☐	P2
Ich stelle gerne den aktuellen Zustand in Frage.	☐	☐	☐	☐	☐	☐	☐	D2
Der Lohn meiner getätigten Anstrengung ist mir wichtig.	☐	☐	☐	☐	☐	☐	☐	R3
Ich probiere gerne neue Dinge aus.	☐	☐	☐	☐	☐	☐	☐	F3
Ich mag Gruppenaktivitäten.	☐	☐	☐	☐	☐	☐	☐	S4
Ich provoziere gerne.	☐	☐	☐	☐	☐	☐	☐	D1
Wenn die Belohnung ausreicht, werde ich mich anstrengen.	☐	☐	☐	☐	☐	☐	☐	R4
Ich teile gerne mein Wissen.	☐	☐	☐	☐	☐	☐	☐	P3
Ich lasse mich oft von meiner Neugier leiten.	☐	☐	☐	☐	☐	☐	☐	F2
Es ist mir wichtig, mich als Teil einer Gemeinschaft zu fühlen.	☐	☐	☐	☐	☐	☐	☐	S3
Ich mag Wettbewerbe, bei denen ein Preis gewonnen werden kann.	☐	☐	☐	☐	☐	☐	☐	R1
Es ist mir wichtig, meine Aufgaben immer vollständig zu erfüllen.	☐	☐	☐	☐	☐	☐	☐	A2
Es fällt mir schwer, ein Problem loszulassen, bevor ich eine Lösung gefunden habe.	☐	☐	☐	☐	☐	☐	☐	A3
Belohnungen sind eine gute Möglichkeit, mich zu motivieren.	☐	☐	☐	☐	☐	☐	☐	R2
Es ist mir wichtig, meinen eigenen Weg zu gehen.	☐	☐	☐	☐	☐	☐	☐	F1
Ich mag es, Teil eines Teams zu sein.	☐	☐	☐	☐	☐	☐	☐	S2
Der Umgang mit anderen ist mir wichtig.	☐	☐	☐	☐	☐	☐	☐	S1

P: Philanthropist, S: Socialiser, F: Free Spirit, A: Achiever, D: Disruptor, R: Player
(Note: The assignment to the player type is only included here for scoring purposes. This was not visible for participants.)

Figure 29. Enlarged version of Figure 11: Ratings of Game Elements depending on User Type in Patients. Figure from Gabele et al. [136].

Digital version of the attached questionnaires

3.2.1 Complementarity, Effects and Deepening in the Use of Interactive Storytelling and Quest

The appendix contains

- Questionnaires used within the studies as a basis for the Research Questions, sorted by chapters
- Link to the Gamification Guide Video Prototype

Note: Parts are blacked out for copyright reasons.

Datum: __________ ID:____

Vorbefragung

Geburtsdatum: ____________________ (TT.MM.JJJJ)

Geschlecht: ☐ männlich ☐ weiblich

Höchster Bildungsabschluss:
☐ kein Abschluss
☐ 8. Klasse (Haupt- / Volksschulabschluss)
☐ 10. Klasse (Realschule / Mittlere Reife / POS)
☐ 12./13. Klasse (Abitur / Fachabitur)

Händigkeit: ☐ rechts ☐ links ☐ ambidexter

neurologische Erkrankung: ☐ Schlaganfall ☐ Schädel-Hirn-Trauma

Zeitpunkt der Hirnschädigung: ____________________ (TT.MM.JJJJ)

Wie häufig nutzen Sie Computer in Ihrem Alltag?
☐ (fast) nie ☐ selten ☐ ein wenig ☐ häufig ☐ (fast) täglich

Haben Sie Erfahrungen mit RehaCom?
☐ ja ☐ nein ☐ weiß nicht

Haben Sie Erfahrungen mit dem Trainingsmodul „geteilte Aufmerksamkeit“ (Autofahren)?
☐ ja ☐ nein ☐ weiß nicht

Wie motiviert sind Sie gerade?
☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie erschöpft sind Sie gerade?
☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

---

Einschätzung der Leistungsfähigkeit durch den Therapeuten (zutreffendes bitte ankreuzen):

	intakt	leicht beeinträchtigt	leicht bis mittelgradig beeinträchtigt	mittelgradig bis schwer beeinträchtigt	schwer beeinträchtigt
Aufmerksamkeit					
Gedächtnis					
Exekutivfunktionen					
Belastbarkeit					

Datum: __________ ID:____

Zwischenbefragung

Wie motiviert sind Sie gerade?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie erschöpft sind Sie gerade?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie anstrengend fanden Sie die Trainingseinheit bislang?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Konnten Sie sich konzentrieren und bei der Sache bleiben?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Datum: __________ ID:____

Nachbefragung

Wie motiviert sind Sie gerade?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie erschöpft sind Sie gerade?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie anstrengend fanden Sie die Trainingseinheit?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Konnten Sie sich konzentrieren und bei der Sache bleiben?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie hat Ihnen die Trainingseinheit insgesamt gefallen?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Fanden Sie die Trainingseinheit interessant?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Beschreiben Sie kurz in eigenen Worten Ihre Aufgabe in dieser Trainingseinheit:

___

Was hat Ihnen besonders gut gefallen?

___

Was hat Ihnen nicht gefallen bzw. was könnte verbessert werden?

___

Möchten Sie dieses Trainingsmodul auch in der nächsten Einheit nutzen?

☐ ja ☐ nein ☐ vielleicht

Würden Sie dieses Training zu Hause fortsetzen, wenn es die Möglichkeit gäbe?

☐ ja ☐ nein ☐ vielleicht

Haben Sie die Autofahrten als sinnvoll erlebt?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Welches Ziel hatten Sie im Training vor Augen?

____

Wurde das Autofahren durch das Einbetten in die Detektivgeschichte interessanter?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Haben Sie sich beim Autofahren besonders Mühe gegeben, damit Sie in der Handlung vorankommen und den Fall lösen können?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie wichtig ist es für Sie, dass das Training in eine sinnvolle Handlung einbettet wird?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Hat die freie Auswahl der Fahrtziele Ihr Interesse am Training gesteigert?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Konnten Sie mit Ihren Entscheidungen das Geschehen aktiv beeinflussen?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie wichtig ist es für Sie, die Handlung im Training mitbestimmen zu können?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Hatten Sie das Gefühl, dass Sie die Detektei durch Ihre Leistungen unterstützen konnten?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Haben Sie sich durch Ihre Mitarbeit am Fall aktiv in die Geschichte eingebunden gefühlt?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

War Ihnen die in der Detektivgeschichte an Sie übertragene Verantwortung unangenehm?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Datum: __________ ID:____

Haben Sie während des Autofahrens an die Detektivgeschichte gedacht?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Hat Sie die Detektivgeschichte vom Autofahren abgelenkt?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Mussten Sie während der Autofahrt Informationen Ihres Auftrags im Kopf behalten?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Haben Sie die Detektivgeschichte verstanden?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr gut

War die Detektivgeschichte interessant?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie gut passt die Detektivgeschichte zum Training (Autofahren)?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Wie plausibel war die Auflösung am Ende?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr

Würden Sie gerne weitere Fälle kennenlernen?

☐ überhaupt nicht ☐ fast nicht ☐ ein wenig ☐ überwiegend ☐ sehr gerne

Haben Sie Anmerkungen, Fragen oder Kritik?

____

Wie denken Sie über die heutige Trainingseinheit?

[redacted]

Vielen Dank, dass Sie an der Befragung teilgenommen haben!

3.2.2 In-Depth Designs and Development of Accompanying Non-Player Characters

In die Wanderschuhe..

Informationen und Einwilligung

In der nachfolgenden Studie werden die Daten anonym erhoben. Es können keine Rückschlüsse auf Ihre Person gezogen werden. Sie können Ihre Einwilligung zur Speicherung und Nutzung Ihrer Daten während der Erhebung jederzeit widerrufen, ohne dass Ihnen Nachteile daraus entstehen. Die Daten dienen Forschungszwecken und werden wissenschaftlich veröffentlicht.

Sie werden Fragen beantworten, die sich auf Ihre eigene Ansicht beziehen. Es gibt daher keine richtigen oder falschen Antworten, wir interessieren uns für Ihre eigene Sichtweise.

Die Teilnahme an dieser Studie ist freiwillig. Sie können jederzeit ohne Angabe von Gründen die Teilnahme beenden, ohne dass Ihnen dadurch Nachteile entstehen.

Sollten Sie noch weitere Fragen zum Ablauf der Studie, zum Datenschutz, zu Ihren Rechten, usw. haben, können Sie diese jederzeit an den Versuchsleiter stellen.

Haben Sie die Informationen verstanden und stimmen Sie auf dieser Basis zu an der Studie teilzunehmen?

1.

Markieren Sie nur ein Oval.

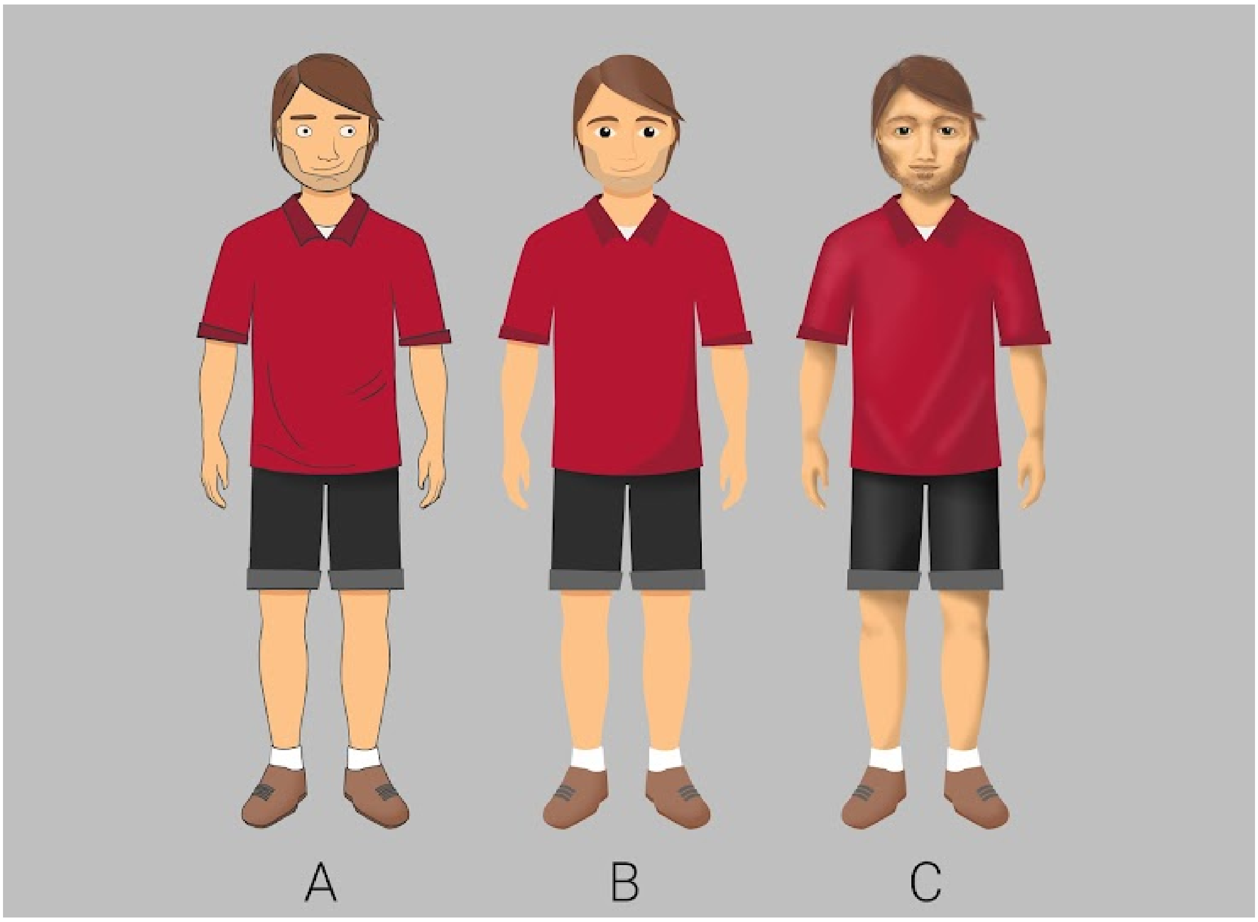
- ( ) Ich stimme zu und möchte teilnehmen *Wechseln Sie zu Abschnitt 3 ()*
- ( ) Ich stimme nicht zu und möchte nicht teilnehmen *Wechseln Sie zu Abschnitt 2 (Vielen Dank und einen schönen Tag!)*

Vielen Dank und einen schönen Tag!

Stellen Sie sich vor, Sie gehen auf eine lange Wanderung und sie haben die Möglichkeit einen Begleiter mitzunehmen...

Wie soll dieser Begleiter sein?

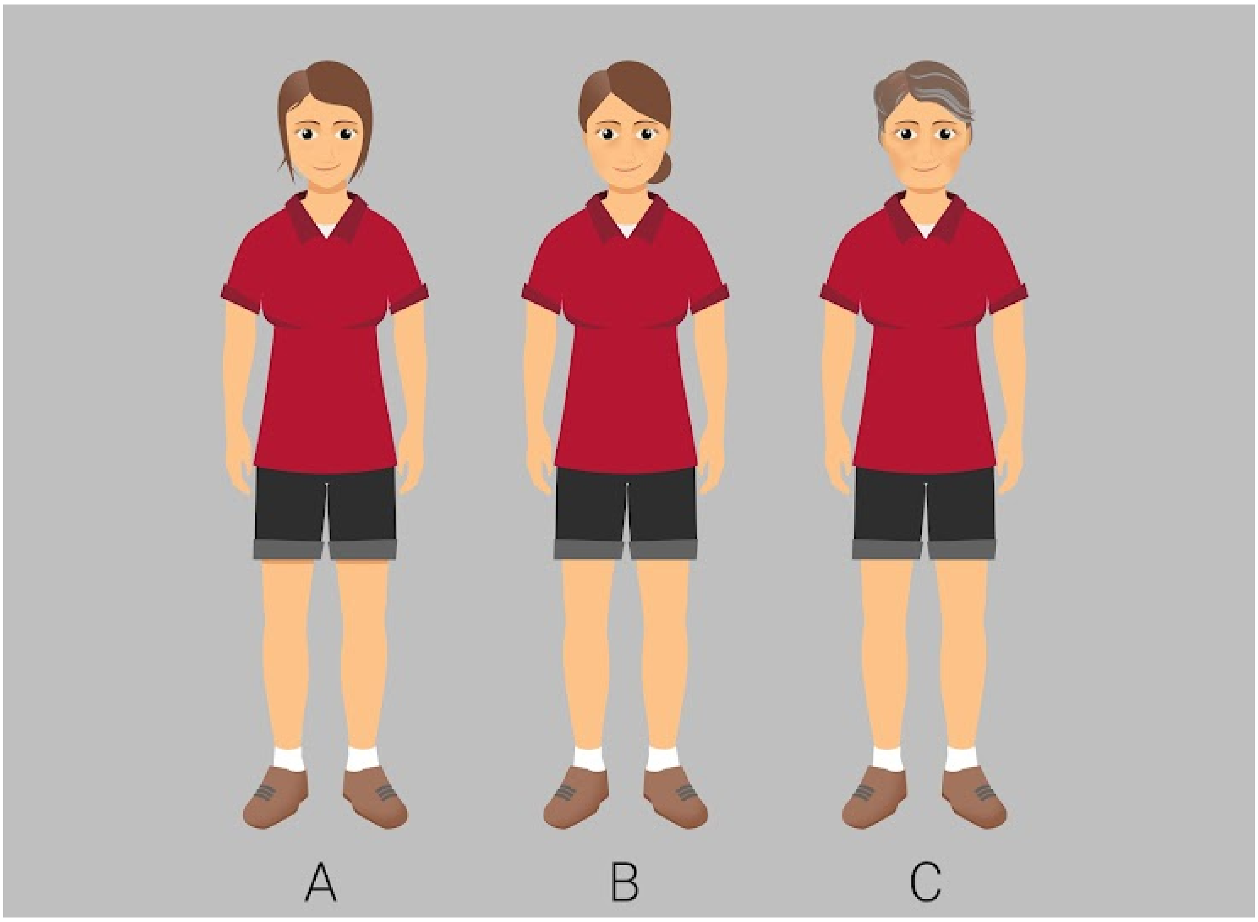
Wen möchten Sie als Begleiter mitnehmen?



2.
Markieren Sie nur ein Oval.

- A
- B
- C

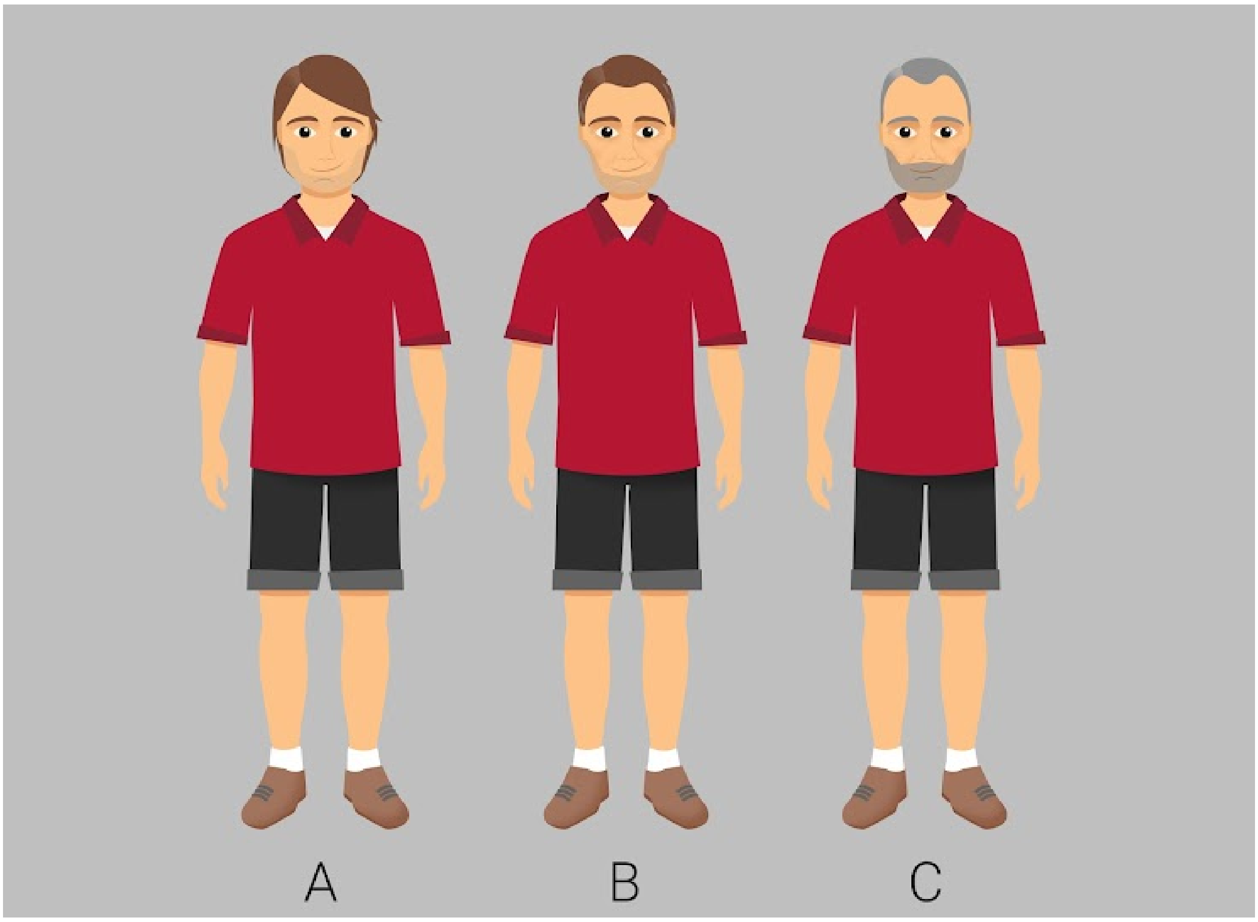
Wen möchten Sie als Begleiter mitnehmen?



3.
Markieren Sie nur ein Oval.

- ⬭ A
- ⬭ B
- ⬭ C

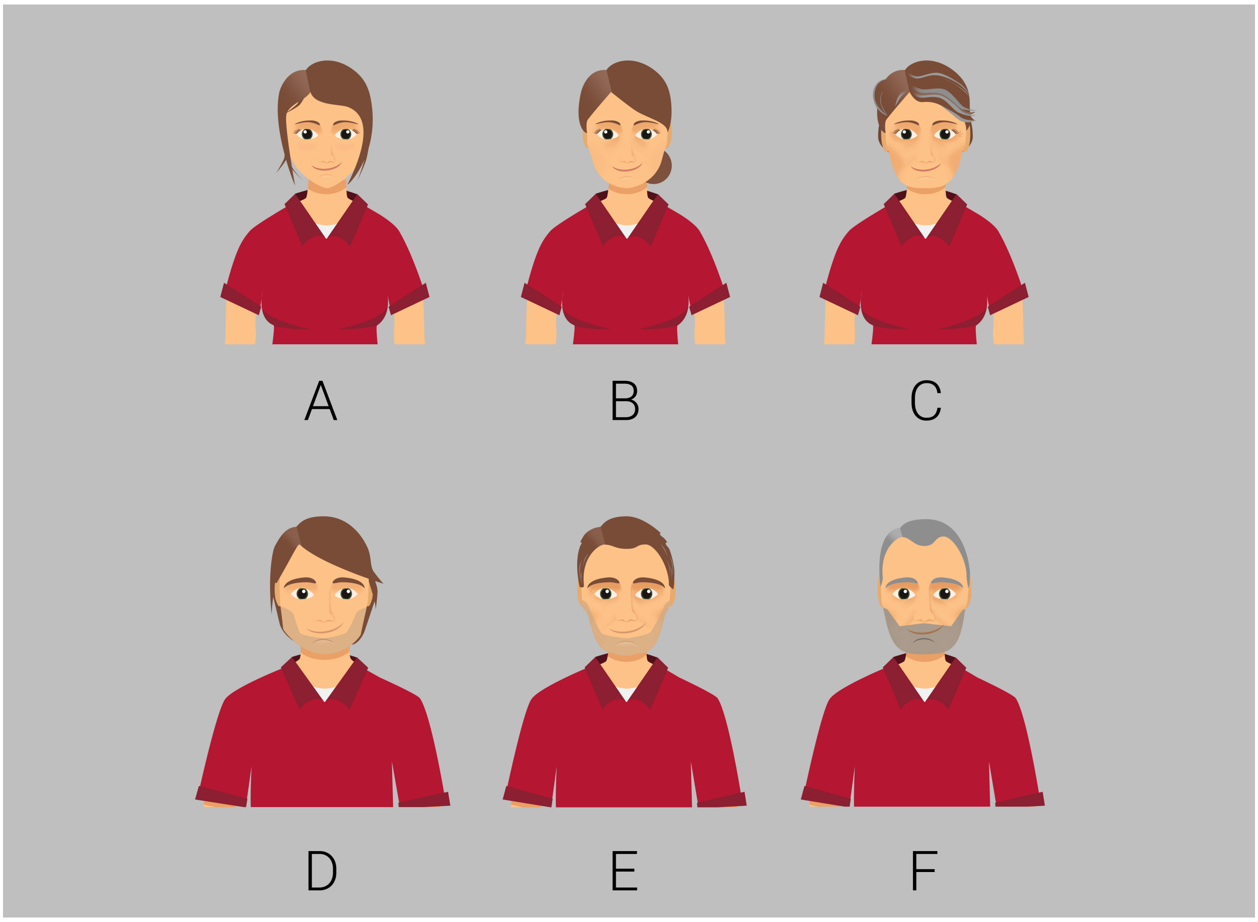
Wen möchten Sie als Begleiter mitnehmen?



4.
Markieren Sie nur ein Oval.

- A
- B
- C

Sie haben eben zwei der Personen ausgewählt. Welche der beiden Personen möchten Sie als Begleiter mitnehmen?



5.

Markieren Sie nur ein Oval.

- A
- B
- C
- D
- E
- F

Und Sie?

...noch drei kurze Fragen zu Ihnen

6. Bitte geben Sie ihr Alter an:

Markieren Sie nur ein Oval.

- bis 20
- 20 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 - 69
- 70 - 79
- über 8

7. Bitte geben Sie Ihr Geschlecht an:

Markieren Sie nur ein Oval.

- weiblich
- männlich
- sonstiges

8. Haben oder hatten Sie eine erworbene Hirnschädigung?

Markieren Sie nur ein Oval.

- Ja
- Nein

Vielen Dank für Ihre Unterstützung!

Offene Fragen

9. Welche Eigenschaften sollte Ihr Begleiter haben?

10. Stil: Warum wurde sich so entschieden?

11. Mann: Warum wurde sich so entschieden?

12. Frau: Warum wurde sich so entschieden?

13. Finale Auswahl: Warum wurde sich so entschieden?

3.3 User Requests, Effects and Ways of Tailored Gamification in Software-Based Training

Datum:____________ ID:______________

Fragebogen Therapeut

Bitte geben Sie bitte für Ihren Patienten an:

Zeitpunkt der Hirnschädigung: __________________ (TT.MM.JJJJ)

Ursache der Hirnschädigung:
- ☐ Schlaganfall
- ☐ Hirnblutung
- ☐ Schädel-Hirn-Trauma
- ☐ Hypoxie
- ☐ Tumor
- ☐ Infektion
- ☐ Intoxikation
- ☐ multiple Sklerose
- ☐ degenerative Erkrankung
- ☐ andere: _____________________________

Wie schwer schätzen Sie die kognitiven Beeinträchtigungen insgesamt ein?

- ☐ leichte Einschränkung (geringe kognitive Defizite und kaum Auswirkungen im Alltag, durch interne Strategien und externe Hilfsmittel gut kompensierbar)
- ☐ mittelgradige Einschränkung (mittelgradige kognitive Defizite und spürbare Auswirkungen im Alltag, durch interne Strategien und externe Hilfsmittel nicht hinreichend kompensierbar)
- ☐ schwere Einschränkung (schwere kognitive Defizite und deutliche Auswirkungen im Alltag, in vielen alltäglichen Situationen aufgrund dieser Beeinträchtigungen auf externe Hilfe angewiesen)

Datum:____________ ID:______________

Informationen und Einwilligung

In der nachfolgenden Studie werden die Daten anonym erhoben. Es können keine Rückschlüsse auf Ihre Person gezogen werden. Sie können Ihre Einwilligung zur Speicherung und Nutzung Ihrer Daten während der Erhebung jederzeit widerrufen, ohne dass Ihnen Nachteile daraus entstehen. Die Daten dienen Forschungszwecken und werden wissenschaftlich veröffentlicht.

Sie werden Fragen beantworten, die sich auf Ihre eigene Ansicht beziehen. Es gibt daher keine richtigen oder falschen Antworten, wir interessieren uns für Ihre eigene Sichtweise.

Die Teilnahme an dieser Studie ist freiwillig. Sie können jederzeit ohne Angabe von Gründen die Teilnahme beenden, ohne dass Ihnen dadurch Nachteile entstehen.

Sollten Sie noch weitere Fragen zum Ablauf der Studie, zum Datenschutz, zu Ihren Rechten, usw. haben, können Sie diese jederzeit an den Versuchsleiter stellen.

Haben Sie die Informationen verstanden und stimmen Sie auf dieser Basis zu an der Studie teilzunehmen?

☐ Ja ☐ Nein

________________________________ ________________________________

Vorname, Nachname Unterschrift

Datum:____________ ID:______________

Bitte geben Sie an:

Alter: ____________ Jahre

Geschlecht:

☐ weiblich
☐ männlich
☐ divers

Nutzen Sie Computer, Tablets oder Smartphones?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Haben Sie Erfahrung mit kognitiven Trainings (zum Beispiel RehaCom)?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Wenn ja:

Machen diese Ihnen Spaß?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Helfen diese Ihnen konkret in Ihrem Alltag?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Datum:____________ ID:______________

Bitte geben Sie entsprechend Ihrer persönlichen Einschätzung an:

1) Wie hat Ihnen das Training gefallen?

☐ Sehr gut ☐ Gut ☐ Befriedigend ☐ Ausreichend ☐ Schlecht

2) Hat Ihnen das Training Spaß gemacht?

☐ Sehr ☐ Eher ☐ Neutral ☐ Eher nicht ☐ Nicht

3) Wie anstrengend war das Training für Sie?

☐ Sehr ☐ Eher ☐ Neutral ☐ Eher nicht ☐ Nicht

4) Haben Sie verstanden, was sie bei der Aufgabe machen sollten?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Wenn es Schwierigkeiten gab, wo lagen diese?

____

5) Haben Sie das “Bildhafte Vorstellen” verstanden?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Wenn es Schwierigkeiten gab, wo lagen diese?

____

6) Haben Sie das “Bildhafte Vorstellen” beim Lesen der Texte angewendet?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Wenn eher nicht, warum?

____

7) Werden Sie das “Bildhaftes Vorstellen” Zuhause in Ihrem Alltag ausprobieren?

☐ Ja ☐ Eher Ja ☐ Teilweise ☐ Eher Nein ☐ Nein

Wenn eher nicht, warum?

____

Datum:____________ ID:______________

8) Im Training haben Sie an verschiedenen Stellen Strategien ("Bildhaftes Vorstellen") gelernt. Bitte bewerten Sie diese nach Ihrer persönlichen Einschätzung:

	trifft voll und ganz zu	**eher zutreffend**	**weder noch**	**trifft eher nicht zu**	**trifft überhaupt nicht zu**
Die Erklärung "Bildhaftes Vorstellen" am Anfang vom Training hat mir gefallen.					
Die Wiederholung und Ergänzung für "Bildhaftes Vorstellen" nach der ersten Aufgabe fand ich sinnvoll.					
Die Idee am Ende, wie ich das "Bildhaftes Vorstellen" im Alltag nutzen kann hat mir gefallen.					

9) Bitte geben Sie an, wie Sie das Training für sich selber bewerten:

	stimme völlig zu	**stimme zu**	**stimme eher zu**	**weder noch**	**stimme eher nicht zu**	**stimme nicht zu**	**stimme gar nicht zu**
Ich denke, die Strategie nützlich ist, um mir leichter Dinge zu merken.	☐	☐	☐	☐	☐	☐	☐
Ich bin mit meiner Leistung bei dieser Aufgabe zufrieden.	☐	☐	☐	☐	☐	☐	☐
Nachdem ich das Training gemacht habe, habe ich mich kompetenter gefühlt.	☐	☐	☐	☐	☐	☐	☐
Ich denke es ist wichtig, Strategien zu lernen um es leichter im Alltag zu haben.	☐	☐	☐	☐	☐	☐	☐
Ich denke, ich werde die Strategie wieder einsetzen, da sie mir hilft.	☐	☐	☐	☐	☐	☐	☐
Ich denke, ich war recht gut in diesem Training.	☐	☐	☐	☐	☐	☐	☐

Datum:____________ ID:______________

Verhaltensbeobachtung:
1) Wurde die Strategie gelesen? (Zeit gelassen zum Lesen oder gleich weiter geklickt?)

Ja	Teilweise	Nein

Anmerkung

2) Wurde “falsch” ausgewählt? (nicht die Antwort falsch, sondern in der Nutzung bzw der Klickreihenfolge falsch)

Ja	Teilweise	Nein

Anmerkung

Datum:____________ ID:______________

Gruppengespräch:

Insgesamt:

- Wie hat es Ihnen gefallen? Und warum? (Was war gut, was war nicht so gut)

- Hat das Programm so reagiert, wie sie erwartet haben? (Wenn nein, wann nicht)

- Wie hat es Ihnen gefallen die Strategie an die Hand zu bekommen?

Instruktionen:

- Waren die Instruktionen in der Länge ok? Zu lang, zu kurz oder unverständlich?

Usability:

- Haben Sie verstanden, wie die Bewertung (die Sterne) funktioniert hat oder gab es Probleme?

- Hat jemand das Fragezeichen / Hilfesymbol genutzt? Wenn, warum?
    - Wenn nein - nicht gesehen oder nicht gebraucht? (Nachfragen?)

Visuell:

- Wie hat Ihnen das Aussehen gefallen? (Wirkte es eher alt oder modern, ruhig oder chaotisch etc)

RehaCom @ home - Einstiegsfragen

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass Sie uns bei der Studie unterstützen. Bevor Sie mit dem Training starten, möchten wir Sie und Ihre persönliche Einstellung kennenlernen. Es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 10 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben: *

Bitte geben Sie Ihre Antwort hier ein:

Demografische Fragen (Seite 1 von 4)

Ihr Alter: *

In dieses Feld dürfen nur Zahlen eingegeben werden.

Bitte geben Sie Ihre Antwort hier ein:

Ihr Geschlecht: *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ männlich
- ◯ weiblich
- ◯ divers

Ihr höchster Bildungsabschluss: *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ kein Abschluss
- ◯ Haupt- / Volksschulabschluss
- ◯ Realschule / Mittlere Reife / POS
- ◯ Abitur / Fachabitur
- ◯ Hochschulabschluss

Wieviel Erfahrung haben Sie mit computergestützten kognitiven Therapien?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ keine
- ◯ nur wenige Trainingseinheiten
- ◯ mehrere Wochen im Rahmen von stationärer/ambulanter Behandlung
- ◯ mehrere Monate mehr oder weniger regelmäßige Anwendung
- ◯ seit mehr als einem Jahr regelmäßige Anwendung

Wie häufig nutzen Sie digitalen Medien (z.B. am Computer, Tablet oder Handy)?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ weniger als einmal im Monat
- ◯ ca. einmal im Monat
- ◯ ca. einmal die Woche
- ◯ mehrfach die Woche
- ◯ täglich

Ihre eigene Einstellung (Seite 2 von 4)

Bitte geben Sie an: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

Bitte beschreiben Sie sich: *

[redacted]

	[redacted]					
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○

Ihre eigene Einstellung (3 von 4)

Inwieweit stimmen Sie den Aussagen zu? Bitte geben Sie Ihre persönliche Meinung an. *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	stimme überhaupt nicht zu	stimme nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme zu	stimme völlig zu
Es macht mich glücklich, wenn ich anderen helfen kann.	○	○	○	○	○	○	○
Ich mag es nicht, Regeln zu befolgen.	○	○	○	○	○	○	○
Ich meistere gerne schwierige Aufgaben.	○	○	○	○	○	○	○
Das Wohlergehen anderer ist mir wichtig.	○	○	○	○	○	○	○
Selbständigkeit ist mir wichtig.	○	○	○	○	○	○	○
Ich überwinde gerne Hindernisse.	○	○	○	○	○	○	○
Ich sehe mich als Rebell.	○	○	○	○	○	○	○
Ich helfe gerne anderen, sich in neuen Situationen zu orientieren.	○	○	○	○	○	○	○
Ich stelle gerne den aktuellen Zustand in Frage.	○	○	○	○	○	○	○
Der Lohn meiner getätigten Anstrengung ist mir wichtig.	○	○	○	○	○	○	○

	stimme überhaupt nicht zu	stimme nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme zu	stimme völlig zu
Ich probiere gerne neue Dinge aus.	○	○	○	○	○	○	○
Ich mag Gruppenaktivitäten.	○	○	○	○	○	○	○
Ich provoziere gerne.	○	○	○	○	○	○	○
Wenn die Belohnung ausreicht, werde ich mich anstrengen.	○	○	○	○	○	○	○
Ich teile gerne mein Wissen.	○	○	○	○	○	○	○
Ich lasse mich oft von meiner Neugier leiten.	○	○	○	○	○	○	○
Es ist mir wichtig, mich als Teil einer Gemeinschaft zu fühlen.	○	○	○	○	○	○	○
Ich mag Wettbewerbe, bei denen ein Preis gewonnen werden kann.	○	○	○	○	○	○	○
Es ist mir wichtig, meine Aufgaben immer vollständig zu erfüllen.	○	○	○	○	○	○	○
Es fällt mir schwer, ein Problem loszulassen, bevor ich eine Lösung gefunden habe.	○	○	○	○	○	○	○
Belohnungen sind eine gute Möglichkeit, mich zu motivieren.	○	○	○	○	○	○	○

	stimme überhaupt nicht zu	stimme nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme zu	stimme völlig zu
Es ist mir wichtig, meinen eigenen Weg zu gehen.	○	○	○	○	○	○	○
Ich mag es, Teil eines Teams zu sein.	○	○	○	○	○	○	○
Der Umgang mit anderen ist mir wichtig.	○	○	○	○	○	○	○

Was motiviert Sie? (Seite 4 von 4)

Sie haben sich entschlossen, im Rahmen der Studie Ihre geistige Leistungsfähigkeit zu trainieren. Welche Funktionen oder Elemente würden Ihnen gefallen? Welche würden Sie im Training motivieren?

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich darf die komplizierten Aufgaben erst machen, wenn ich die einfachen geschafft habe.	○	○	○	○	○
Ich bekomme mehr Verantwortung übertragen und helfe anderen Patienten.	○	○	○	○	○
Ich habe die Freiheit ohne Regeln zu trainieren wie ich möchte.	○	○	○	○	○
Ich kann mir aussuchen, ob ich lieber die Trainingsaufgaben erledige, um im Schwierigkeitsgrad aufzusteigen oder ob ich Geld bezahle (echt oder virtuell) um damit im Schwierigkeitsgrad aufzusteigen.	○	○	○	○	○

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich bleibe während des Trainings anonym, das bedeutet, dass weder dem Programm noch anderen Patienten angezeigt wird, wer ich bin.	◯	◯	◯	◯	◯
Durch die Vorarbeit von Anderen, kann das Training für mich einfacher werden. (Zum Beispiel gesammelte Punkte von einer anderen Person mit nutzen.)	◯	◯	◯	◯	◯
Ich werde im Programm durch eine virtuelle Figur, die ich selbst gestalte, präsentiert.	◯	◯	◯	◯	◯
Ich bekomme eine Anerkennung für das Erreichen wichtiger Ziele innerhalb des Trainings.	◯	◯	◯	◯	◯
Ich werde bei den ersten Aufgaben vom Programm unterstützt, damit ich im Training erfolgreich bin.	◯	◯	◯	◯	◯

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Alles, was ich trainiert habe, wird in einer abschließenden Aufgabe getestet. Diese Abschlussaufgaben sind oft schwieriger als normale Aufgaben.	◯	◯	◯	◯	◯
Ich erhalte Auszeichnungen für die Bewältigung besonderer Herausforderungen.	◯	◯	◯	◯	◯
Ich bewältige schwierige Aufgaben, um meine Fähigkeiten zu testen.	◯	◯	◯	◯	◯
Ich sammle Belohnungen für Trainings, die ich durchgeführt habe und kann sie mir ansehen.	◯	◯	◯	◯	◯
Ich kann eigene Inhalte im Training erstellen und aussuchen.	◯	◯	◯	◯	◯
Ich kann selber aussuchen, wie das Training optisch aussehen soll.	◯	◯	◯	◯	◯
Ich kann im Training selber neue Funktionen hinzuzufügen.	◯	◯	◯	◯	◯

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich entdecke neue überraschende Inhalte, die im Training versteckt sind.	◯	◯	◯	◯	◯
Ich entdecke das Training (z.B. Abläufe, Funktionen oder Lösungswege) selber und kann neue Wege herausfinden, um das Training durchzuführen.	◯	◯	◯	◯	◯
Ich werde mit zusätzlichen Möglichkeiten belohnt, die meine Ergebnisse im Training verbessern und kann mich dadurch kompetenter fühlen.	◯	◯	◯	◯	◯
Das Programm erlaubt mir mit anderen Personen zu trainieren. Die Personen kann ich mir aussuchen.	◯	◯	◯	◯	◯
Ich teile im Training etwas mit anderen Patienten, um ihnen zu helfen, ihre Ziele zu erreichen.	◯	◯	◯	◯	◯
Wenn ich nicht weiterkomme, gibt mir das Training Anregungen oder Hinweise, die mir helfen.	◯	◯	◯	◯	◯

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich arbeite im Training mit kleinen oder großen Teams zusammen.	◯	◯	◯	◯	◯
Ich bekomme im Training das Gefühl, dass ich etwas mache, das für alle wichtig ist.	◯	◯	◯	◯	◯
Ich kann neue Funktionen für das Training vorschlagen und mit anderen darüber reden.	◯	◯	◯	◯	◯
Ich teile mein Wissen mit anderen Personen in einem speziellen Bereich für Fragen und Antworten.	◯	◯	◯	◯	◯
Ich vergleiche meine Leistung mit anderen.	◯	◯	◯	◯	◯
Ich werde angeregt, Fähigkeiten zu lernen, die im wirklichen Leben nützlich sein können.	◯	◯	◯	◯	◯
Ich bekomme angezeigt, wie weit ich im Training fortgeschritten bin und wie weit ich noch kommen kann, um die höchste Schwierigkeitsstufe zu erreichen.	◯	◯	◯	◯	◯

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich entwickle Motivation durch den Druck, dass ich etwas verlieren kann (z.B. Status, Freunde, Punkte, Belohnungen, Fortschritt).	○	○	○	○	○
Ich erhalte Belohnungen für mein Training, die auf Glück basieren.	○	○	○	○	○
Ich sehe, dass mein Training ein sinnvolles Ziel erfüllt.	○	○	○	○	○
Ich kann mir aussuchen auf welche Art ich mein Training erledige. Dadurch kann ich den weiteren Verlauf meines Trainings beeinflussen.	○	○	○	○	○
Innerhalb des Trainings bleiben einige Aufgaben offen. Dadurch wird meine Neugier geweckt und ich versuche die Antworten darauf selbstständig zu finden.	○	○	○	○	○

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Innerhalb des Trainings wird eine Handlung erzählt und ich habe die Möglichkeit durch mein Verhalten und meine Entscheidungen ein Teil der Handlung zu sein.	◯	◯	◯	◯	◯
Ich kann ein Ziel auf verschiedenen Wegen erreichen.	◯	◯	◯	◯	◯
Das Trainingsprogramm lernt mich mit der Zeit kennen und empfiehlt mir Dinge, die mir helfen könnten.	◯	◯	◯	◯	◯
Ich erhalte Punkte zur Erledigung bestimmter Aufgaben. Punkte können zum Beispiel für Belohnungen verwendet werden.	◯	◯	◯	◯	◯
Ich bekomme für eine begrenzte Zeit die Möglichkeit, dass das Training leichter wird. Dadurch kann ich höhere Level erreichen, die ich sonst nicht geschafft hätte.	◯	◯	◯	◯	◯

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich habe ein klares Bild davon, wie weit ich im Training fortgeschritten bin und was ich tun muss, um das nächste Level zu erreichen.	◯	◯	◯	◯	◯
Ich erhalte die Fähigkeit, etwas (z.B. eine virtuelle Figur oder einen anderen Patienten) vor Schaden zu schützen.	◯	◯	◯	◯	◯
Ich bekomme die Möglichkeit, besondere Aufgaben zu erledigen, um für mich bedeutsame Ziele zu erreichen.	◯	◯	◯	◯	◯
Ich erhalte Belohnungen, indem ich bestimmte Aufgaben erfülle bzw. Leistungen erbringe.	◯	◯	◯	◯	◯
Einige Belohnungen sind sehr selten oder schwer zu bekommen.	◯	◯	◯	◯	◯
Das Trainingsprogramm zeigt anderen Patienten an, wenn ich auf einer Schwierigkeitsstufe nicht weiter komme und spornt mich so an weiterzumachen.	◯	◯	◯	◯	◯

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich bekomme durch direkte Hinweise gezeigt, was ich als nächstes machen kann.	○	○	○	○	○
Ich kann meine Leistung mit anderen vergleichen und herausfinden, wie ich im Vergleich zu anderen Patienten oder Gesunden stehe.	○	○	○	○	○
Ich fordere mich selbst und beweise mich im Training vor mir selbst.	○	○	○	○	○
Ich kann andere Patienten im Programm durch ihre Namen oder unsere gleichen Trainings finden.	○	○	○	○	○
Ich verbinde mich über ein Netzwerk im Programm mit so vielen anderen Patienten wie ich will.	○	○	○	○	○
Ich bekomme Aufmerksamkeit, indem ich meinen Fortschritt anderen Patienten zeige.	○	○	○	○	○
Die Trainingsaufgabe wird in eine thematisch passende Situation eingebettet.	○	○	○	○	○

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Im Training muss ich bestimmte Aufgaben in einer vorgeschriebenen Zeit erledigen.	○	○	○	○	○
Ich kann von mir gesammelte Belohnungen für das Training mit anderen Patienten tauschen.	○	○	○	○	○
Ich bekomme von einem Tutor eine Einführung in das Programm und er erklärt mir die Funktionen.	○	○	○	○	○
Ich kann besondere Inhalte im Training benutzen, wenn ich verschiedene Lösungswege im Training gefunden habe.	○	○	○	○	○
Ich verdiene im Training eine virtuelle Währung, um damit Güter (virtuell oder real) zu kaufen.	○	○	○	○	○
Das Training findet in einer eigenen virtuellen Welt statt, in der ich selbstständig handeln kann.	○	○	○	○	○

	Finde ich überhaupt nicht gut	Finde ich eher nicht gut	Neutral	Finde ich eher gut	Finde ich sehr gut
Ich kann innerhalb des Trainings über dessen Veränderungen mit abstimmen.	◯	◯	◯	◯	◯

Herzlichen Dank für Ihre Unterstützung!

Sie können jetzt diesen Browser-Tab schließen, um sich mit RehaCom vertraut zu machen.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Zwischenbefragung A

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass sie bisher trainiert haben. Nachfolgend haben wir bis zum heutigen Training einige Fragen an Sie.

Bitte beantworten Sie diese Fragen nach ihrer persönlichen Einschätzung, es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 11 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben: *

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 3)

Wieviel Spaß hat Ihnen das Training bisher gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ keinen
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ viel

Wie anstrengend fanden Sie das Training bisher? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ nicht
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ sehr

Wie sind Sie mit dem Training zuhause selbstständig zurecht gekommen?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ überhaupt nicht
- ◯ nicht so gut
- ◯ mittelmäßig
- ◯ eher gut
- ◯ einwandfrei

Gab es anfangs technische Schwierigkeiten?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar folgende:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Haben Sie Hilfe benötigt?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar bei folgendem Problem, dabei hat mir folgende Person helfen können:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	○	○	○	○	○
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	○	○	○	○	○
Ich finde die Texte inhaltlich spannend.	○	○	○	○	○
Mir gefällt die Trainingsaufgabe.	○	○	○	○	○
Ich habe während des Trainings ein gutes Gefühl.	○	○	○	○	○
Ich habe nach dem Training ein gutes Gefühl.	○	○	○	○	○
Ich möchte in höhere Level aufsteigen.	○	○	○	○	○
Ich möchte positives Feedback bekommen.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich habe mir Ziele gesetzt, die ich erreichen möchte.					
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.					
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.					
Das Training hilft mir dabei, meinen Tag zu strukturieren.					
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.					
Ich kann durch das Training meine Belastbarkeit erproben.					
Das Training ist eine sinnvolle Beschäftigung.					

Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Die Person an Ihrer Seite (2 von 3)

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt.

Virtuelle Personen Mann und Frau

Bitte geben Sie an. Die von mir gewählte virtuelle Person wirkte auf mich:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Sicherheit vermittelnd	○	○	○	○	○
hat Durchsetzungsvermögen	○	○	○	○	○
als Autoritätsperson	○	○	○	○	○
empathisch	○	○	○	○	○
vertrauensvoll	○	○	○	○	○
kompetent	○	○	○	○	○
motivierend	○	○	○	○	○
weiß was gut für mich ist	○	○	○	○	○
sympathisch	○	○	○	○	○

Die Person an Ihrer Seite (3 von 3)

Bitte geben Sie in Bezug auf die Person an:

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ich habe die Frau gewählt.
- ◯ Ich habe den Mann gewählt.

Warum haben Sie sich für die Frau / den Mann entschieden?

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Sie können jetzt diesen Browser-Tab schließen, um mit RehaCom weiterzuarbeiten.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Zwischenbefragung B

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass sie bisher trainiert haben. Nachfolgend haben wir bis zum heutigen Training einige Fragen an Sie.

Bitte beantworten Sie diese Fragen nach ihrer persönlichen Einschätzung, es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 11 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben: *

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 3)

Wieviel Spaß hat Ihnen das Training bisher gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ keinen
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ viel

Wie anstrengend fanden Sie das Training bisher? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ nicht
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ sehr

Wie sind Sie mit dem Training zuhause selbstständig zurecht gekommen?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ überhaupt nicht
- ◯ nicht so gut
- ◯ mittelmäßig
- ◯ eher gut
- ◯ einwandfrei

Gab es anfangs technische Schwierigkeiten?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar folgende:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Haben Sie Hilfe benötigt?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar bei folgendem Problem, dabei hat mir folgende Person helfen können:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte positives Feedback bekommen.	○	○	○	○	○
Ich möchte in höhere Level aufsteigen.	○	○	○	○	○
Ich habe nach dem Training ein gutes Gefühl.	○	○	○	○	○
Das Training ist eine sinnvolle Beschäftigung.	○	○	○	○	○
Ich kann durch das Training meine Belastbarkeit erproben.	○	○	○	○	○
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.	○	○	○	○	○
Das Training hilft mir dabei, meinen Tag zu strukturieren.	○	○	○	○	○
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.	○	○	○	○	○
Ich habe mir Ziele gesetzt, die ich erreichen möchte.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.	○	○	○	○	○
Ich habe während des Trainings ein gutes Gefühl.	○	○	○	○	○
Mir gefällt die Trainingsaufgabe.	○	○	○	○	○
Ich finde die Texte inhaltlich spannend.	○	○	○	○	○
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	○	○	○	○	○
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○

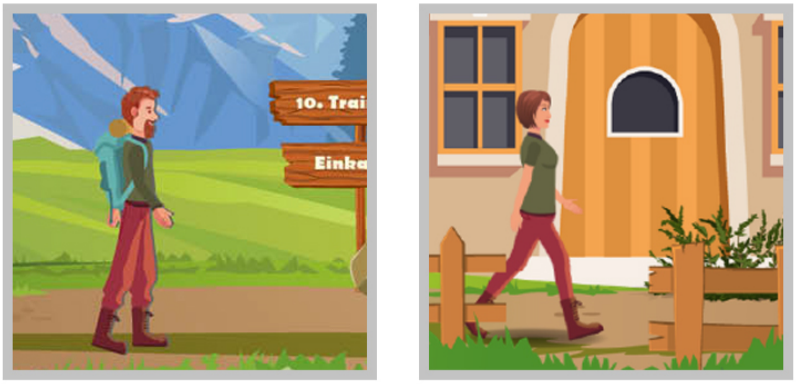
Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Die Person an Ihrer Seite (2 von 3)

[redacted] [redacted]

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt.



Virtuelle Personen Mann und Frau

Bitte geben Sie an. Die von mir gewählte virtuelle Person wirkte auf mich:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
kompetent	○	○	○	○	○
motivierend	○	○	○	○	○
weiß was gut für mich ist	○	○	○	○	○
sympathisch	○	○	○	○	○

[redacted]

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
als Autoritätsperson	◯	◯	◯	◯	◯
empathisch	◯	◯	◯	◯	◯
vertrauensvoll	◯	◯	◯	◯	◯
Sicherheit vermittelnd	◯	◯	◯	◯	◯
hat Durchsetzungsvermögen	◯	◯	◯	◯	◯

Die Person an Ihrer Seite (3 von 3)

Bitte geben Sie in Bezug auf die Person an: *

Bitte wählen Sie nur eine der folgenden Antworten aus:

◯ Ich habe die Frau gewählt.

◯ Ich habe den Mann gewählt.

Warum haben Sie sich für die Frau / den Mann entschieden?

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Sie können jetzt diesen Browser-Tab schließen, um mit RehaCom weiterzuarbeiten.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Zwischenbefragung C

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass sie bisher trainiert haben. Nachfolgend haben wir bis zum heutigen Training einige Fragen an Sie.

Bitte beantworten Sie diese Fragen nach ihrer persönlichen Einschätzung, es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 8 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben: *

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 2)

Wieviel Spaß hat Ihnen das Training bisher gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ keinen
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ viel

Wie anstrengend fanden Sie das Training bisher? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ nicht
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ sehr

Wie sind Sie mit dem Training zuhause selbstständig zurecht gekommen?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ überhaupt nicht
- ◯ nicht so gut
- ◯ mittelmäßig
- ◯ eher gut
- ◯ einwandfrei

Gab es anfangs technische Schwierigkeiten?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar folgende:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Haben Sie Hilfe benötigt?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar bei folgendem Problem, dabei hat mir folgende Person helfen können:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Ihre Motivation (2 von 2)

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	○	○	○	○	○
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	○	○	○	○	○
Ich finde die Texte inhaltlich spannend.	○	○	○	○	○
Mir gefällt die Trainingsaufgabe.	○	○	○	○	○
Ich habe während des Trainings ein gutes Gefühl.	○	○	○	○	○
Ich habe nach dem Training ein gutes Gefühl.	○	○	○	○	○
Ich möchte in höhere Level aufsteigen.	○	○	○	○	○
Ich möchte positives Feedback bekommen.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich habe mir Ziele gesetzt, die ich erreichen möchte.	○	○	○	○	○
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.	○	○	○	○	○
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.	○	○	○	○	○
Das Training hilft mir dabei, meinen Tag zu strukturieren.	○	○	○	○	○
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.	○	○	○	○	○
Ich kann durch das Training meine Belastbarkeit erproben.	○	○	○	○	○
Das Training ist eine sinnvolle Beschäftigung.	○	○	○	○	○

Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Sie können jetzt diesen Browser-Tab schließen, um mit RehaCom weiterzuarbeiten.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Zwischenbefragung D

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass sie bisher trainiert haben. Nachfolgend haben wir bis zum heutigen Training einige Fragen an Sie.

Bitte beantworten Sie diese Fragen nach ihrer persönlichen Einschätzung, es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 8 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben: *

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 2)

Wieviel Spaß hat Ihnen das Training bisher gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ keinen
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ viel

Wie anstrengend fanden Sie das Training bisher? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ nicht
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ sehr

Wie sind Sie mit dem Training zuhause selbstständig zurecht gekommen?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ überhaupt nicht
- ◯ nicht so gut
- ◯ mittelmäßig
- ◯ eher gut
- ◯ einwandfrei

Gab es anfangs technische Schwierigkeiten?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar folgende:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Haben Sie Hilfe benötigt?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Ja, und zwar bei folgendem Problem, dabei hat mir folgende Person helfen können:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Ihre Motivation (2 von 2)

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	○	○	○	○	○
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	○	○	○	○	○
Ich finde die Texte inhaltlich spannend.	○	○	○	○	○
Mir gefällt die Trainingsaufgabe.	○	○	○	○	○
Ich habe während des Trainings ein gutes Gefühl.	○	○	○	○	○
Ich habe nach dem Training ein gutes Gefühl.	○	○	○	○	○
Ich möchte in höhere Level aufsteigen.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte positives Feedback bekommen.	○	○	○	○	○
Ich habe mir Ziele gesetzt, die ich erreichen möchte.	○	○	○	○	○
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.	○	○	○	○	○
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.	○	○	○	○	○
Das Training hilft mir dabei, meinen Tag zu strukturieren.	○	○	○	○	○
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.	○	○	○	○	○
Ich kann durch das Training meine Belastbarkeit erproben.	○	○	○	○	○
Das Training ist eine sinnvolle Beschäftigung.	○	○	○	○	○

Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Sie können jetzt diesen Browser-Tab schließen, um mit RehaCom weiterzuarbeiten.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Abschlussbefragung A

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass Sie uns bei der Studie unterstützen. Abschließend zu ihrem letzten Training haben wir noch einige Fragen an Sie. Es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 26 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben:

*

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 8)

Wieviel Spaß hat Ihnen das Training gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- keinen
- eher wenig
- mittelmäßig
- eher mehr
- viel

Wie anstrengend fanden Sie das Training? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- nicht
- eher wenig
- mittelmäßig
- eher mehr
- sehr

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	○	○	○	○	○
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	○	○	○	○	○
Ich finde die Texte inhaltlich spannend.	○	○	○	○	○
Mir gefällt die Trainingsaufgabe.	○	○	○	○	○
Ich habe während des Trainings ein gutes Gefühl.	○	○	○	○	○
Ich habe nach dem Training ein gutes Gefühl.	○	○	○	○	○
Ich möchte in höhere Level aufsteigen.	○	○	○	○	○
Ich möchte positives Feedback bekommen.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich habe mir Ziele gesetzt, die ich erreichen möchte.	◯	◯	◯	◯	◯
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.	◯	◯	◯	◯	◯
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.	◯	◯	◯	◯	◯
Das Training hilft mir dabei, meinen Tag zu strukturieren.	◯	◯	◯	◯	◯
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.	◯	◯	◯	◯	◯
Ich kann durch das Training meine Belastbarkeit erproben.	◯	◯	◯	◯	◯
Das Training ist eine sinnvolle Beschäftigung.	◯	◯	◯	◯	◯

Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Ihr Training (2 von 8)

Bitte geben Sie an, welche der folgenden Dinge Sie für Ihr Training möchten:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich erzähle meinen Freunden und / oder meiner Familie von meinen Schritten in der Therapie.	○	○	○	○	○
Ich kann den Fortschritt sehen, den ich bisher gemacht habe.	○	○	○	○	○
Ich bekomme von meinem Therapeuten regelmäßig Feedback zu meinem Training.	○	○	○	○	○
Ich erfahre, ob das Training wirklich etwas bringt.	○	○	○	○	○
Durch das Training wird meine Hoffnung in Rehabilitationserfolge gestärkt.	○	○	○	○	○
Mein Therapeut stellt mir ein wirksames Training zusammen.	○	○	○	○	○
Ich bin im Training nicht auf die Hilfe anderer Personen angewiesen.	○	○	○	○	○

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Meine Fähigkeiten sind nach der Rehabilitation höher als zu Beginn.	○	○	○	○	○
Ich bekomme von meinen Freunden und / oder meiner Familie positives Feedback.	○	○	○	○	○
Die Inhalte des Trainings sprechen meine Interessen an.	○	○	○	○	○
Das Training macht mir Spaß.	○	○	○	○	○
Ich habe eigene Ziele, die ich erreichen will.	○	○	○	○	○
Ich arbeite mit dem Training aktiv an der Verbesserung meiner Lebenssituation.	○	○	○	○	○
Ich suche mir zwischen verschiedenen Strategien zum Lösen der Aufgaben die Strategie aus, die mir am meisten liegt.	○	○	○	○	○
Die Aufgabe hat einen Bezug zu meinem eigenen Alltag.	○	○	○	○	○
Ich kann mich mit meinen vorherigen Leistungen im Training vergleichen.	○	○	○	○	○

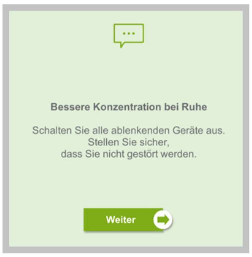
	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich bekomme weitere Informationen zu meiner Erkrankung und zu meinem Training.	◯	◯	◯	◯	◯
Ich verstehe, warum das Training was ich mache, mir hilft.	◯	◯	◯	◯	◯
Ich kann mir gleich am Anfang des Trainings ein Ziel für die nächsten Wochen festlegen.	◯	◯	◯	◯	◯
Ich kann einschätzen, welche Aufgaben in der Therapie noch vor mir liegen.	◯	◯	◯	◯	◯
Ich kann jederzeit Kontakt zu meinem Therapeuten aufnehmen, falls ich Probleme habe.	◯	◯	◯	◯	◯
Ich erfahre, ob andere Betroffene ähnliche Schwierigkeiten haben wie ich.	◯	◯	◯	◯	◯
Ich sehe ob ich mich verbessere.	◯	◯	◯	◯	◯
Ich lege meine Ziele selber fest.	◯	◯	◯	◯	◯
Ich entscheide selber, wann ich trainiere.	◯	◯	◯	◯	◯

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich teile gerne meine Erfahrungen mit anderen Betroffenen.	◯	◯	◯	◯	◯
Ich bekomme erklärt, wie ich das, was ich geübt habe, auch im Alltag anwenden kann.	◯	◯	◯	◯	◯
Ich sehe, wie ich meinen eigenen Zielen Schritt für Schritt näher komme.	◯	◯	◯	◯	◯
Durch das Training habe ich das Gefühl, meine Lebenssituation wieder selbst in die Hand nehmen zu können.	◯	◯	◯	◯	◯
Ich bekomme Strategien erklärt, mit denen ich die Aufgaben besser lösen kann.	◯	◯	◯	◯	◯

Ihr Training (3 von 8)

Sie haben in dem Training, das Sie in den letzten Wochen gemacht haben, verschiedene Elemente kennengelernt.


Wanderweg



Strategie


Leistungskurve

Bitte geben Sie an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Der Wanderweg war eine gute Möglichkeit zu sehen, was ich alles schon geschafft habe.					
Ich konnte die virtuelle Person nicht ernst nehmen.					
Ich habe mir nur wenig Zeit für die Strategien genommen, da ich lieber mit dem Training vorankommen wollte.					
Dass ich die Person an meiner Seite nach und nach weiter ausstatten durfte hat mich motiviert.					

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
An meine Stärken und Hobbies erinnert zu werden, hat mich im Training unterstützt.	○	○	○	○	○
Es hat mir gefallen, dass ich die Person an meiner Seite selbst gestalten konnte.	○	○	○	○	○
Es war angenehm, die Person an meiner Seite zu haben.	○	○	○	○	○
Es war ein gutes Gefühl zu sehen, dass ich es geschafft habe einen steilen Berg zu erklimmen.	○	○	○	○	○
Ich war mit der Zielsetzung am Anfang des Trainings ehrlich gesagt überfordert.	○	○	○	○	○
Die Strategien und Anregungen zur Textarbeit haben mir sehr geholfen.	○	○	○	○	○
Es hat mir gut getan, dass ich meine Angehörigen durch die Strategien im Alltag in die Therapie einbeziehen konnte.	○	○	○	○	○

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Eine Übersicht über die Strategien würde mir helfen, um mich für die zu entscheiden, die mir am meisten liegt.	◯	◯	◯	◯	◯
Es hat mir gefallen, dass die Leistungskurve als Bergkamm dargestellt wurde.	◯	◯	◯	◯	◯
Es war gut, am Ende der Trainingseinheiten einzuschätzen, ob mir die Strategien etwas gebracht haben.	◯	◯	◯	◯	◯
Mir gefällt die Vorstellung, meine Rehabilitation als eine Wanderung zu sehen.	◯	◯	◯	◯	◯
Mir hat die Gestaltung des Wanderwegs gut gefallen.	◯	◯	◯	◯	◯
Ich war stolz, wenn ich einen neuen Meilenstein erhalten hatte.	◯	◯	◯	◯	◯
Es hat mich nicht angesprochen, dass das gesamte Training als Wanderung dargestellt wurde.	◯	◯	◯	◯	◯

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Das Programm hat mich überzeugt, dass regelmäßiges Training meine Leistungsfähigkeit verbessert.	◯	◯	◯	◯	◯
Es war ein gutes Gefühl, ein Ziel zu formulieren und darauf hinzuarbeiten.	◯	◯	◯	◯	◯
Ich habe mich über das Erreichen von Meilensteinen sehr gefreut.	◯	◯	◯	◯	◯
Die Hinweise zu Erkenntnissen aus der Forschung fand ich hilfreich.	◯	◯	◯	◯	◯
Es gibt mir Kraft daran zu denken, was mir im Alltag gut tut.	◯	◯	◯	◯	◯
Ich habe mir meine bisherigen Meilensteine gerne nochmal angeschaut.	◯	◯	◯	◯	◯
Ich habe der Darstellung meines aktuellen Trainingsverlaufs in der Leistungskurve viel Aufmerksamkeit gewidmet.	◯	◯	◯	◯	◯

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Es fiel mir leicht die gezeigten Informationen in der Leistungskurve zu verstehen.	◯	◯	◯	◯	◯
Die dargestellten Informationen in der Leistungskurve halfen mir meine eigene Leistung besser einzuschätzen.	◯	◯	◯	◯	◯
Ich hätte gern detaillierte Informationen zu meinem aktuellen Training erhalten, um meine momentane Leistung besser einschätzen zu können.	◯	◯	◯	◯	◯

Diese Strategie hat mir bei der Arbeit mit den Texten am meisten geholfen:

Bitte geben Sie Ihre Antwort hier ein:

Haben Sie die eine oder mehrere Strategien in Ihrem Alltag eingesetzt?

Sie können Ihre Auswahl kommentieren, wenn Sie möchten.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Gar nicht
- ◯ Eher selten
- ◯ Manchmal
- ◯ Eher öfter
- ◯ Oft

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Ihr Training (4 von 8)

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an.

Während des Trainings...

*

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen:

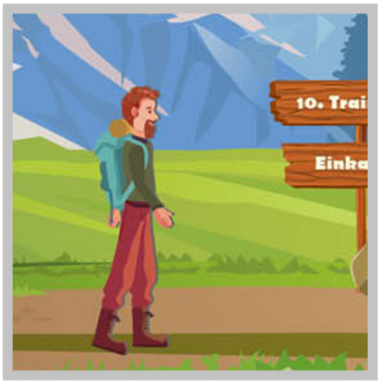
*

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Die Person an Ihrer Seite 1 (5 von 8)

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt.



Virtuelle Personen Mann und Frau

Bitte geben Sie an. Die von mir gewählte virtuelle Person wirkte auf mich:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
kompetent					
motivierend					
weiß was gut für mich ist					
sympathisch					
als Autoritätsperson					
empathisch					
vertrauensvoll					
Sicherheit vermittelnd					
hat Durchsetzungsvermögen					

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt. Bitte geben Sie an: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Die Person ist ein guter Begleiter / Begleiterin für mich.	○	○	○	○	○
Die Person ist eine Unterstützung für mich.	○	○	○	○	○
Die Person hat ein treuherziges Wesen.	○	○	○	○	○
Die Person ist für mich wie ein Freund.	○	○	○	○	○
Die Person hilft mir mit seinen / ihren Fähigkeiten.	○	○	○	○	○
Das Verhältnis zu der Person fühlt sich freundschaftlich an.	○	○	○	○	○
Die Person hilft mir durch sein / ihr persönliches Verhalten mir gegenüber.	○	○	○	○	○
Die Person hilft mir durch seine / ihre fachlichen Tipps.	○	○	○	○	○
Das Verhältnis zu der Person fühlt sich professionell an.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Die Person ist für mich ähnlich einem Therapeuten / einer Therapeutin.	○	○	○	○	○
Die Person ist ein guter Mentor / Mentorin für mich.	○	○	○	○	○
Die Person hat mich mit Ratschlägen unterstützt.	○	○	○	○	○
Die Person hat sich so verhalten, dass es hilfreich für mich war.	○	○	○	○	○
Ich möchte, dass die Person innerhalb der Therapie weiterhin an meiner Seite ist.	○	○	○	○	○
Ich möchte, dass die Person auch nach der Therapie an meiner Seite ist.	○	○	○	○	○
Ich hätte die Person gerne als reale Person an meiner Seite.	○	○	○	○	○
Es war schön, dass die Person sich gefreut hat mich zu sehen.	○	○	○	○	○
Es war schön, die Person durch die Kleidung / Ausstattung, die wir im Training bekommen haben, zu unterstützen.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Es war schön, dass ich von der Person Unterstützung bekommen habe.	○	○	○	○	○
Ich habe mich darauf gefreut, die Person im Training zu sehen.	○	○	○	○	○
Die Person hat für mich beim Training zuhause meinen Therapeuten / meine Therapeutin ergänzt.	○	○	○	○	○
Die Person hat für mich beim Training zuhause meinen Therapeuten / meine Therapeutin ersetzt.	○	○	○	○	○
Ich möchte, dass die Person mit mir übt was ich bei meinem Therapeuten / meiner Therapeutin gemacht habe und mir mehr dazu erklärt.	○	○	○	○	○
Ich möchte meine Therapiesitzungen mit dieser Person und nicht mit meinem Therapeuten / meiner Therapeutin machen.	○	○	○	○	○

Die Person an Ihrer Seite 2 (6 von 8)

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt. Bitte geben Sie an:

*

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]
[redacted].	◯	◯	◯	◯	◯	◯	◯

Würden Sie die Wahl der virtuellen Person (Mann bzw. Frau) an Ihrer Seite im Nachhinein gerne ändern? (Bitte begründen Sie) *

Bitte wählen Sie nur eine der folgenden Antworten aus:

◯ Ja

◯ Nein

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Was würden Sie sich von der Person noch wünschen?

Bitte geben Sie Ihre Antwort hier ein:

Die Benutzung Ihres Trainings (7 von 8)

Bitte geben Sie an: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○

[redacted]

	[redacted]				[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○	○	○	○	○

Haben Sie Anmerkungen zur Benutzung?

Bitte geben Sie Ihre Antwort hier ein:

Hatten Sie technische Probleme bei der Nutzung?

Bitte geben Sie Ihre Antwort hier ein:

Abschließende Bewertung (8 von 8)

Wie haben Sie folgende Aspekte während Ihres Trainings wahrgenommen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	überhaupt nicht	eher nicht	weder noch	eher ja	ja, voll und ganz
Fanden Sie die Bewertung der Fehler angemessen?	○	○	○	○	○
Wenn Sie in den ersten Leveln schon bei einem Fehler im Level abgestiegen sind, war das für Sie frustrierend?	○	○	○	○	○

Wenn Sie Ihre Vorgaben pro Woche nicht erfüllt haben, woran lag es?

Bitte wählen Sie alle zutreffenden Antworten aus:

- ☐ Ich hatte es vergessen.
- ☐ Ich hatte keine Lust auf das Training.
- ☐ Ich hatte zu viele andere Dinge zu tun.
- ☐ Ich weiß es nicht.
- ☐ Ich habe meine Vorgaben immer erfüllt.
- ☐ Sonstiges: ____________________

Wie ist ihr beruflicher Status? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Berentet ohne Zuverdienst
- ◯ Berentet mit Zuverdienst
- ◯ Arbeitssuchend
- ◯ Arbeitsunfähig
- ◯ Anstellungsverhältnis oder Selbstständigkeit (durchschnittliche Stundenzahl pro Woche bitte im Kommentarfeld angeben)
- ◯ Sonstiges

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Welche Aspekte am RehaCom Prgramm und am Training haben Ihnen besonders gefallen?

Bitte geben Sie Ihre Antwort hier ein:

Welche Aspekte am RehaCom Programm und am Training fanden Sie nicht so gut?

Bitte geben Sie Ihre Antwort hier ein:

Wie hat Ihnen die Organisation der Studie gefallen? Gab es Schwierigkeiten?

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Damit leisten Sie einen wertvollen Beitrag zur Verbesserung von kognitiven Therapien.

Sie können diesen Browser-Tab jetzt schließen.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Abschlussbefragung B

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass Sie uns bei der Studie unterstützen. Abschließend zu ihrem letzten Training haben wir noch einige Fragen an Sie. Es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 24 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben:

*

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 8)

Wieviel Spaß hat Ihnen das Training gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ keinen
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ viel

Wie anstrengend fanden Sie das Training? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ nicht
- ◯ eher wenig
- ◯ mittelmäßig
- ◯ eher mehr
- ◯ sehr

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich habe mir Ziele gesetzt, die ich erreichen möchte.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○
Das Training ist eine sinnvolle Beschäftigung.	○	○	○	○	○
Ich kann durch das Training meine Belastbarkeit erproben.	○	○	○	○	○
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.	○	○	○	○	○
Das Training hilft mir dabei, meinen Tag zu strukturieren.	○	○	○	○	○
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.	◯	◯	◯	◯	◯
Ich möchte positives Feedback bekommen.	◯	◯	◯	◯	◯
Ich möchte in höhere Level aufsteigen.	◯	◯	◯	◯	◯
Ich habe nach dem Training ein gutes Gefühl.	◯	◯	◯	◯	◯
Ich habe während des Trainings ein gutes Gefühl.	◯	◯	◯	◯	◯
Mir gefällt die Trainingsaufgabe.	◯	◯	◯	◯	◯
Ich finde die Texte inhaltlich spannend.	◯	◯	◯	◯	◯
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	◯	◯	◯	◯	◯
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	◯	◯	◯	◯	◯

Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Ihr Training (2 von 8)

Bitte geben Sie an, welche der folgenden Dinge Sie für Ihr Training möchten:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich sehe ob ich mich verbessere.	○	○	○	○	○
Ich lege meine Ziele selber fest.	○	○	○	○	○
Ich entscheide selber, wann ich trainiere.	○	○	○	○	○
Ich erfahre, ob andere Betroffene ähnliche Schwierigkeiten haben wie ich.	○	○	○	○	○
Ich kann jederzeit Kontakt zu meinem Therapeuten aufnehmen, falls ich Probleme habe.	○	○	○	○	○
Ich kann einschätzen, welche Aufgaben in der Therapie noch vor mir liegen.	○	○	○	○	○
Ich kann mir gleich am Anfang des Trainings ein Ziel für die nächsten Wochen festlegen.	○	○	○	○	○
Ich verstehe, warum das Training was ich mache, mir hilft.	○	○	○	○	○

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich bekomme weitere Informationen zu meiner Erkrankung und zu meinem Training.					
Die Aufgabe hat einen Bezug zu meinem eigenen Alltag.					
Ich kann mich mit meinen vorherigen Leistungen im Training vergleichen.					
Ich suche mir zwischen verschiedenen Strategien zum Lösen der Aufgaben die Strategie aus, die mir am meisten liegt.					
Ich arbeite mit dem Training aktiv an der Verbesserung meiner Lebenssituation.					
Ich habe eigene Ziele, die ich erreichen will.					
Das Training macht mir Spaß.					
Die Inhalte des Trainings sprechen meine Interessen an.					
Ich bekomme von meinen Freunden und / oder meiner Familie positives Feedback.					

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Meine Fähigkeiten sind nach der Rehabilitation höher als zu Beginn.	○	○	○	○	○
Ich bin im Training nicht auf die Hilfe anderer Personen angewiesen.	○	○	○	○	○
Durch das Training wird meine Hoffnung in Rehabilitationserfolge gestärkt.	○	○	○	○	○
Mein Therapeut stellt mir ein wirksames Training zusammen.	○	○	○	○	○
Ich erfahre, ob das Training wirklich etwas bringt.	○	○	○	○	○
Ich bekomme von meinem Therapeuten regelmäßig Feedback zu meinem Training.	○	○	○	○	○
Ich kann den Fortschritt sehen, den ich bisher gemacht habe.	○	○	○	○	○
Ich erzähle meinen Freunden und / oder meiner Familie von meinen Schritten in der Therapie.	○	○	○	○	○

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich sehe, wie ich meinen eigenen Zielen Schritt für Schritt näher komme.	○	○	○	○	○
Ich teile gerne meine Erfahrungen mit anderen Betroffenen.	○	○	○	○	○
Ich bekomme erklärt, wie ich das, was ich geübt habe, auch im Alltag anwenden kann.	○	○	○	○	○
Durch das Training habe ich das Gefühl, meine Lebenssituation wieder selbst in die Hand nehmen zu können.	○	○	○	○	○
Ich bekomme Strategien erklärt, mit denen ich die Aufgaben besser lösen kann.	○	○	○	○	○

Ihr Training (3 von 8)

Sie haben in dem Training, das Sie in den letzten Wochen gemacht haben, verschiedene Elemente kennengelernt.

Wanderweg

Leistungskurve

Bitte geben Sie an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft überhaupt nicht zu	**Trifft eher nicht zu**	**weder noch**	**eher zutreffend**	**Trifft voll und ganz zu**
Der Wanderweg war eine gute Möglichkeit zu sehen, was ich alles schon geschafft habe.	○	○	○	○	○
Ich konnte die virtuelle Person nicht ernst nehmen.	○	○	○	○	○

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Dass ich die Person an meiner Seite nach und nach weiter ausstatten durfte hat mich motiviert.	○	○	○	○	○
An meine Stärken und Hobbies erinnert zu werden, hat mich im Training unterstützt.	○	○	○	○	○
Es hat mir gefallen, dass ich die Person an meiner Seite selbst gestalten konnte.	○	○	○	○	○
Es war angenehm, die Person an meiner Seite zu haben.	○	○	○	○	○
Es war ein gutes Gefühl zu sehen, dass ich es geschafft habe einen steilen Berg zu erklimmen.	○	○	○	○	○
Ich war mit der Zielsetzung am Anfang des Trainings ehrlich gesagt überfordert.	○	○	○	○	○
Es hat mir gut getan, dass ich meine Angehörigen durch die Strategien im Alltag in die Therapie einbeziehen konnte.	○	○	○	○	○

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Es hat mir gefallen, dass die Leistungskurve als Bergkamm dargestellt wurde.	◯	◯	◯	◯	◯
Mir gefällt die Vorstellung, meine Rehabilitation als eine Wanderung zu sehen.	◯	◯	◯	◯	◯
Mir hat die Gestaltung des Wanderwegs gut gefallen.	◯	◯	◯	◯	◯
Ich war stolz, wenn ich einen neuen Meilenstein erhalten hatte.	◯	◯	◯	◯	◯
Es hat mich nicht angesprochen, dass das gesamte Training als Wanderung dargestellt wurde.	◯	◯	◯	◯	◯
Das Programm hat mich überzeugt, dass regelmäßiges Training meine Leistungsfähigkeit verbessert.	◯	◯	◯	◯	◯
Es war ein gutes Gefühl, ein Ziel zu formulieren und darauf hinzuarbeiten.	◯	◯	◯	◯	◯
Ich habe mich über das Erreichen von Meilensteinen sehr gefreut.	◯	◯	◯	◯	◯

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Die Hinweise zu Erkenntnissen aus der Forschung fand ich hilfreich.	◯	◯	◯	◯	◯
Es gibt mir Kraft daran zu denken, was mir im Alltag gut tut.	◯	◯	◯	◯	◯
Ich habe mir meine bisherigen Meilensteine gerne nochmal angeschaut.	◯	◯	◯	◯	◯
Ich habe der Darstellung meines aktuellen Trainingsverlaufs in der Leistungskurve viel Aufmerksamkeit gewidmet.	◯	◯	◯	◯	◯
Es fiel mir leicht die gezeigten Informationen in der Leistungskurve zu verstehen.	◯	◯	◯	◯	◯
Die dargestellten Informationen in der Leistungskurve halfen mir meine eigene Leistung besser einzuschätzen.	◯	◯	◯	◯	◯

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Ich hätte gern detaillierte Informationen zu meinem aktuellen Training erhalten, um meine momentane Leistung besser einschätzen zu können.	○	○	○	○	○

Ihr Training (4 von 8)

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an.

Während des Trainings... *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

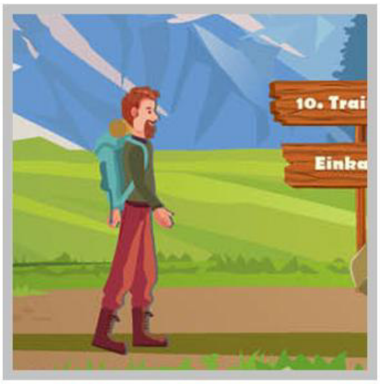
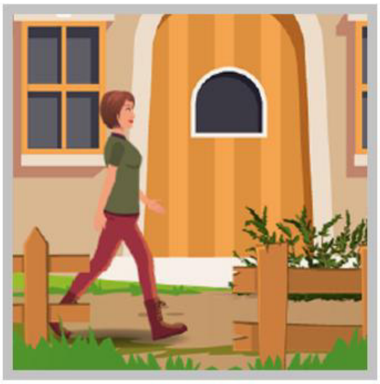
Bitte geben Sie Ihrer persönlichen Meinung entsprechend an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted].	○	○	○	○	○	○	○

Die Person an Ihrer Seite 1 (5 von 8)

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt.

Virtuelle Personen Mann und Frau

Bitte geben Sie an. Die von mir gewählte virtuelle Person wirkte auf mich:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
hat Durchsetzungsvermögen					
vertrauensvoll					
Sicherheit vermittelnd					
empathisch					
als Autoritätsperson					
sympathisch					
motivierend					
weiß was gut für mich ist					
kompetent					

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt. Bitte geben Sie an: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte, dass die Person auch nach der Therapie an meiner Seite ist.					
Die Person hat sich so verhalten, dass es hilfreich für mich war.					
Ich möchte, dass die Person innerhalb der Therapie weiterhin an meiner Seite ist.					
Das Verhältnis zu der Person fühlt sich professionell an.					
Die Person hat mich mit Ratschlägen unterstützt.					
Die Person ist ein guter Mentor / Mentorin für mich.					
Die Person ist für mich ähnlich einem Therapeuten / einer Therapeutin.					
Die Person hilft mir durch seine / ihre fachlichen Tipps.					

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich hätte die Person gerne als reale Person an meiner Seite.	○	○	○	○	○
Die Person hilft mir durch sein / ihr persönliches Verhalten mir gegenüber.	○	○	○	○	○
Das Verhältnis zu der Person fühlt sich freundschaftlich an.	○	○	○	○	○
Die Person hilft mir mit seinen / ihren Fähigkeiten.	○	○	○	○	○
Die Person ist für mich wie ein Freund.	○	○	○	○	○
Die Person hat ein treuherziges Wesen.	○	○	○	○	○
Die Person ist eine Unterstützung für mich.	○	○	○	○	○
Die Person ist ein guter Begleiter / Begleiterin für mich.	○	○	○	○	○
Es war schön, dass die Person sich gefreut hat mich zu sehen.	○	○	○	○	○

[redacted] [redacted]

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Es war schön, die Person durch die Kleidung / Ausstattung, die wir im Training bekommen haben, zu unterstützen.	○	○	○	○	○
Es war schön, dass ich von der Person Unterstützung bekommen habe.	○	○	○	○	○
Ich habe mich darauf gefreut, die Person im Training zu sehen.	○	○	○	○	○
Die Person hat für mich beim Training zuhause meinen Therapeuten / meine Therapeutin ergänzt.	○	○	○	○	○
Die Person hat für mich beim Training zuhause meinen Therapeuten / meine Therapeutin ersetzt.	○	○	○	○	○
Ich möchte, dass die Person mit mir übt was ich bei meinem Therapeuten / meiner Therapeutin gemacht habe und mir mehr dazu erklärt.	○	○	○	○	○

[redacted]

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte meine Therapiesitzungen mit dieser Person und nicht mit meinem Therapeuten / meiner Therapeutin machen.	◯	◯	◯	◯	◯

Die Person an Ihrer Seite 2 (6 von 8)

Sie haben auf Ihrer Wanderung im Training eine virtuelle Person gewählt. Bitte geben Sie an: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]							

Würden Sie die Wahl der virtuellen Person (Mann bzw. Frau) an Ihrer Seite im Nachhinein gerne ändern? (Bitte begründen Sie) *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- Ja
- Nein

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Was würden Sie sich von der Person noch wünschen?

Bitte geben Sie Ihre Antwort hier ein:

Die Benutzung Ihres Trainings (7 von 8)

Bitte geben Sie an: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						

[redacted]

	[redacted]		[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○	○	○	○	○

Haben Sie Anmerkungen zur Benutzung?

Bitte geben Sie Ihre Antwort hier ein:

Hatten Sie technische Probleme bei der Nutzung?

Bitte geben Sie Ihre Antwort hier ein:

Abschließende Bewertung (8 von 8)

Wie haben Sie folgende Aspekte während Ihres Trainings wahrgenommen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	überhaupt nicht	eher nicht	weder noch	eher ja	ja, voll und ganz
Fanden Sie die Bewertung der Fehler angemessen?	○	○	○	○	○
Wenn Sie in den ersten Leveln schon bei einem Fehler im Level abgestiegen sind, war das für Sie frustrierend?	○	○	○	○	○

Wenn Sie Ihre Vorgaben pro Woche nicht erfüllt haben, woran lag es?

Bitte wählen Sie alle zutreffenden Antworten aus:

- ☐ Ich hatte es vergessen.
- ☐ Ich hatte keine Lust auf das Training.
- ☐ Ich hatte zu viele andere Dinge zu tun.
- ☐ Ich weiß es nicht.
- ☐ Ich habe meine Vorgaben immer erfüllt.
- ☐ Sonstiges: ______

Wie ist ihr beruflicher Status? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Berentet ohne Zuverdienst
- ◯ Berentet mit Zuverdienst
- ◯ Arbeitssuchend
- ◯ Arbeitsunfähig
- ◯ Anstellungsverhältnis oder Selbstständigkeit (durchschnittliche Stundenzahl pro Woche bitte im Kommentarfeld angeben)
- ◯ Sonstiges

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Welche Aspekte am RehaCom Prgramm und am Training haben Ihnen besonders gefallen?

Bitte geben Sie Ihre Antwort hier ein:

Welche Aspekte am RehaCom Programm und am Training fanden Sie nicht so gut?

Bitte geben Sie Ihre Antwort hier ein:

Wie hat Ihnen die Organisation der Studie gefallen? Gab es Schwierigkeiten?

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Damit leisten Sie einen wertvollen Beitrag zur Verbesserung von kognitiven Therapien.

Sie können diesen Browser-Tab jetzt schließen.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Abschlussbefragung C

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass Sie uns bei der Studie unterstützen. Abschließend zu ihrem letzten Training haben wir noch einige Fragen an Sie. Es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 21 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben:

*

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 6)

Wieviel Spaß hat Ihnen das Training gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- keinen
- eher wenig
- mittelmäßig
- eher mehr
- viel

Wie anstrengend fanden Sie das Training? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- nicht
- eher wenig
- mittelmäßig
- eher mehr
- sehr

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	○	○	○	○	○
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	○	○	○	○	○
Ich finde die Texte inhaltlich spannend.	○	○	○	○	○
Mir gefällt die Trainingsaufgabe.	○	○	○	○	○
Ich habe während des Trainings ein gutes Gefühl.	○	○	○	○	○
Ich habe nach dem Training ein gutes Gefühl.	○	○	○	○	○
Ich möchte in höhere Level aufsteigen.	○	○	○	○	○
Ich möchte positives Feedback bekommen.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich habe mir Ziele gesetzt, die ich erreichen möchte.	◯	◯	◯	◯	◯
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.	◯	◯	◯	◯	◯
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.	◯	◯	◯	◯	◯
Das Training hilft mir dabei, meinen Tag zu strukturieren.	◯	◯	◯	◯	◯
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.	◯	◯	◯	◯	◯
Ich kann durch das Training meine Belastbarkeit erproben.	◯	◯	◯	◯	◯
Das Training ist eine sinnvolle Beschäftigung.	◯	◯	◯	◯	◯

Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Ihr Training (2 von 6)

Bitte geben Sie an, welche der folgenden Dinge Sie für Ihr Training möchten:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich sehe ob ich mich verbessere.	○	○	○	○	○
Ich lege meine Ziele selber fest.	○	○	○	○	○
Ich entscheide selber, wann ich trainiere.	○	○	○	○	○
Ich erfahre, ob andere Betroffene ähnliche Schwierigkeiten haben wie ich.	○	○	○	○	○
Ich kann jederzeit Kontakt zu meinem Therapeuten aufnehmen, falls ich Probleme habe.	○	○	○	○	○
Ich kann einschätzen, welche Aufgaben in der Therapie noch vor mir liegen.	○	○	○	○	○
Ich kann mir gleich am Anfang des Trainings ein Ziel für die nächsten Wochen festlegen.	○	○	○	○	○
Ich verstehe, warum das Training was ich mache, mir hilft.	○	○	○	○	○

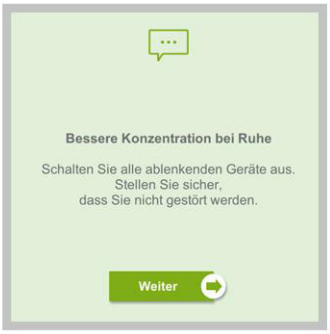
	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich bekomme weitere Informationen zu meiner Erkrankung und zu meinem Training.	◯	◯	◯	◯	◯
Die Aufgabe hat einen Bezug zu meinem eigenen Alltag.	◯	◯	◯	◯	◯
Ich kann mich mit meinen vorherigen Leistungen im Training vergleichen.	◯	◯	◯	◯	◯
Ich suche mir zwischen verschiedenen Strategien zum Lösen der Aufgaben die Strategie aus, die mir am meisten liegt.	◯	◯	◯	◯	◯
Ich arbeite mit dem Training aktiv an der Verbesserung meiner Lebenssituation.	◯	◯	◯	◯	◯
Ich habe eigene Ziele, die ich erreichen will.	◯	◯	◯	◯	◯
Das Training macht mir Spaß.	◯	◯	◯	◯	◯
Die Inhalte des Trainings sprechen meine Interessen an.	◯	◯	◯	◯	◯
Ich bekomme von meinen Freunden und / oder meiner Familie positives Feedback.	◯	◯	◯	◯	◯

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Meine Fähigkeiten sind nach der Rehabilitation höher als zu Beginn.	◯	◯	◯	◯	◯
Ich bin im Training nicht auf die Hilfe anderer Personen angewiesen.	◯	◯	◯	◯	◯
Durch das Training wird meine Hoffnung in Rehabilitationserfolge gestärkt.	◯	◯	◯	◯	◯
Mein Therapeut stellt mir ein wirksames Training zusammen.	◯	◯	◯	◯	◯
Ich erfahre, ob das Training wirklich etwas bringt.	◯	◯	◯	◯	◯
Ich bekomme von meinem Therapeuten regelmäßig Feedback zu meinem Training.	◯	◯	◯	◯	◯
Ich kann den Fortschritt sehen, den ich bisher gemacht habe.	◯	◯	◯	◯	◯
Ich erzähle meinen Freunden und / oder meiner Familie von meinen Schritten in der Therapie.	◯	◯	◯	◯	◯

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich sehe, wie ich meinen eigenen Zielen Schritt für Schritt näher komme.	◯	◯	◯	◯	◯
Ich teile gerne meine Erfahrungen mit anderen Betroffenen.	◯	◯	◯	◯	◯
Ich bekomme erklärt, wie ich das, was ich geübt habe, auch im Alltag anwenden kann.	◯	◯	◯	◯	◯
Durch das Training habe ich das Gefühl, meine Lebenssituation wieder selbst in die Hand nehmen zu können.	◯	◯	◯	◯	◯
Ich bekomme Strategien erklärt, mit denen ich die Aufgaben besser lösen kann.	◯	◯	◯	◯	◯

Ihr Training (3 von 6)

Sie haben in dem Training, das Sie in den letzten Wochen gemacht haben, verschiedene Elemente kennengelernt.



Strategie

Bitte geben Sie an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Ich habe mir nur wenig Zeit für die Strategien genommen, da ich lieber mit dem Training vorankommen wollte.	○	○	○	○	○
An meine Stärken und Hobbies erinnert zu werden, hat mich im Training unterstützt.	○	○	○	○	○
Die Strategien und Anregungen zur Textarbeit haben mir sehr geholfen.	○	○	○	○	○

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Es hat mir gut getan, dass ich meine Angehörigen durch die Strategien im Alltag in die Therapie einbeziehen konnte.	◯	◯	◯	◯	◯
Eine Übersicht über die Strategien würde mir helfen, um mich für die zu entscheiden, die mir am meisten liegt.	◯	◯	◯	◯	◯
Es war gut, am Ende der Trainingseinheiten einzuschätzen, ob mir die Strategien etwas gebracht haben.	◯	◯	◯	◯	◯
Das Programm hat mich überzeugt, dass regelmäßiges Training meine Leistungsfähigkeit verbessert.	◯	◯	◯	◯	◯
Die Hinweise zu Erkenntnissen aus der Forschung fand ich hilfreich.	◯	◯	◯	◯	◯
Es gibt mir Kraft daran zu denken, was mir im Alltag gut tut.	◯	◯	◯	◯	◯

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Ich habe der Darstellung meines aktuellen Trainingsverlaufs in der Leistungskurve viel Aufmerksamkeit gewidmet.	◯	◯	◯	◯	◯
Es fiel mir leicht die gezeigten Informationen in der Leistungskurve zu verstehen.	◯	◯	◯	◯	◯
Die dargestellten Informationen in der Leistungskurve halfen mir meine eigene Leistung besser einzuschätzen.	◯	◯	◯	◯	◯
Ich hätte gern detaillierte Informationen zu meinem aktuellen Training erhalten, um meine momentane Leistung besser einschätzen zu können.	◯	◯	◯	◯	◯

Diese Strategie hat mir bei der Arbeit mit den Texten am meisten geholfen:

Bitte geben Sie Ihre Antwort hier ein:

Haben Sie die eine oder mehrere Strategien in Ihrem Alltag eingesetzt?

Sie können Ihre Auswahl kommentieren, wenn Sie möchten.

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Gar nicht
- ◯ Eher selten
- ◯ Manchmal
- ◯ Eher öfter
- ◯ Oft

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Ihr Training (4 von 6)

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an.

Während des Trainings... *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Die Benutzung Ihres Trainings (5 von 6)

Bitte geben Sie an: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						
[redacted]						

[redacted]

	[redacted]		[redacted]								
	[redacted]				[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]											

Haben Sie Anmerkungen zur Benutzung?

Bitte geben Sie Ihre Antwort hier ein:

Hatten Sie technische Probleme bei der Nutzung?

Bitte geben Sie Ihre Antwort hier ein:

Abschließende Bewertung (6 von 6)

Wie haben Sie folgende Aspekte während Ihres Trainings wahrgenommen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	überhaupt nicht	eher nicht	weder noch	eher ja	ja, voll und ganz
Fanden Sie die Bewertung der Fehler angemessen?	○	○	○	○	○
Wenn Sie in den ersten Leveln schon bei einem Fehler im Level abgestiegen sind, war das für Sie frustrierend?	○	○	○	○	○

Wenn Sie Ihre Vorgaben pro Woche nicht erfüllt haben, woran lag es?

Bitte wählen Sie alle zutreffenden Antworten aus:

- ☐ Ich hatte es vergessen.
- ☐ Ich hatte keine Lust auf das Training.
- ☐ Ich hatte zu viele andere Dinge zu tun.
- ☐ Ich weiß es nicht.
- ☐ Ich habe meine Vorgaben immer erfüllt.
- ☐ Sonstiges: ____________________

Wie ist ihr beruflicher Status? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Berentet ohne Zuverdienst
- ◯ Berentet mit Zuverdienst
- ◯ Arbeitssuchend
- ◯ Arbeitsunfähig
- ◯ Anstellungsverhältnis oder Selbstständigkeit (durchschnittliche Stundenzahl pro Woche bitte im Kommentarfeld angeben)
- ◯ Sonstiges

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Welche Aspekte am RehaCom Prgramm und am Training haben Ihnen besonders gefallen?

Bitte geben Sie Ihre Antwort hier ein:

Welche Aspekte am RehaCom Programm und am Training fanden Sie nicht so gut?

Bitte geben Sie Ihre Antwort hier ein:

Wie hat Ihnen die Organisation der Studie gefallen? Gab es Schwierigkeiten?

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Damit leisten Sie einen wertvollen Beitrag zur Verbesserung von kognitiven Therapien.

Sie können diesen Browser-Tab jetzt schließen.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Abschlussbefragung D

Sehr geehrter Teilnehmer / Sehr geehrte Teilnehmerin,

vielen Dank, dass Sie uns bei der Studie unterstützen. Abschließend zu ihrem letzten Training haben wir noch einige Fragen an Sie. Es gibt keine falschen oder richtigen Antworten. Bei Fragen erreichen Sie uns über das Nachrichtensystem der Trainings-Website.

Ihr RehaCom-Forschungsteam

In dieser Umfrage sind 19 Fragen enthalten.

Bevor wir beginnen...

Bitte geben Sie Ihre Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben: *

Bitte geben Sie Ihre Antwort hier ein:

Ihre Gesamteinschätzung (1 von 5)

Wieviel Spaß hat Ihnen das Training gemacht? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- keinen
- eher wenig
- mittelmäßig
- eher mehr
- viel

Wie anstrengend fanden Sie das Training? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- nicht
- eher wenig
- mittelmäßig
- eher mehr
- sehr

Was motiviert Sie zur Zeit das Training durchzuführen? *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich möchte meine Gedächtnisleistung verbessern.	○	○	○	○	○
Ich möchte die Mindestvorgaben der Studie erfüllen.	○	○	○	○	○
Ich möchte meinen Therapeuten / die Studienleitung nicht enttäuschen.	○	○	○	○	○
Ich möchte sehen , was in der nächsten Trainingseinheit passiert.	○	○	○	○	○
Ich finde die Texte inhaltlich spannend.	○	○	○	○	○
Mir gefällt die Trainingsaufgabe.	○	○	○	○	○
Ich habe während des Trainings ein gutes Gefühl.	○	○	○	○	○
Ich habe nach dem Training ein gutes Gefühl.	○	○	○	○	○
Ich möchte in höhere Level aufsteigen.	○	○	○	○	○
Ich möchte positives Feedback bekommen.	○	○	○	○	○

	trifft überhaupt nicht zu	trifft eher nicht zu	weder noch	eher zutreffend	trifft voll und ganz zu
Ich habe mir Ziele gesetzt, die ich erreichen möchte.	○	○	○	○	○
Ich möchte zur Erforschung von neuen Therapien für andere Betroffene beitragen.	○	○	○	○	○
Ich möchte selbst von solchen neu entwickelten Therapien profitieren.	○	○	○	○	○
Das Training hilft mir dabei, meinen Tag zu strukturieren.	○	○	○	○	○
Mir gefällt, dass ich trainieren kann, wann und wie lange ich möchte.	○	○	○	○	○
Ich kann durch das Training meine Belastbarkeit erproben.	○	○	○	○	○
Das Training ist eine sinnvolle Beschäftigung.	○	○	○	○	○

Weitere Gründe, die Sie zur Zeit motivieren das Training durchzuführen:

Bitte geben Sie Ihre Antwort hier ein:

Ihr Training (2 von 5)

Sie haben in dem Training, dass Sie in den letzten Wochen gemacht haben, verschiedene Elemente kennengelernt. Bitte geben Sie Ihrer persönlichen Meinung entsprechend an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft überhaupt nicht zu	Trifft eher nicht zu	weder noch	eher zutreffend	Trifft voll und ganz zu
Ich hätte gern detaillierte Informationen zu meinem aktuellen Training erhalten, um meine momentane Leistung besser einschätzen zu können.	○	○	○	○	○
Die dargestellten Informationen in der Leistungskurve halfen mir meine eigene Leistung besser einzuschätzen.	○	○	○	○	○
Ich habe der Darstellung meines aktuellen Trainingsverlaufs in der Leistungskurve viel Aufmerksamkeit gewidmet.	○	○	○	○	○
Es fiel mir leicht die gezeigten Informationen in der Leistungskurve zu verstehen.	○	○	○	○	○

Bitte geben Sie an, welche der folgenden Dinge Sie für Ihr Training möchten:

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich entscheide selber, wann ich trainiere.	◯	◯	◯	◯	◯
Ich sehe ob ich mich verbessere.	◯	◯	◯	◯	◯
Ich lege meine Ziele selber fest.	◯	◯	◯	◯	◯
Ich erfahre, ob andere Betroffene ähnliche Schwierigkeiten haben wie ich.	◯	◯	◯	◯	◯
Ich kann jederzeit Kontakt zu meinem Therapeuten aufnehmen, falls ich Probleme habe.	◯	◯	◯	◯	◯
Ich kann einschätzen, welche Aufgaben in der Therapie noch vor mir liegen.	◯	◯	◯	◯	◯
Ich kann mir gleich am Anfang des Trainings ein Ziel für die nächsten Wochen festlegen.	◯	◯	◯	◯	◯
Ich verstehe, warum das Training was ich mache, mir hilft.	◯	◯	◯	◯	◯

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich bekomme weitere Informationen zu meiner Erkrankung und zu meinem Training.	◯	◯	◯	◯	◯
Ich kann mich mit meinen vorherigen Leistungen im Training vergleichen.	◯	◯	◯	◯	◯
Die Aufgabe hat einen Bezug zu meinem eigenen Alltag.	◯	◯	◯	◯	◯
Ich suche mir zwischen verschiedenen Strategien zum Lösen der Aufgaben die Strategie aus, die mir am meisten liegt.	◯	◯	◯	◯	◯
Ich arbeite mit dem Training aktiv an der Verbesserung meiner Lebenssituation.	◯	◯	◯	◯	◯
Ich habe eigene Ziele, die ich erreichen will.	◯	◯	◯	◯	◯
Die Inhalte des Trainings sprechen meine Interessen an.	◯	◯	◯	◯	◯
Das Training macht mir Spaß.	◯	◯	◯	◯	◯
Ich bekomme von meinen Freunden und / oder meiner Familie positives Feedback.	◯	◯	◯	◯	◯

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Meine Fähigkeiten sind nach der Rehabilitation höher als zu Beginn.	◯	◯	◯	◯	◯
Mein Therapeut stellt mir ein wirksames Training zusammen.	◯	◯	◯	◯	◯
Ich bin im Training nicht auf die Hilfe anderer Personen angewiesen.	◯	◯	◯	◯	◯
Durch das Training wird meine Hoffnung in Rehabilitationserfolge gestärkt.	◯	◯	◯	◯	◯
Ich erfahre, ob das Training wirklich etwas bringt.	◯	◯	◯	◯	◯
Ich bekomme von meinem Therapeuten regelmäßig Feedback zu meinem Training.	◯	◯	◯	◯	◯
Ich kann den Fortschritt sehen, den ich bisher gemacht habe.	◯	◯	◯	◯	◯
Ich erzähle meinen Freunden und / oder meiner Familie von meinen Schritten in der Therapie.	◯	◯	◯	◯	◯
Ich teile gerne meine Erfahrungen mit anderen Betroffenen.	◯	◯	◯	◯	◯

	Möchte ich nicht	Möchte ich eher nicht	Weder noch	Möchte ich eher	Möchte ich
Ich sehe, wie ich meinen eigenen Zielen Schritt für Schritt näher komme.	◯	◯	◯	◯	◯
Ich bekomme erklärt, wie ich das, was ich geübt habe, auch im Alltag anwenden kann.	◯	◯	◯	◯	◯
Durch das Training habe ich das Gefühl, meine Lebenssituation wieder selbst in die Hand nehmen zu können.	◯	◯	◯	◯	◯
Ich bekomme Strategien erklärt, mit denen ich die Aufgaben besser lösen kann.	◯	◯	◯	◯	◯

Ihr Training (3 von 5)

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an, inwiefern Sie auf Ihr Training bezogen den folgenden Aussagen zustimmen:

*

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯
[redacted]	◯	◯	◯	◯	◯	◯	◯
[redacted]	◯	◯	◯	◯	◯	◯	◯
[redacted]	◯	◯	◯	◯	◯	◯	◯

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an.

Während des Training:

*

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

Die Benutzung Ihres Trainings (4 von 5)

Bitte geben Sie an: *

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○

[redacted]

	[redacted]				[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○	○	○	○	○

Haben Sie Anmerkungen zur Benutzung?

Bitte geben Sie Ihre Antwort hier ein:

Hatten Sie technische Probleme bei der Benutzung?

Bitte geben Sie Ihre Antwort hier ein:

Abschließende Bewertung (5 von 5)

Wie haben Sie folgende Aspekte während Ihres Trainings wahrgenommen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	überhaupt nicht	**eher nicht**	**weder noch**	**eher ja**	**ja, voll und ganz**
Fanden Sie die Bewertung der Fehler angemessen?	○	○	○	○	○
Wenn Sie in den ersten Leveln schon bei einem Fehler im Level abgestiegen sind, war das für Sie frustrierend?	○	○	○	○	○

Wenn Sie Ihre Vorgaben pro Woche nicht erfüllt haben, woran lag es?

Bitte wählen Sie alle zutreffenden Antworten aus:

- ☐ Ich hatte es vergessen.
- ☐ Ich hatte keine Lust auf das Training.
- ☐ Ich hatte zu viele andere Dinge zu tun.
- ☐ Ich weiß es nicht.
- ☐ Ich habe meine Vorgaben immer erfüllt.
- ☐ Sonstiges: ____________________

Wie ist ihr beruflicher Status? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Berentet ohne Zuverdienst
- ◯ Berentet mit Zuverdienst
- ◯ Arbeitssuchend
- ◯ Arbeitsunfähig
- ◯ Anstellungsverhältnis oder Selbstständigkeit (durchschnittliche Stundenzahl pro Woche bitte im Kommentarfeld angeben)
- ◯ Sonstiges

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Welche Aspekte an RehaCom und am Training haben Ihnen besonders gefallen?

Bitte geben Sie Ihre Antwort hier ein:

Welche Aspekte an RehaCom und am Training fanden Sie nicht so gut?

Bitte geben Sie Ihre Antwort hier ein:

Wie hat Ihnen die Organisation der Studie gefallen? Gab es Schwierigkeiten?

Bitte geben Sie Ihre Antwort hier ein:

Herzlichen Dank für Ihre Unterstützung!

Damit leisten Sie einen wertvollen Beitrag zur Verbesserung von kognitiven Therapien.

Sie können diesen Browser-Tab jetzt schließen.

Ihr RehaCom-Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

RehaCom @ home - Nachbefragung

Sehr geehrter Studienteilnehmer, sehr geehrte Studienteilnehmerin,

leider haben sich ein paar technische Schwierigkeiten in der Umsetzung des Online-Trainings eingeschlichen. Damit wir Ihre Studienerfahrungen korrekt einschätzen können, bitten wir Sie um eine kurze Rückmeldung, ob Sie bestimmte Funktionen gesehen haben. Dies dauert maximal 3 Minuten und würde uns einen großen Schritt voran bringen.

Vielen Dank,

Ihre RehaCom-Online Studienleitung

In dieser Umfrage sind 9 Fragen enthalten.

Nachbefragung (Seite 1 von 2)

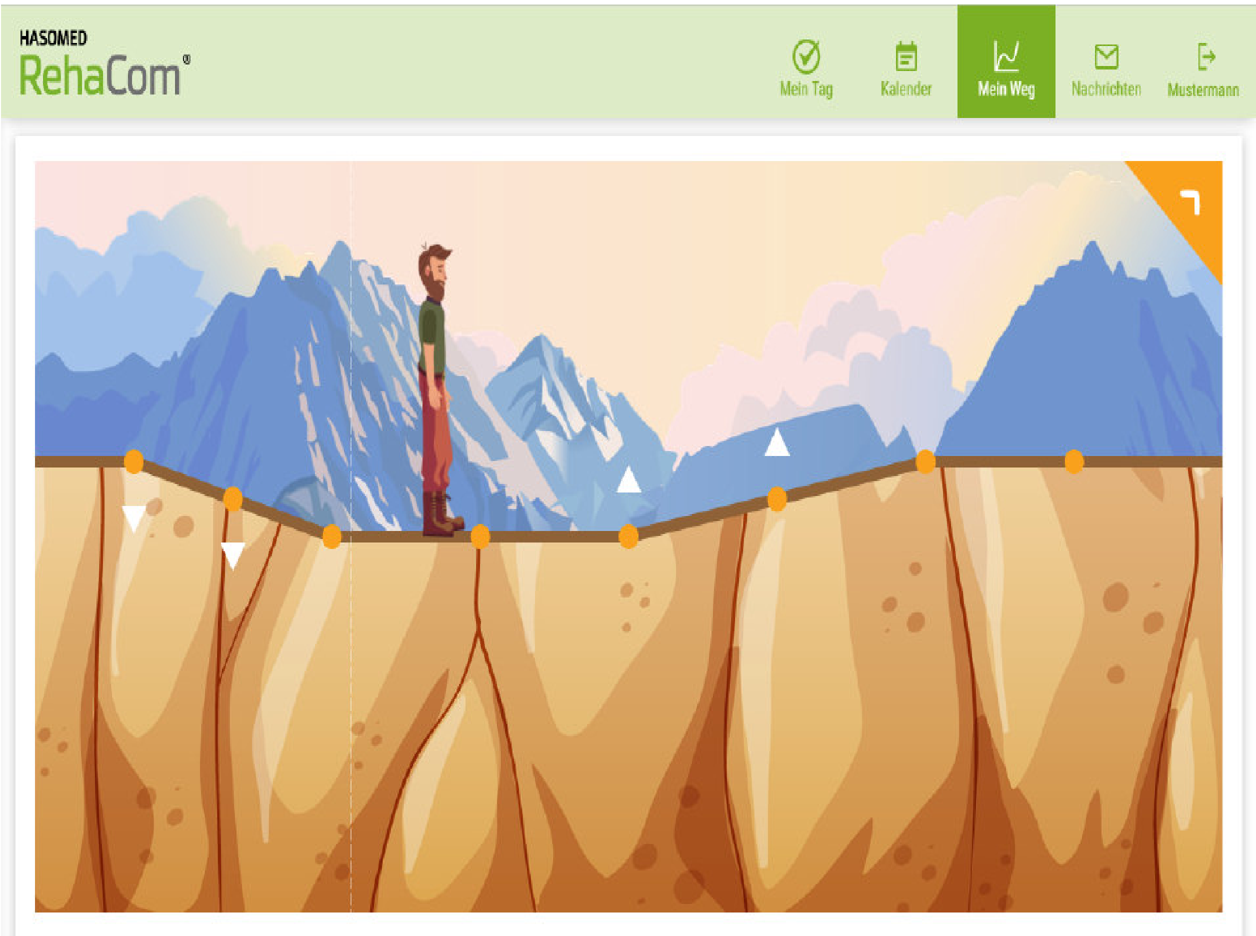
Bitte geben Sie die Teilnehmernummer an, die Sie in der Begrüßungsmail für die Teilnahme an der Studie von uns bekommen haben:

*

Bitte geben Sie Ihre Antwort hier ein:

[redacted] [redacted]

Haben Sie verstanden, dass man mit einem Klick auf die orange Ecke oben rechts auf die Ansicht des Wanderwegs wechseln kann?



*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein, ich habe diese Funktion nicht gesehen.
- ◯ Ja, ich habe diese Funktion gesehen, habe sie aber nicht genutzt.
- ◯ Ja, ich habe diese Funktion gesehen und habe sie manchmal genutzt.
- ◯ Ja, ich habe diese Funktion gesehen und habe sie jedes Mal genutzt.

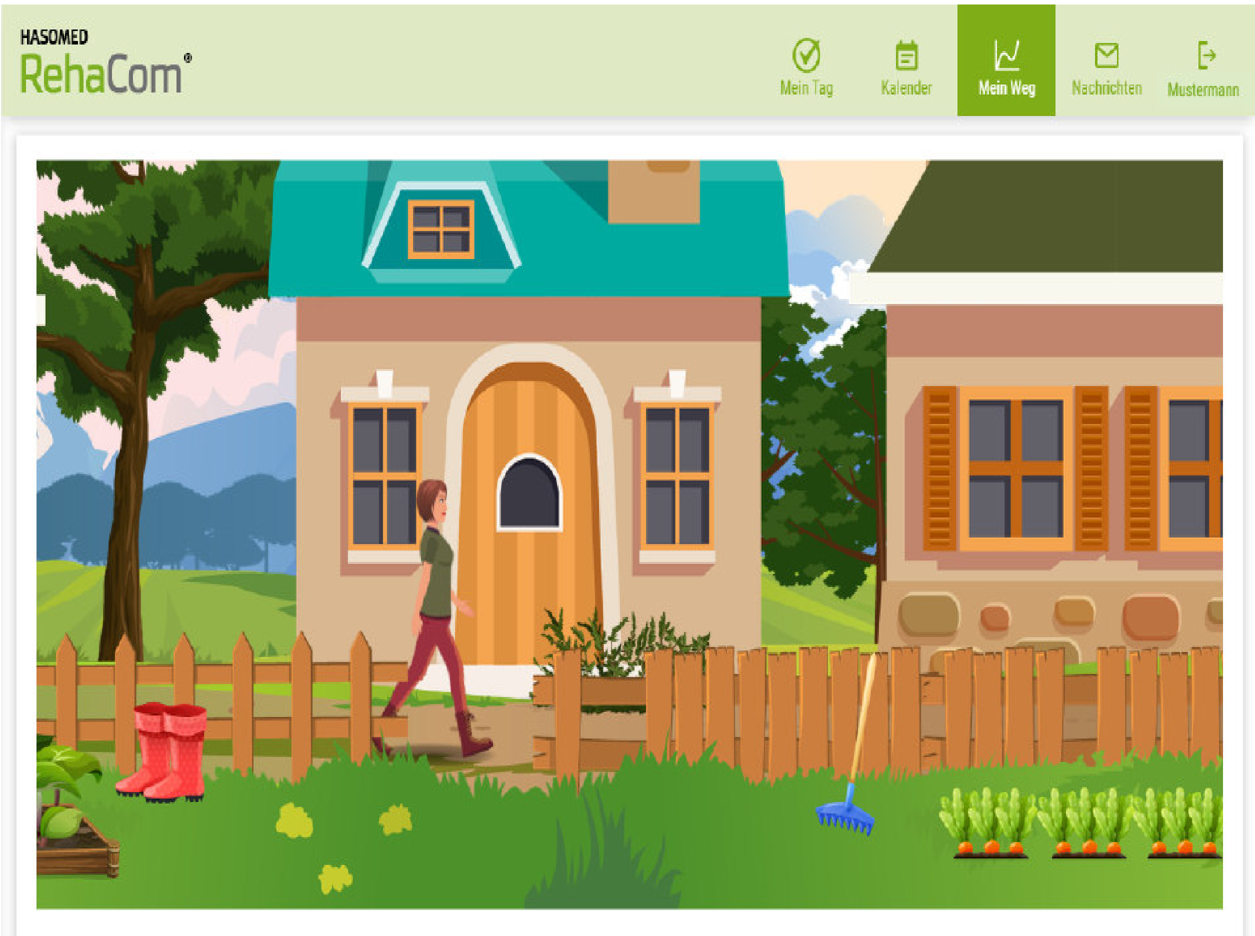
Wenn Sie die Funktion der orangen Ecke und den Wechsel zum Wanderweg nicht genutzt haben, geben Sie bitte an, warum: *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ich hatte es nicht verstanden oder es war mir nicht bewusst.
- ◯ Ich hatte es nach dem Training vergessen.
- ◯ Es hat mich nicht interessiert.
- ◯ Es hat mich nicht mehr interessiert, nachdem ich es ausprobiert hatte.
- ◯ Ein anderer Grund und zwar:

Bitte schreiben Sie einen Kommentar zu Ihrer Auswahl

Haben Sie gesehen, wie Ihr Begleiter nach dem Training ein paar Schritte vorangeht?



*

Bitte wählen Sie nur eine der folgenden Antworten aus:

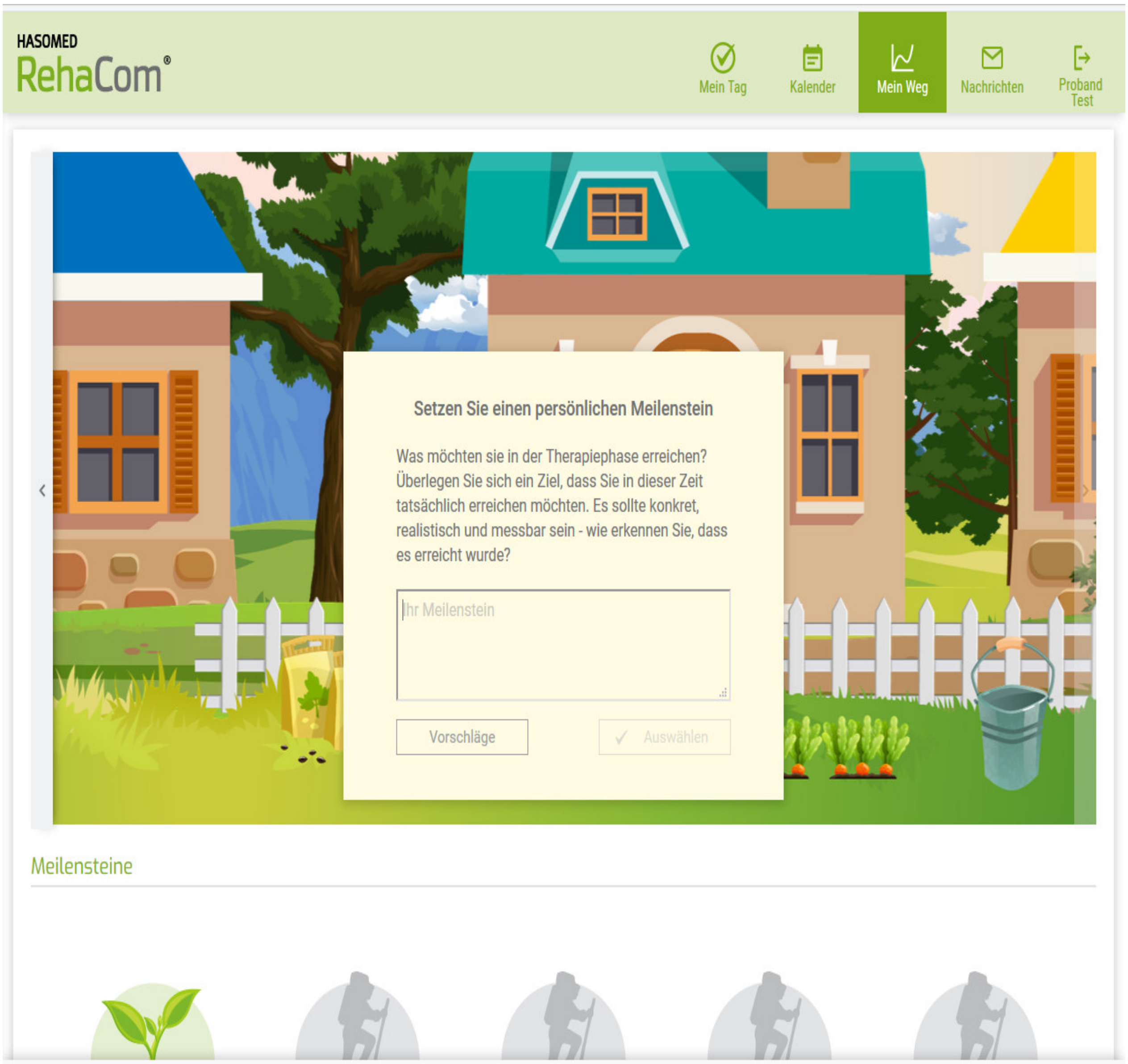
◯ Nein, ich habe diese Funktion nicht gesehen.

◯ Ja, ich habe diese Funktion gesehen.

◯ Ich habe den Weg gesehen, aber hatten keinen Begleiter.

Nachbefragung 2 (Seite 2 von 2)

Haben Sie die folgenden Funktionen in Ihrem Training gesehen? Bitte geben Sie an:



*

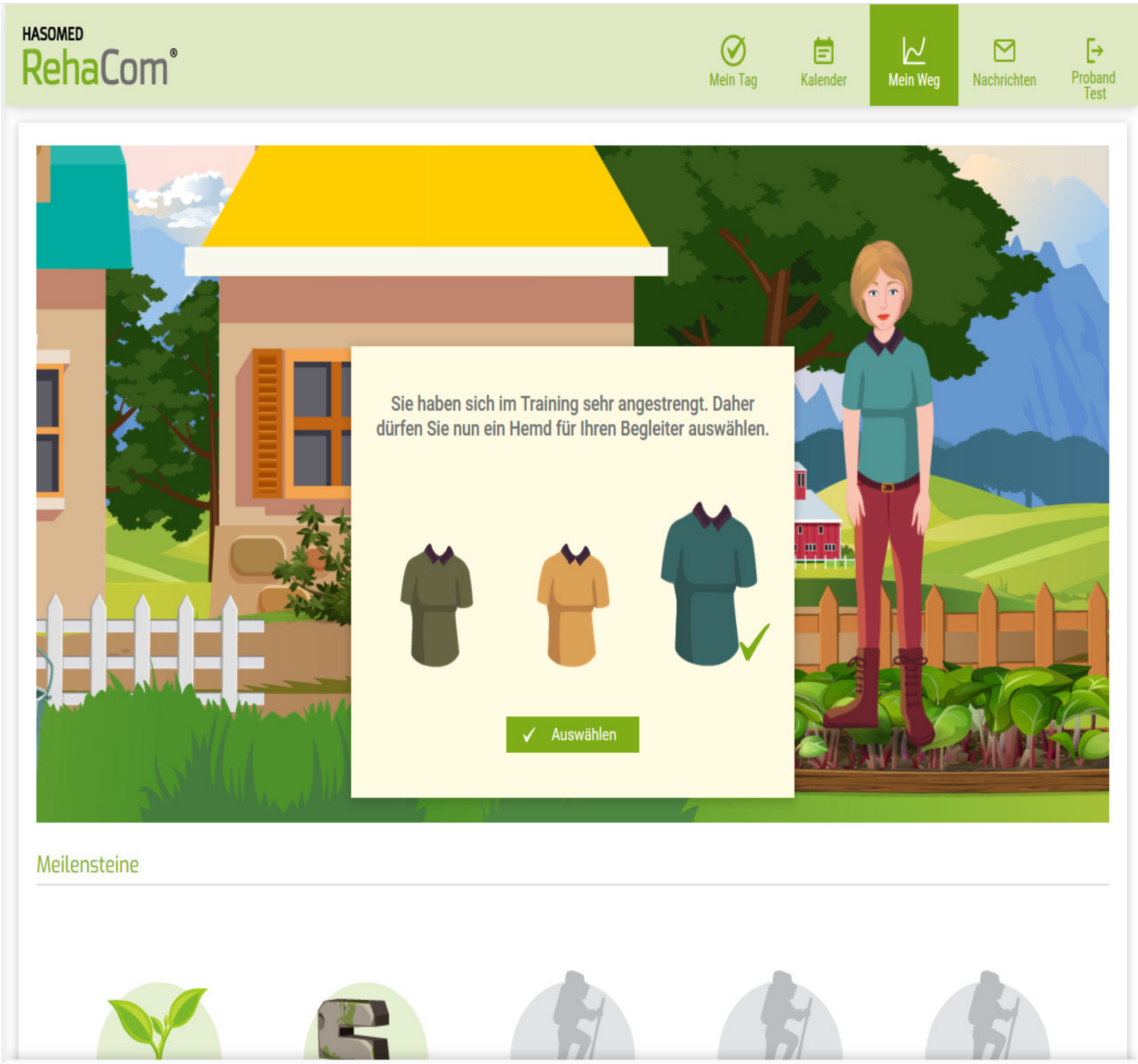
Bitte wählen Sie nur eine der folgenden Antworten aus:

◯ Nein, ich habe diese Funktion nicht gesehen.

◯ Ja, ich habe diese Funktion gesehen, habe sie aber nicht genutzt.

◯ Ja, ich habe diese Funktion gesehen und habe sie genutzt.

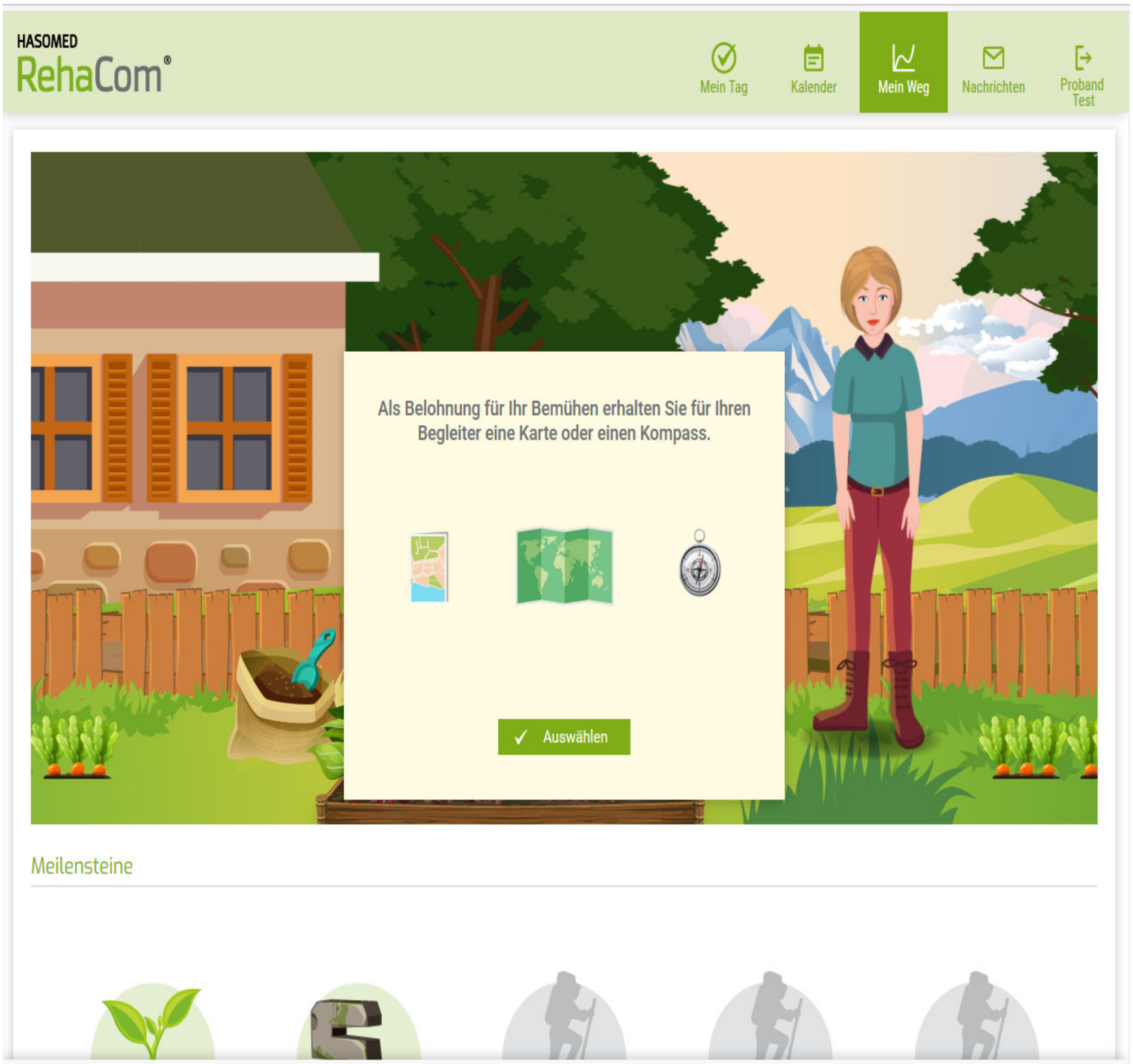
[redacted] [redacted]



*

Bitte wählen Sie nur eine der folgenden Antworten aus:

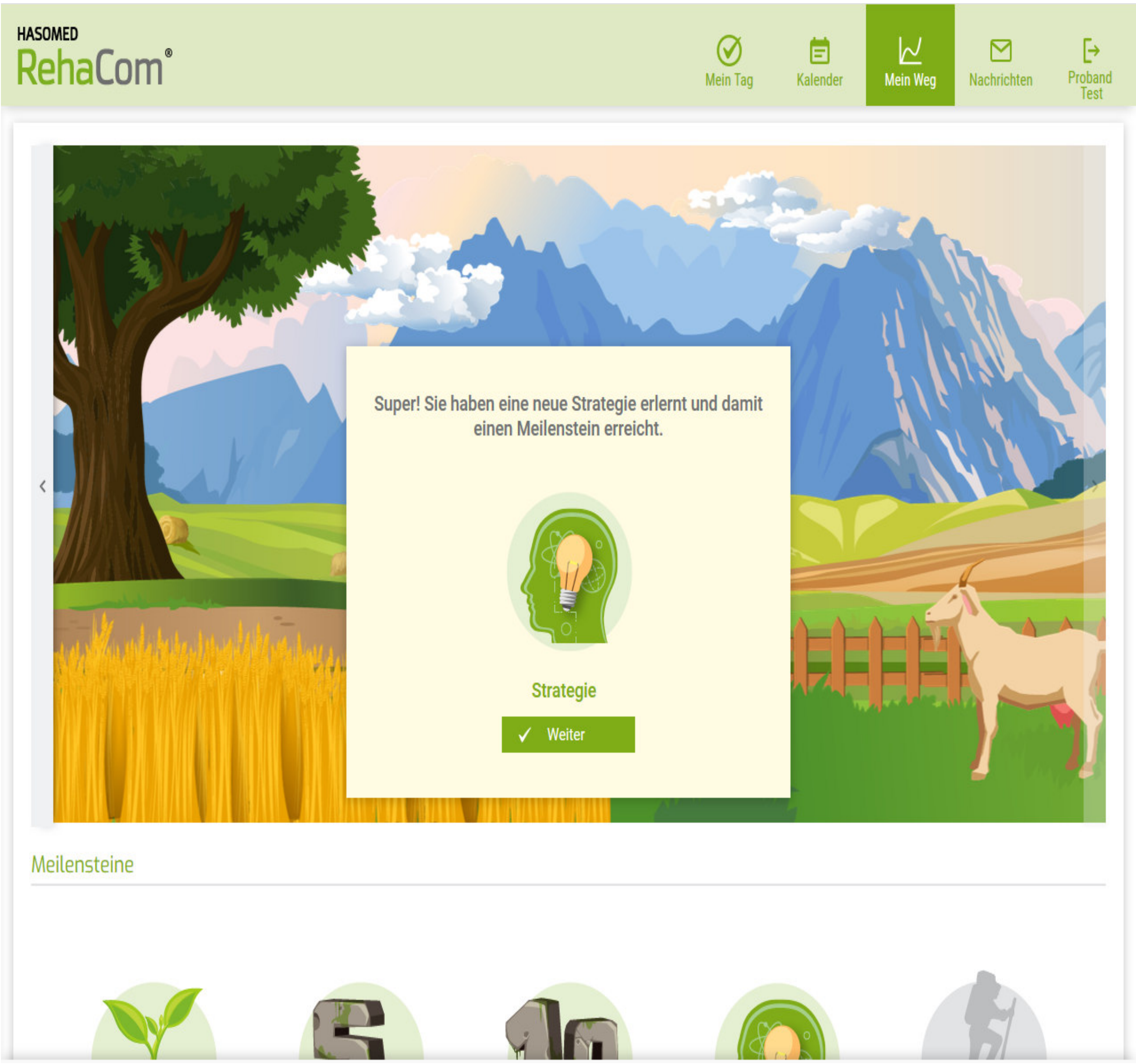
- ◯ Nein, ich habe diese Funktion nicht gesehen.
- ◯ Ja, ich habe diese Funktion gesehen, habe sie aber nicht genutzt.
- ◯ Ja, ich habe diese Funktion gesehen und habe sie genutzt.



[redacted]

[redacted]

- ◯ [redacted]
- ◯ [redacted]
- ◯ [redacted], ich habe diese Funktion gesehen und habe sie genutzt.



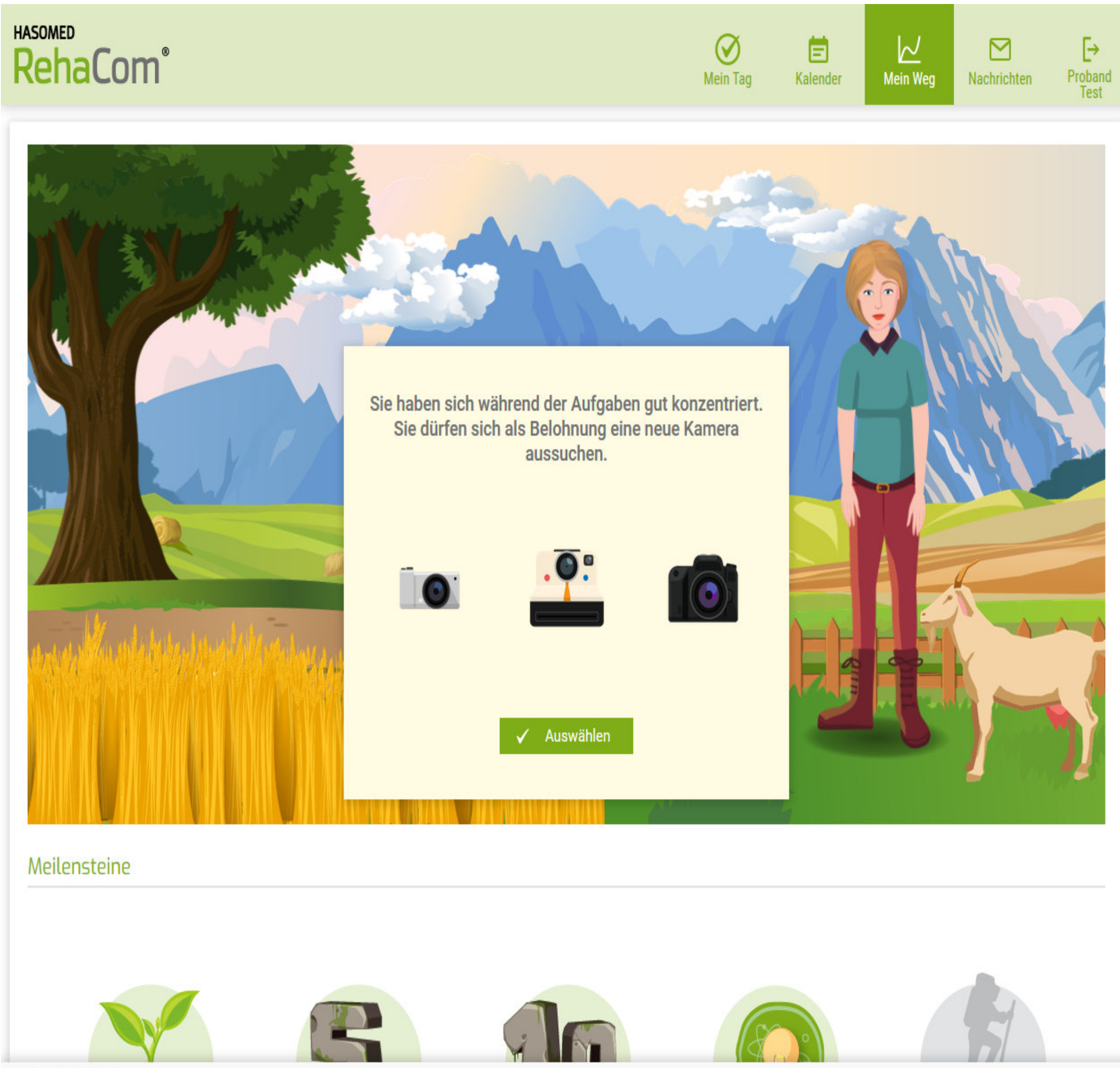
*

Bitte wählen Sie nur eine der folgenden Antworten aus:

◯ Nein, ich habe diese Funktion nicht gesehen.

◯ Ja, ich habe diese Funktion gesehen, habe sie aber nicht genutzt.

◯ Ja, ich habe diese Funktion gesehen und habe sie genutzt.



*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein, ich habe diese Funktion nicht gesehen.
- ◯ Ja, ich habe diese Funktion gesehen, habe sie aber nicht genutzt.
- ◯ Ja, ich habe diese Funktion gesehen und habe sie genutzt.

Vielen Dank!

Sie haben einen wertvollen Beitrag zu der Verbesserung kognitiver Therapien geleistet.

Ihre RehaCom-Online Studienleitung

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

3.4 Outlook Potentials of a Web-based Gamification Guide for Knowledge Transfer between Research and Industry. A Method to Support Design and Development

Link Video Prototyp:

Title: Potentials of a web-based gamification guidance for knowledge transfer between research and industry
Link: https://dl.acm.org/doi/10.1145/3450337.3483458

Citation: M. Gabele and V. T. Fischer, M. Steinbrügge, D. Thiemke, S. Hußlein, C. Hansen, „Potentials of a Web-based Gamification Guide for Knowledge Transfer between Research and Industry", in Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play (CHI Play), Austria (Virtual Event), Oct. 2021, pp. 301-307, doi: 10.1145/3450337.3483458.

4.2 Effects of a Tailoring Method and Combined Browser-Based and Mobile Cognitive Software Training

Datenschutz und Einwilligung

Die Teilnahme an dieser Studie ist freiwillig. Sie können jederzeit ohne Angabe von Gründen die Teilnahme beenden, ohne dass Ihnen dadurch Nachteile entstehen.

In der nachfolgenden Studie werden die Daten anonym erhoben. Ihre Angaben und Ihre Einwilligung werden getrennt voneinander aufbewahrt und einander nicht zugeordnet. Sie können Ihre Einwilligung zur Speicherung und Nutzung Ihrer Daten während der Erhebung jederzeit widerrufen, ohne dass Ihnen Nachteile daraus entstehen.

Die erhobenen Daten, werden im Rahmen einer Studie an der Otto-von-Guericke-Universität erhoben, ausgewertet und gespeichert. Die Verarbeitung der Daten erfolgt für Forschungszwecke. Im Falle einer Veröffentlichung von Studienergebnissen bleibt Ihre Identität vertraulich. D.h. eine Zuordnung der Daten zu Ihrer Person nicht möglich, und es ist auch nicht aus den Daten ersichtlich, dass Sie an einer Untersuchung teilgenommen haben.

Sollten Sie noch weitere Fragen zum Ablauf der Studie, zum Datenschutz, zu Ihren Rechten, usw. haben, können Sie diese jederzeit an den Versuchsleiter stellen.

Haben Sie die Informationen verstanden und stimmen Sie auf dieser Basis zu an der Studie teilzunehmen?

O Ich stimme zu und möchte teilnehmen.
O Ich stimme nicht zu und möchte nicht teilnehmen.

____

Ort, Datum

______________________________	______________________________
Name in Druckbuchstaben	Unterschrift

1) Bitte geben Sie für sich an:

Alter: ___________ Jahre

Geschlecht:
- ☐ weiblich
- ☐ männlich
- ☐ divers

Höchster Bildungsabschluss:
- ☐ kein Abschluss
- ☐ Haupt- / Volksschulabschluss
- ☐ Realschule / Mittlere Reife / POS
- ☐ Abitur / Fachabitur
- ☐ Hochschulabschluss

Wie schätzen Sie selber Ihre Fähigkeiten im Kopfrechnen ein?

☐ schlecht ☐ eher schlecht ☐ durchschnittlich ☐ eher gut ☐ gut

---

2) Lösen Sie bitte die folgenden Rechenaufgaben im Kopf. Kommen Sie bei einzelnen Aufgaben auf keine Lösung, streichen Sie diese bitte.

Aufgabe	**Lösung**
5 + 2	
35 + 16	
217 + 612	
3,6 + 5,7	
46,7 + 13,8	
582,3 + 147,6	
3,54 + 4,82	
231,92 + 382,53	
2,853 + 6,286	
724,631 + 198,335	

3) Bitte geben Sie in Bezug auf die durchgeführten Rechenaufgaben an:

[redacted]

Studie: Online Rechentraining 1

Sehr geehrte Interessentin, sehr geehter Interessent,

vielen Dank für Ihr Interesse uns bei der Studie zum Online-Rechentraining zu unterstützen.

Zunächst möchten wir Sie und Ihre persönliche Einstellung kennenlernen.

Beste Grüße,

ihr Forschungsteam

In dieser Umfrage sind 8 Fragen enthalten.

Einwilligungserklärung zur Studienteilnahme

Bevor wir beginnen, geben Sie bitte an:

Sie wurden über die Studie (u.a. den Ablauf und deren Wesen, Bedeutung, sowie Nutzen, Risiken und Datenschutz) innerhalb der per E-Mail erhaltenen Studieninformation aufgeklärt. Sie habe diese Informationen gelesen und verstanden.

Stimmen Sie auf dieser Basis der Teilnahme an der Studie zu?

(Hinweis: Wenn Sie nicht zustimmen möchten, schließen Sie diese Seite jetzt).

*****

Bitte wählen Sie nur eine der folgenden Antworten aus:

○ Ja, ich stimme zu und möchte teilnehmen

Zu Ihrer Person

Bitte geben Sie an:

Ihre Teilnehmernummer, die Sie in der E-Mail von uns bekommen haben: *

Bitte geben Sie Ihre Antwort hier ein:

Ihr Alter in Jahren: *

Bitte geben Sie Ihre Antwort hier ein:

Ihr Geschlecht:

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ männlich
- ◯ weiblich
- ◯ divers

Höchster Bildungsabschluss:

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ kein Abschluss
- ◯ Haupt- / Volksschulabschluss
- ◯ Realschule / Mittlere Reife / POS
- ◯ Abitur / Fachabitur
- ◯ Hochschulabschluss

Selbsteinschätzung

Macht Ihnen Kopfrechnen Spaß?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Absolut nein
- ◯ Nein
- ◯ Eher Nein
- ◯ Weder noch
- ◯ Eher ja
- ◯ Ja
- ◯ Absolut ja

Wie schätzen Sie selber Ihre Fähigkeiten im Kopfrechnen ein?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Sehr schlecht
- ◯ Schlecht
- ◯ Eher schlecht
- ◯ Durchschnittlich
- ◯ Eher gut
- ◯ Gut
- ◯ Sehr gut

Bitte geben Sie Ihrer persönlichen Meinung entsprechend an, inwiefern Sie den folgenden Aussagen zustimmen: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Weder noch	Stimme eher zu	Stimme zu	Stimme völlig zu
Es macht mich glücklich, wenn ich anderen helfen kann.	○	○	○	○	○	○	○
Ich mag es nicht, Regeln zu befolgen.	○	○	○	○	○	○	○
Ich meistere gerne schwierige Aufgaben.	○	○	○	○	○	○	○
Das Wohlergehen anderer ist mir wichtig.	○	○	○	○	○	○	○
Selbständigkeit ist mir wichtig.	○	○	○	○	○	○	○
Ich überwinde gerne Hindernisse.	○	○	○	○	○	○	○
Ich sehe mich als Rebell.	○	○	○	○	○	○	○
Ich helfe gerne anderen, sich in neuen Situationen zu orientieren.	○	○	○	○	○	○	○
Ich stelle gerne den aktuellen Zustand in Frage.	○	○	○	○	○	○	○

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Weder noch	Stimme eher zu	Stimme zu	Stimme völlig zu
Der Lohn meiner getätigten Anstrengung ist mir wichtig.	◯	◯	◯	◯	◯	◯	◯
Ich probiere gerne neue Dinge aus.	◯	◯	◯	◯	◯	◯	◯
Ich mag Gruppenaktivitäten.	◯	◯	◯	◯	◯	◯	◯
Ich provoziere gerne.	◯	◯	◯	◯	◯	◯	◯
Wenn die Belohnung ausreicht, werde ich mich anstrengen.	◯	◯	◯	◯	◯	◯	◯
Ich teile gerne mein Wissen.	◯	◯	◯	◯	◯	◯	◯
Ich lasse mich oft von meiner Neugier leiten.	◯	◯	◯	◯	◯	◯	◯
Es ist mir wichtig, mich als Teil einer Gemeinschaft zu fühlen.	◯	◯	◯	◯	◯	◯	◯
Ich mag Wettbewerbe, bei denen ein Preis gewonnen werden kann.	◯	◯	◯	◯	◯	◯	◯
Es ist mir wichtig, meine Aufgaben immer vollständig zu erfüllen.	◯	◯	◯	◯	◯	◯	◯

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Weder noch	Stimme eher zu	Stimme zu	Stimme völlig zu
Es fällt mir schwer, ein Problem loszulassen, bevor ich eine Lösung gefunden habe.	○	○	○	○	○	○	○
Belohnungen sind eine gute Möglichkeit, mich zu motivieren.	○	○	○	○	○	○	○
Es ist mir wichtig, meinen eigenen Weg zu gehen.	○	○	○	○	○	○	○
Ich mag es, Teil eines Teams zu sein.	○	○	○	○	○	○	○
Der Umgang mit anderen ist mir wichtig.	○	○	○	○	○	○	○

Herzlichen Dank für Ihre Unterstützung!

Wir werden uns schnellstmöglich mit dem Link zu Ihrem Rechentraining und Ihren Zugangsdaten per E-Mail bei Ihnen melden.

Beste Grüße,

ihr Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

Studie: Online Rechentraining A (Teil 2)

Vielen Dank für die Durchführung des Trainings.

Im Anschluss haben wir noch einige Fragen dazu an Sie.

In dieser Umfrage sind 12 Fragen enthalten.

Ihre persönliche Wahrnehmung im Training (Seite 1 von 4)

Bitte geben Sie Ihre Teilnehmernummer an, die Sie per E-Mail von uns bekommen haben und auch für den Login genutzt haben: *

Bitte geben Sie Ihre Antwort hier ein:

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung während des Trainings:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Ihre persönliche Wahrnehmung im Training (Seite 2 von 4)

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung in Training:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Geben Sie bitte für die unten stehenden Punkte an, wie gering (1 Punkt) oder hoch (21 Punkte) Sie sich von der Aufgabe beansprucht oder gefordert gesehen haben:

[redacted]

	[redacted]
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○

	1	10	11	12	13	14	15	16	17	18	19	2	20	21	3	4	5	6	7	8	9
[redacted]																					

Elemente in Ihrem Training (Seite 3 von 4)

Wie haben Ihnen die folgenden Elemente im Training gefallen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Absolut schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Absolut gut
Das Layout							
Die Verständlichkeit des Ablaufs							
Die Rechenaufgaben							

Das Training würde mir mehr Spaß machen, wenn...

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Die Aufgaben sinnvoll in eine Handlung eingebettet wären.	○	○	○	○	○	○
Ich es gemeinsam mit einem Mitspieler machen könnte.	○	○	○	○	○	○

Ihre Einschätzung (Seite 4 von 4)

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Bei regelmäßiger Nutzung hat das Training einen positiven Effekt auf meine Rechenfähigkeiten.	○	○	○	○	○	○	○
Ich sollte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich möchte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich werde ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○

Bitte begründen Sie Ihre Auswahl in der letzten Frage:

Bitte geben Sie Ihre Antwort hier ein:

Warum haben Sie das Training an dem Punkt beendet, als Sie es beendet haben? Und was hätte Ihnen an diesem Punkt geholfen mit dem Training fortzufahren?

Bitte geben Sie Ihre Antwort hier ein:

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Sehr schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Sehr gut
Wie bewerten Sie das Kopfrechentraining insgesamt?	○	○	○	○	○	○	○

Haben Sie Erfahrung mit ...

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Nein, keine	Einmalig bis mehrere Tage	Eine bis mehrere Wochen	Einen bis mehrere Monate	Eins bis mehrere Jahre
kognitiven Trainings am Computer?	○	○	○	○	○
Brainjogging Apps am Smartphone / Tablet?	○	○	○	○	○

Möchten Sie an der Verlosung der Überraschung als Dankeschön für Ihr Feedback teilnehmen?

(Durch das Beantworten des Fragebogens zum nachfolgenden Videoprototypen können Sie Ihre Chancen auch noch einmal verdoppeln)

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ja
- ◯ Nein

Vielen Dank für Ihre Einschätzung.

Sie unterstützen uns und die Weiterentwicklung kognitiver Trainings damit sehr!

Beste Grüße,

Ihr Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

Studie: Online Rechentraining B (Teil 2)

Vielen Dank für die Durchführung des Trainings.

Im Anschluss haben wir noch einige Fragen dazu an Sie.

In dieser Umfrage sind 12 Fragen enthalten.

Ihre persönliche Wahrnehmung im Training (Seite 1 von 4)

Bitte geben Sie Ihre Teilnehmernummer an, die Sie per E-Mail von uns bekommen haben und auch für den Login genutzt haben: *

Bitte geben Sie Ihre Antwort hier ein:

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung während des Trainings:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Ihre persönliche Wahrnehmung im Training (Seite 2 von 4)

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung in Training:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Geben Sie bitte für die unten stehenden Punkte an, wie gering (1 Punkt) oder hoch (21 Punkte) Sie sich von der Aufgabe beansprucht oder gefordert gesehen haben:

[redacted]

	[redacted]
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○

	1	10	11	12	13	14	15	16	17	18	19	2	20	21	3	4	5	6	7	8	9
[redacted]	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Elemente in Ihrem Training (Seite 3 von 4)

Wie haben Ihnen die folgenden Elemente im Training gefallen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Absolut schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Absolut gut
Die Rechenaufgaben	◯	◯	◯	◯	◯	◯	◯
Das Layout	◯	◯	◯	◯	◯	◯	◯
Die Verständlichkeit des Ablaufs	◯	◯	◯	◯	◯	◯	◯

Das Training würde mir mehr Spaß machen, wenn...

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Ich es gemeinsam mit einem Mitspieler machen könnte.	◯	◯	◯	◯	◯	◯
Die Aufgaben sinnvoll in eine Handlung eingebettet wären.	◯	◯	◯	◯	◯	◯

Ihre Einschätzung (Seite 4 von 4)

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Ich werde ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich möchte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich sollte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Bei regelmäßiger Nutzung hat das Training einen positiven Effekt auf meine Rechenfähigkeiten.	○	○	○	○	○	○	○

Bitte begründen Sie Ihre Auswahl in der letzten Frage:

Bitte geben Sie Ihre Antwort hier ein:

Warum haben Sie das Training an dem Punkt beendet, als Sie es beendet haben? Und was hätte Ihnen an diesem Punkt geholfen mit dem Training fortzufahren?

Bitte geben Sie Ihre Antwort hier ein:

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Sehr schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Sehr gut
Wie bewerten Sie das Kopfrechentraining insgesamt?	○	○	○	○	○	○	○

Haben Sie Erfahrung mit ...

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Nein, keine	Einmalig bis mehrere Tage	Eine bis mehrere Wochen	Einen bis mehrere Monate	Eins bis mehrere Jahre
kognitiven Trainings am Computer?	○	○	○	○	○
Brainjogging Apps am Smartphone / Tablet?	○	○	○	○	○

Möchten Sie an der Verlosung der Überraschung als Dankeschön für Ihr Feedback teilnehmen?

(Durch das Beantworten des Fragebogens zum nachfolgenden Videoprototypen können Sie Ihre Chancen auch noch einmal verdoppeln)

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ja
- ◯ Nein

Vielen Dank für Ihre Einschätzung.

Sie unterstützen uns und die Weiterentwicklung kognitiver Trainings damit sehr!

Beste Grüße,

Ihr Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

Studie: Online Rechentraining C (Teil 2)

Vielen Dank für die Durchführung des Trainings.

Im Anschluss haben wir noch einige Fragen dazu an Sie.

In dieser Umfrage sind 12 Fragen enthalten.

Ihre persönliche Wahrnehmung im Training (Seite 1 von 4)

Bitte geben Sie Ihre Teilnehmernummer an, die Sie per E-Mail von uns bekommen haben und auch für den Login genutzt haben: *

Bitte geben Sie Ihre Antwort hier ein:

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung während des Trainings:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Ihre persönliche Wahrnehmung im Training (Seite 2 von 4)

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung in Training:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Geben Sie bitte für die unten stehenden Punkte an, wie gering (1 Punkt) oder hoch (21 Punkte) Sie sich von der Aufgabe beansprucht oder gefordert gesehen haben:

[redacted]

	[redacted]
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○
[redacted]	○ ○

	[redacted]
[redacted]	

Elemente in Ihrem Training (Seite 3 von 4)

Wie haben Ihnen die folgenden Elemente im Training gefallen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Absolut schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Absolut gut
Die Rechenaufgaben							
Das Layout							
Die Verständlichkeit des Ablaufs							
Sterne für gelöste Aufgaben bekommen							

Bitte geben Sie für die folgenden Elemente in Ihrem Training an:

Ich möchte...

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
...mit mehreren Personen in einem Team trainieren	◯	◯	◯	◯	◯	◯	◯
...mit Fremden gemeinsam trainieren	◯	◯	◯	◯	◯	◯	◯
...mit Freunden, die ich kenne, trainieren	◯	◯	◯	◯	◯	◯	◯
...mit einem Trainier gemeinsam trainieren	◯	◯	◯	◯	◯	◯	◯
...mich mit den Leistungen von anderen vergleichen können.	◯	◯	◯	◯	◯	◯	◯
...meine Fortschritte anderen zeigen.	◯	◯	◯	◯	◯	◯	◯
...durch das Training neue Menschen kennen lernen.	◯	◯	◯	◯	◯	◯	◯

Ihre Einschätzung (Seite 4 von 4)

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Ich werde ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich möchte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich sollte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Bei regelmäßiger Nutzung hat das Training einen positiven Effekt auf meine Rechenfähigkeiten.	○	○	○	○	○	○	○

Bitte begründen Sie Ihre Auswahl in der letzten Frage:

Bitte geben Sie Ihre Antwort hier ein:

Warum haben Sie das Training an dem Punkt beendet, als Sie es beendet haben? Und was hätte Ihnen an diesem Punkt geholfen mit dem Training fortzufahren?

Bitte geben Sie Ihre Antwort hier ein:

Haben Sie Erfahrung mit ...

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Nein, keine	Einmalig bis mehrere Tage	Eine bis mehrere Wochen	Einen bis mehrere Monate	Eins bis mehrere Jahre
Brainjogging Apps am Smartphone / Tablet?	◯	◯	◯	◯	◯
kognitiven Trainings am Computer?	◯	◯	◯	◯	◯

Bitte geben Sie an: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Sehr schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Sehr gut
Wie bewerten Sie das Kopfrechentraining insgesamt?	◯	◯	◯	◯	◯	◯	◯

Möchten Sie an der Verlosung der Überraschung als Dankeschön für Ihr Feedback teilnehmen? (Durch das Beantworten des Fragebogens zum nachfolgenden Videoprototypen können Sie Ihre Chancen auch noch einmal verdoppeln)

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ja
- ◯ Nein

Vielen Dank für Ihre Einschätzung.

Sie unterstützen uns und die Weiterentwicklung kognitiver Trainings damit sehr!

Beste Grüße,

Ihr Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

Studie: Online Rechentraining D (Teil 2)

Vielen Dank für die Durchführung des Trainings.

Im Anschluss haben wir noch einige Fragen dazu an Sie.

In dieser Umfrage sind 13 Fragen enthalten.

Ihre persönliche Wahrnehmung im Training (Seite 1 von 4)

Bitte geben Sie Ihre Teilnehmernummer an, die Sie per E-Mail von uns bekommen haben und auch für den Login genutzt haben: *

Bitte geben Sie Ihre Antwort hier ein:

[redacted]

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung während des Trainings:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Ihre persönliche Wahrnehmung im Training (Seite 2 von 4)

Bitte beschreiben Sie nach Ihrer persönlichen Wahrnehmung in Training:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Die Rechenaufgabe mit einer Story zu kombinieren macht mir mehr Spaß als die Rechenaufgaben ohne Story zu machen.	○	○	○	○	○	○	○
Die Rechenaufgaben mit einer Story zu kombinieren gefällt mir.	○	○	○	○	○	○	○

Geben Sie bitte für die unten stehenden Punkte an, wie gering (1 Punkt) oder hoch (21 Punkte) Sie sich von der Aufgabe beansprucht oder gefordert gesehen haben:

[redacted]

	[redacted]
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	

	[redacted]
[redacted]	

Elemente in Ihrem Training (Seite 3 von 4)

Wie hat Ihnen die Story gefallen?

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Ich fand die Story interessant.							
Ich konnte mich gut auf die Story einlassen.							
Die Rechenaufgaben haben von der Story abgelenkt.							
Die Story hat von den Rechenaufgaben abgelenkt.							

Wie haben Ihnen die folgenden Elemente im Training gefallen:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Absolut schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Absolut gut
Die Story zu lesen	◯	◯	◯	◯	◯	◯	◯
Bilder zur Story zu sehen	◯	◯	◯	◯	◯	◯	◯
Die Rechenaufgaben	◯	◯	◯	◯	◯	◯	◯
Die Verständlichkeit des Ablaufs	◯	◯	◯	◯	◯	◯	◯
Das Layout	◯	◯	◯	◯	◯	◯	◯

Bitte geben Sie für die folgenden Elemente in Ihrem Training an:

Ich möchte...

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
...verschiedene Storys lesen.	◯	◯	◯	◯	◯	◯	◯
...mir meine Story (oder ein Themengebiet) selber aussuchen.	◯	◯	◯	◯	◯	◯	◯
...den Verlauf der Story beeinflussen können.	◯	◯	◯	◯	◯	◯	◯
...eine eigene Person als Teil der Story sein.	◯	◯	◯	◯	◯	◯	◯
...dass die Story in Echtzeit weitergeht und ich zwischendurch (z.B. per Smartphone) immer wieder neue Teile der Handlung bekomme.	◯	◯	◯	◯	◯	◯	◯

Ihre Einschätzung (Seite 4 von 4)

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Bei regelmäßiger Nutzung hat das Training einen positiven Effekt auf meine Rechenfähigkeiten.	○	○	○	○	○	○	○
Ich sollte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich möchte ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○
Ich werde ein Training in dieser Art, angepasst an meine Fähigkeiten, häufiger durchführen.	○	○	○	○	○	○	○

Bitte begründen Sie Ihre Auswahl in der letzten Frage:

Bitte geben Sie Ihre Antwort hier ein:

Warum haben Sie das Training an dem Punkt beendet, als Sie es beendet haben? Und was hätte Ihnen an diesem Punkt geholfen mit dem Training fortzufahren?

Bitte geben Sie Ihre Antwort hier ein:

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Sehr schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Sehr gut
Wie bewerten Sie das Kopfrechentraining insgesamt?	○	○	○	○	○	○	○

Haben Sie Erfahrung mit ... *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Nein, keine	Einmalig bis mehrere Tage	Eine bis mehrere Wochen	Einen bis mehrere Monate	Eins bis mehrere Jahre
kognitiven Trainings am Computer?	○	○	○	○	○
Brainjogging Apps am Smartphone / Tablet?	○	○	○	○	○

Möchten Sie an der Verlosung der Überraschung als Dankeschön für Ihr Feedback teilnehmen? (Durch das Beantworten des Fragebogens zum nachfolgenden Videoprototypen können Sie Ihre Chancen auch noch einmal verdoppeln)

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ja
- ◯ Nein

Vielen Dank für Ihre Einschätzung.

Sie unterstützen uns und die Weiterentwicklung kognitiver Trainings damit sehr!

Beste Grüße,

Ihr Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

Studie: Online Rechentraining - Training mit der App

Vielen Dank, dass Sie sich das Video mit der neuen App angesehen haben. Im Anschluss haben wir noch einige Fragen dazu an Sie.
In dieser Umfrage sind 12 Fragen enthalten.

Ihre persönliche Wahrnehmung (Seite 1 von 2)

Bitte geben Sie Ihre Teilnehmernummer an, die Sie per E-Mail von uns bekommen haben und auch für den Login genutzt haben: *

Bitte geben Sie Ihre Antwort hier ein:

Sie haben einen Video mit einer Rechentraining-App gesehen. Bitte geben Sie in Bezug darauf an:

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○
[redacted]	○	○	○	○	○	○	○

Bitte geben Sie in Bezug auf die im Video gesehene Trainingsapp an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft absolut nicht zu	Trifft nicht zu	Trifft eher nicht zu	Weder noch	Trifft etwas zu	Trifft zu	Trifft absolut zu
Bei regelmäßiger Nutzung hat das Training einen positiven Effekt auf meine Rechenfähigkeiten.							
Ich sollte ein Training mit der App, angepasst an meine Fähigkeiten, häufiger durchführen.							
Ich möchte ein Training mit der App, angepasst an meine Fähigkeiten, häufiger durchführen.							
Ich werde ein Training mit App, angepasst an meine Fähigkeiten, häufiger durchführen.							

Bitte geben Sie an:

Welches der beiden Trainings (das von Ihnen am PC durchgeführte oder die im Video gesehene Trainingsapp)...

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Definitiv PC	PC	Eher PC	Beides	Eher App	App	Definitv App
motiviert Sie mehr Aufgaben zu Rechnen?							
motiviert Sie das Training häufiger durchzuführen?							
motiviert Sie das Training länger am Stück durchzuführen?							
macht Ihnen voraussichtlich mehr Spaß?							
führt eher zu einer Verbesserung ihrer Kopfrechenfähigkeiten?							
ist ein seriöses kognitives Training?							
könnten Sie sich eher vorstellen in Ihrem Alltag zu nutzen?							
hat Ihnen vom Aussehen besser gefallen?							
hat Ihnen insgesamt besser gefallen?							

Wie wichtig sind für Sie folgende Aspekte im Training um regelmäßig zu trainieren:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Absolut nicht wichtig	Nicht wichtig	Eher nicht wichtig	Weder noch	Eher wichtig	Wichtig	Absolut wichtig
Zu einer Zeit trainieren, wenn ich möchte							
An dem Ort trainieren, wo ich möchte							
Spaß am Training zu haben							
Wirksamkeit des Trainings							

Nutzung (Seite 2 von 2)

[redacted] [redacted]

Wenn Sie sowohl das Training am Computer als auch das Training mit der App frei nutzen könnten, bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Das Training am Computer / Laptop	Hauptsächlich Computer / Laptop, aber App als Ergänzung	Hauptsächlich App, aber Computer / Laptop als Ergänzung	Das Training mit der App
Was würden Sie selber am ehesten nutzen?	○	○	○	○
In welcher Form denken Sie ist es für den Trainingseffekt am sinnvollsten ein Rechentraining zu nutzen?	○	○	○	○

[redacted]

[redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]

Bitte geben Sie in Bezug auf “Kopfrechnen lernen” an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Stimme absolut nicht zu	Stimme nicht zu	Stimme eher nicht zu	Weder noch	Stimme etwas zu	Stimme zu	Stimme absolut zu
Ich möchte das Training vom Computer so wie es ist als App für Smartphone / Tablet nutzen können (statt der App wie im Video).	○	○	○	○	○	○	○
Ein Training am Computer bringt einen hohen Trainingseffekt.	○	○	○	○	○	○	○
Ein Training am Smartphone bringt einen hohen Trainingseffekt.	○	○	○	○	○	○	○
Ein Spiel am Computer bringt einen hohen Trainingseffekt.	○	○	○	○	○	○	○
Ein Spiel am Smartphone bringt einen hohen Trainingseffekt.	○	○	○	○	○	○	○

Bitte geben Sie an:

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Sehr schlecht	Schlecht	Eher schlecht	Neutral	Eher gut	Gut	Sehr gut
Wie bewerten Sie ein Kopfrechentraining mit der gesehenen App insgesamt?	◯	◯	◯	◯	◯	◯	◯

Für das Training mit der App hätte ich mir noch folgendes gewünscht:

Bitte geben Sie Ihre Antwort hier ein:

Im ersten Teil der Studie wurden Fragen zu Ihren Charaktereigenschaften erhoben um sie mit Spielen in Verbindung zu bringen. Möchten Sie Ihr persönliches Ergebnis per E-Mail geschickt bekommen?

Bitte wählen Sie nur eine der folgenden Antworten aus:

◯ Ja

◯ Nein

Möchten Sie an der Verlosung der Überraschung als Dankeschön für Ihr Feedback teilnehmen? (Wenn Sie im vorherigen Fragebogen schon mit "Ja" geantwortet haben, können Sie nun Ihre Gewinnchancen verdoppeln)

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ja
- ◯ Nein

Vielen Dank für Ihre Einschätzung. Sie unterstützen uns und die Weiterentwicklung kognitiver Trainings damit sehr!

Beste Grüße, Ihr Forschungsteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

4.3 Outlook Smart Home Feedback Object. Further Development, Implementation for Independent Use and Tailoring of Gamification

Einstiegsfragebogen: Studie - Feedbackobjekt im Training

Sehr geehrte Teilnehmerin, Sehr geehrter Teilnehmer,

vielen Dank für Ihr Interesse an der Studie.

Nachfolgend haben wir einige Fragen zu Ihnen und Ihrem Training für die Studie.

Mit dem Ausfüllen des Fragebogens bestätigen Sie, dass Sie die Teilnahmedokumente unterschrieben haben und mit Ihnen einverstanden sind.

(Sind Sie nicht einverstanden, können Sie das Browserfenster nun schließen)-

Beste Grüße,

Ihr Studienteam

In dieser Umfrage sind 13 Fragen enthalten.

Ihr Hintergrund

Zunächst möchten wir Sie etwas besser kennenlernen. Bitte geben Sie zu Ihrem eigenen Hintergrund an:

Ihre Teilnahme-Nummer der Studie: *

Bitte geben Sie Ihre Antwort hier ein:

Ihr Alter in Jahren: *

Bitte geben Sie Ihre Antwort hier ein:

Ihr Geschlecht: *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Weiblich
- ◯ Männlich
- ◯ Divers
- ◯ Ich möchte nicht antworten
- ◯ Sonstiges

Ihr höchster Bildungsabschluss: *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ keinen Abschluss
- ◯ Haupt-/Volksschulabschluss
- ◯ Realschule / Mittlere Reife / POS
- ◯ Abitur / Fachabitur
- ◯ Hochschulabschluss
- ◯ Ich möchte nicht antworten
- ◯ Sonstiges

Mögen Sie Pflanzen in Ihrer Wohnung? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Eher Nein
- ◯ Neutral
- ◯ Eher Ja
- ◯ Ja

Wie häufig nutzen Sie digitalen Medien (z.B. am Computer, Tablet oder Handy)?

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ weniger als einmal im Monat
- ◯ ca. einmal im Monat
- ◯ ca. einmal die Woche
- ◯ mehrfach die Woche
- ◯ täglich
- ◯ mehrfach täglich

Haben Sie Erfahrungen mit kognitiven Trainings? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Ja
- ◯ Nein
- ◯ Weiß ich nicht
- ◯ Ein wenig

Ihr Training

Bitte geben Sie für Ihr geplantes Training in der Studie an:

Innerhalb des Studienzeitraums können verschiedene Trainings durchgeführt werden. Welche <u>zwei</u> Trainings möchten Sie durchführen? Bitte wählen Sie aus: *

Bitte wählen Sie alle zutreffenden Antworten aus:

☐ C: Exekutivfunktionen (‘Logisches Denken’: Das Modul verwendet Problemlösungsaufgaben. Im Training wird eine Bilderreihe mit einfachen grafischen Figuren gezeigt und aus einer Auswahl von Figuren passend ergänzt.)

☐ B: Gedächtnis (‘Arbeitsgedächtnis’: Das Arbeitsgedächtnis wird alltagsnah und auf spielerische Weise mit Hilfe eines Kartenspiels trainiert.)

☐ A: Aufmerksamkeit (‘Reaktionsverhalten’: Das Reaktionsverhalten wird realitätsnah trainiert, indem thematisch zusammenhängende Objekte (z.B. Verkehrsschilder, Tiere auf der Wiese, etc.) verwendet werden. Beim Erscheinen verschiedener Objekte auf dem Bildschirm ist so schnell wie möglich eine dem jeweiligen Objekt zugeordnete Taste zu drücken.)

Das Training soll 2 Tage die Woche je ca. 30 Minuten durchgeführt werden. (Trainings nach eigenem Bedarf sind ergänzend möglich.)

Suchen Sie sich bitte zwei Tage aus, an denen Sie das Training regelmäßig durchführen wollen. Zusätzlich können Sie so häufig trainieren, wie Sie möchten.

*

Bitte wählen Sie alle zutreffenden Antworten aus:

☐ Montag

☐ Dienstag

☐ Mittwoch

☐ Donnerstag

☐ Freitag

☐ Samstag

☐ Sonntag

Schätzen Sie selber ein: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1 schwer	2 eher schwer	3 mittel	4 eher leicht	5 leicht
Es wird mir … fallen die Trainingstage einzuhalten	◯	◯	◯	◯	◯

Ihre Einschätzung

Bitte geben Sie für sich an:

Bitte geben Sie an: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1 stimme überhaupt nicht zu	2 stimme nicht zu	3 stimme eher nicht zu	4 weder noch	5 stimme eher zu	6 stimme zu	7 stimme völlig zu
Es macht mich glücklich, wenn ich anderen helfen kann.	○	○	○	○	○	○	○
Ich mag es nicht, Regeln zu befolgen.	○	○	○	○	○	○	○
Ich meistere gerne schwierige Aufgaben.	○	○	○	○	○	○	○
Das Wohlergehen anderer ist mir wichtig.	○	○	○	○	○	○	○
Selbständigkeit ist mir wichtig.	○	○	○	○	○	○	○
Ich überwinde gerne Hindernisse.	○	○	○	○	○	○	○
Ich sehe mich als Rebell.	○	○	○	○	○	○	○
Ich helfe gerne anderen, sich in neuen Situationen zu orientieren.	○	○	○	○	○	○	○
Ich stelle gerne den aktuellen Zustand in Frage.	○	○	○	○	○	○	○
Der Lohn meiner getätigten Anstrengung ist mir wichtig.	○	○	○	○	○	○	○

	1 stimme überhaupt nicht zu	2 stimme nicht zu	3 stimme eher nicht zu	4 weder noch	5 stimme eher zu	6 stimme zu	7 stimme völlig zu
Ich probiere gerne neue Dinge aus.	○	○	○	○	○	○	○
Ich mag Gruppenaktivitäten.	○	○	○	○	○	○	○
Ich provoziere gerne.	○	○	○	○	○	○	○
Wenn die Belohnung ausreicht, werde ich mich anstrengen.	○	○	○	○	○	○	○
Ich teile gerne mein Wissen.	○	○	○	○	○	○	○
Ich lasse mich oft von meiner Neugier leiten.	○	○	○	○	○	○	○
Es ist mir wichtig, mich als Teil einer Gemeinschaft zu fühlen.	○	○	○	○	○	○	○
Ich mag Wettbewerbe, bei denen ein Preis gewonnen werden kann.	○	○	○	○	○	○	○
Es ist mir wichtig, meine Aufgaben immer vollständig zu erfüllen.	○	○	○	○	○	○	○
Es fällt mir schwer, ein Problem loszulassen, bevor ich eine Lösung gefunden habe.	○	○	○	○	○	○	○

	1 stimme überhaupt nicht zu	2 stimme nicht zu	3 stimme eher nicht zu	4 weder noch	5 stimme eher zu	6 stimme zu	7 stimme völlig zu
Belohnungen sind eine gute Möglichkeit, mich zu motivieren.	◯	◯	◯	◯	◯	◯	◯
Es ist mir wichtig, meinen eigenen Weg zu gehen.	◯	◯	◯	◯	◯	◯	◯
Ich mag es, Teil eines Teams zu sein.	◯	◯	◯	◯	◯	◯	◯
Der Umgang mit anderen ist mir wichtig.	◯	◯	◯	◯	◯	◯	◯

Sie über sich

Als letztes möchten wir ihre Eigenschaften kennenlernen.

Die nachfolgenden Fragen befassen sich mit Ihrer persönlichen Meinung zu verschiedenen Aspekten elektronischer Geräte sowie mit der Erfahrung, die Sie im Umgang mit diesen Geräten haben.

[redacted]

[redacted]

[redacted]

Bitte geben Sie für sich an:

*

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○
[redacted]	○	○	○	○	○

Sie erhalten für das Training ein Feedbackobjekt. Es beinhaltet eine Zierpflanze. Für sie sollte ein Standort im Innenraum gewählt werden, der halbschattig, bis schattig und ohne direkte Sonneneinstrahlung liegt. Die Zierpflanze ist nicht zum Verzehr geeignet (weder für Mensch noch Tier). Kontakt mit den Schleimhäuten vermeiden. Die Erde kann bei Bedarf befeuchtet werden - nicht jedoch das Gerät / der Innenraum. Die Pflanze kann aus dem Objekt entnommen werden.

Haben Sie die Informationen verstanden, erhalten / entnehmen Sie für den nächsten Schritt nun ihr Feedbackobjekt. Bitte geben Sie an:

*

Bitte wählen Sie nur eine der folgenden Antworten aus:

◯ Verstanden

◯ Nicht verstanden (Bitte kontaktieren Sie bei Fragen oder Abbruch das Studienteam)

Vielen Dank für Ihre Unterstützung, Sie leisten einen wichtigen Beitrag zur Weiterentwicklung kognitiver Trainings.

Beste Grüße,

Ihr Studienteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

Technische Einrichtung: Studie - Feedbackobjekt im Training

Sehr geehrte Teilnehmerin, Sehr geehrter Teilnehmer,

vielen Dank für die Einrichtung des Feedbackobjekts. Nachfolgend haben wir einige Fragen zu diesem Vorgang.

Beste Grüße,

Ihr Studienteam

In dieser Umfrage sind 7 Fragen enthalten.

Ihr weiteres Training

Bitte geben Sie Ihre Teilnahme-Nummer ein: *

Bitte geben Sie Ihre Antwort hier ein:

Schätzen Sie selber ein *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1 schwer	2 eher schwer	3 mittel	4 eher leicht	5 leicht
Es wird mir … fallen die Trainingstage einzuhalten	○	○	○	○	○

Technische EInrichtung

Die Einrichtung des Geräts beinhaltete verschiedene Schritte. Bitte geben Sie auf einer Skala von 1 (schwer) - 5 (leicht) an wie leicht oder schwer Ihnen die einzelnen Schritte gefallen sind oder wenn Sie Hilfe benötigt haben. *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	0 Hilfe benötigt	1 schwer	2 eher schwer	3 mittel	4 eher leicht	5 leicht
1 Platzieren des Objekts	○	○	○	○	○	○
2 Anschließen an eine Stromquelle	○	○	○	○	○	○
3 Starten des Trainingsgeräts (PC / Laptop)	○	○	○	○	○	○
4a Gerät im Netzwerk finden	○	○	○	○	○	○
4b Aufrufen der Verbindungswebsite im Browser	○	○	○	○	○	○
4c Login des Geräts online (Tasmota)	○	○	○	○	○	○
5 Login auf der Onlinetraining-Website für Ihr Training	○	○	○	○	○	○
Insgesamt fand ich die Einrichtung (1-5)	○	○	○	○	○	○

Schätzen Sie ein: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Ja	Eher Ja	Weder noch	Eher Nein	Nein
War die Einrichtung eine Hürde um mit dem Training zu beginnen?	○	○	○	○	○

Haben Sie Hilfe benötigt? Wenn ja, wer hat Ihnen geholfen?

Bitte wählen Sie alle zutreffenden Antworten aus:

- ☐ Ich habe keine Hilfe benötigt
- ☐ Familienangehörige
- ☐ Freunde
- ☐ Bekannte
- ☐ Studienteam
- ☐ Sonstiges: ____________________

Hätten Sie sich die Einrichtung anders gewünscht?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Ja
- ○ Nein

Was hätten Sie sich für die Einrichtung gewünscht? (Mehrfachnennung möglich)

Bitte wählen Sie alle zutreffenden Antworten aus:

- ☐ Einrichtung über die Website des Online Trainings
- ☐ Videoerklärung
- ☐ Videotelefonie-Erklärung
- ☐ Einrichtung durch Techniker
- ☐ Plug & Play (Einstecken und (fast) selbstständige Einrichtung)
- ☐ Sonstiges: ____________

Vielen Dank für Ihre Unterstützung, Sie leisten einen wichtigen Beitrag zur Weiterentwicklung kognitiver Trainings.

Beste Grüße,

Ihr Studienteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.

Abschlussbefragung: Studie - Feedbackobjekt im Training

Sehr geehrte Teilnehmerin, Sehr geehrter Teilnehmer,

vielen Dank für das Durchführen des Trainings. Sie haben während des Trainings ein Feedbackobjekt genutzt. Die nachfolgenden Fragen beziehen sich auf die Nutzung des Objekts während der Trainingswochen (nicht auf die Einrichtung).

Beste Grüße,

Ihr Studienteam

In dieser Umfrage sind 12 Fragen enthalten.

Position ihres Feedbackobjekts

Bitte geben Sie Ihre Teilnahme-Nummer ein: *

Bitte geben Sie Ihre Antwort hier ein:

Wo haben Sie das Feedbackobjekt für die Trainingswochen aufgestellt und warum?

Bitte geben Sie Ihre Antwort hier ein:

Wie präsent war das Feedbackobjekt in Ihrer Umgebung aufgestellt?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nicht sichtbar
- ◯ Nur sichtbar, wenn aktiv angeschaut
- ◯ Einmal täglich sichtbar möglich
- ◯ Einmal bis mehrfach sichtbar möglich
- ◯ Mehrfach bis häufiger sichtbar möglich

Haben Sie das Feedbackobjekt während der Trainingswochen an einen anderen Platz umgestellt? *

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ◯ Nein
- ◯ Sonstiges

Einschätzung

Schätzen Sie selber ein: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1 Schwer	2 Eher schwer	3 Mittel	4 Eher leicht	5 Leicht
Es ist mir … gefallen die Trainingstage einzuhalten	◯	◯	◯	◯	◯

Bitte geben Sie in Bezug auf die Nutzung des Feedbackobjekts an: *

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1 nein	2 eher nein	3 weder noch	4 eher ja	5 ja
Unterstützt das Objekt das regelmäßige Durchführen des Online Trainings?	○	○	○	○	○
Unterstützt das Objekt die Erinnerung an das Training?	○	○	○	○	○
Waren die Informationen zum Status des Trainings (Anzeige des kommenden Trainings durch Licht) für sie verständlich?	○	○	○	○	○
Hat Ihnen das Objekt selbstständig die Informationen dann zur Verfügung gestellt, wenn Sie sie benötigten?	○	○	○	○	○
Konnten Sie das Objekt vergessen, wenn Sie es nicht benötigten?	○	○	○	○	○
Haben Sie die Pflanze gegossen, wie Ihre anderen Pflanzen auch?	○	○	○	○	○
Wenn Sie das zukünftig das Training weiter nutzen wollen würden um ihre kognitiven Leistungen zu verbessern, würden Sie das Objekt weiterhin als Unterstützung nutzen?	○	○	○	○	○
Würden Sie das Objekt zur Unterstützung des Online-Trainings weiterempfehlen?	○	○	○	○	○

Ich fühle mich dann gut, wenn das Objekt folgendes kann / können würde (Bitte nach Wichtigkeit sortieren): *

Bitte nummerieren Sie jede Box in der Reihenfolge Ihrer Präferenz, beginnen mit 1 bis 6

[ ] Mir meinen Fortschritt / meine Erfolge anzeigen.

[ ] Mich belohnt, wenn ich mein Training gemacht habe.

[ ] Mich zusätzlich mit kurzen Hintergrundgeschichten und Informationen zu meinem Training überrascht.

[ ] Ich das Wachstum der Pflanze unterstützen kann.

[ ] Ich mich durch das Licht mit der Pflanze verbunden fühle.

[ ] Ich durch das Füllen des Lichts besondere Herausforderungen gewinnen und dadurch das Training verändern kann.

Form und Funktion

Gab es technische Schwierigkeiten oder Fragen zum Feedbackobjekt innerhalb der Trainingsphase (nicht bezogen auf das Einrichten)?

Bitte wählen Sie nur eine der folgenden Antworten aus:

- ○ Nein
- ○ Sonstiges [ ]

[redacted]

ÜBERSICHTLICHKEIT

[redacted]

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1	2	3	4	5	6	7	
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]

VERTRAUENSWÜRIGKEIT

[redacted]

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1	2	3	4	5	6	7	
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]

NÜTZLICHKEIT

[redacted]

*

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	1	2	3	4	5	6	7	
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]
[redacted]	◯	◯	◯	◯	◯	◯	◯	[redacted]

VISUELLE ÄSTHETIK

[redacted]
*

[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	○	○	○	○	○	○	○	[redacted]
[redacted]	○	○	○	○	○	○	○	[redacted]
[redacted]	○	○	○	○	○	○	○	[redacted]
[redacted]	○	○	○	○	○	○	○	[redacted]

Vielen Dank für Ihre Unterstützung, Sie leisten einen wichtigen Beitrag zur Weiterentwicklung kognitiver Trainings.

Beste Grüße,

Ihr Studienteam

Übermittlung Ihres ausgefüllten Fragebogens:
Vielen Dank für die Beantwortung des Fragebogens.