No. 12 / 2018

ONLINE-ZEITSCHRIFT FÜR WISSENSCHAFT UND PRAXIS
MEDIENPRODUKTION

Digitale Gesundheit

Inhalt

Editorial

Digitale Gesundheit: Wie digitale Medien zur Unterstützung der Gesundheit eingesetzt werden 2
von Sven Meisster, Wolfgang Deiters, Andre Hellwig und Michael Pantförder

Gesundheitskompetenz im digitalen Zeitalter 6
von Veronika Strotbaum

Digitale Gesundheitsförderung - Mit dem ergoscan zu einem gesunden Rücken am Arbeitsplatz 15
von Johannes Heering

Digitalisierung im Gesundheitswesen - Herausforderungen und Chancen für NutzerInnen 18
von Karoline Malchus

User-centered digital health application development to promote healty ageing 23
von Simon Langerer, Tiara Ratz und Sonia Lippke

Digitale Gesundheit 33
von Thomas Lux

Lehre und Forschung von eHealth-Services in einem Living Lab 41
von Robert Mischak

Buchrezension: Sitzen ist fürn Arsch 45
von Mara Seupel

Abschied von Prof. Dr. Paul Klimsa 1955-2018 46

Impressum

User-centered digital health application development to promote healthy ageing

von Simon Langener, Tiara Ratz und Sonia Lippke

Introduction

Participatory and theory-based empirical research is frequently applied in order to develop, implement and evaluate interventions to encourage healthy ageing by means of **physical activity** (PA). By the year 2060 the main target group of such interventions i.e. adults aged 65+ years will represent up to 33% of the German population [1]. As a result of recent population ageing during the last century, costs on the societal level are accumulating due to increasing healthcare demands and caregiver burden [2]. Therefore, rehabilitative and preventive services are increasingly gaining importance with regard to reducing the costs of care as well as to improve function, mobility and social engagement in older adults [3].

Research has shown that regular PA is associated with improvements in the domains of psychological, cognitive, physical as well as functional health [4; 5; 6; 7]. The World Health Organization (WHO) recommends at least 150 minutes of moderate exercise per week for older adults aged 60 years and above. However, in Germany only 18% of adults aged between 60 and 69 years, and 14% of adults aged between 70 and 79 years fulfill these recommendations [8], thus significant improvements are needed. PA promotion interventions, provided via face-to-face interaction or using print versions, have been shown to be effective. However, the increasing use of digital technology and wearables yields new opportunities for personalized **eHealth, mHealth** and **dHealth** interventions, e.g., health interventions delivered with electronic and/or mobile devices such as a smartphone in a digitalized mode [9; 10]. **Personalization** utilizes the user's data to provide recommendations and feedback that match the individual user [11]. In 2017, 41% of adults aged 65+ years in Germany owned a smartphone and this trend is rapidly increasing, since in 2014 merely 17% owned one [12; 13]. In contrast, 88% of adults in the age-group 50-64 years own a smartphone, which highlights the potential for the future. In 2018, a national survey in Germany found 16.5% of the surveyed older adults aged 60+ years to use health apps, mostly in the domain of PA [14]. In the following, we will only use the term mHealth for all digital health application.

Although older adults show interest and have the intention to use mHealth applications, studies on the actual adoption and usage are scarce and inconsistent [15; 16]. Four key categories of barriers due to ageing have been identified to influence the ease of mHealth use: cognition, motivation, behavior and perception [17]. Interventions effectively addressing the changes and requirements accompanying ageing should be evidence-based by means of using **behavior change techniques (BCTs)**. Moreover, they should be based on theory (such as the Health Action Process Approach, HAPA [18]; the Transtheoretical Model TTM [19]; the Compensatory Carry-over Action Model, CCAM [20]; or the COM-B (‚capability', ‚opportunity', ‚motivation' and ‚behavior') model [21]).

The aim of this review is to answer the following research question: What aspects should be considered in order to develop a user-centered mHealth intervention (digital health application) to promote a health promoting, physically active lifestyle in older adults? A literature scan focusing on the changes accompanying ageing was conducted in order to gain insight into the age-related barriers and limitations when using mHealth applications. Recommendations to overcome the obstacles and enhance the ease of mHealth technology in older adults are provided, especially focusing on age-related barriers, **persuasive system design (PSD)**, user interface, inclusion of BCTs and privacy and data management issues.

Age-dependent barriers and limitations to use mHealth

Several barriers and limitations develop or increase with age, e.g., regarding the use of technology [22]. According to Sugarman (2005) the physical changes in early late-adulthood (60-75 years) can be summarized using the four words: slower, lesser, smaller and weaker [23]. Accordingly, this age-group needs increased attention to support them in performing PA as recommended in order to maintain their physical resources and cognitive capabilities across the whole life-span [24]. Regular PA and its resulting decrease in stress levels result in a lowered risk of chronic and mental disease and increase the perceived quality of life – an effect which is applicable not only to the older age-groups [2]. However, with regard to mHealth usage for PA promotion, four key categories of barriers that especially influence older adults have been identified: (1) cognition, (2) motivation, (3) physical ability/behavior and (4) perception [17].

Figure 1, which was adapted based on the „MOLD-US" framework by Wildenbos et al. (2018) [17], demonstrates how these four barrier-categories influence the usability of mHealth in older adults through age-dependent abilities. The cognitive component mainly involves the reduced capacity of the semantic, working, prospective and procedural memory. This memory decline impairs the attention and thus increases the time needed to acquire new skills. The physical decline results in restrictions regarding movement, balance and locomotion in finger joints. In fact, functional and rheumatic conditions are common in 60% of adults aged 65+ years [17]. In total, 75% of adults aged 65+ years report having problems in physical functioning, which results in poorer speed performance and hand-eye coordination as well as an increased retention time in mHealth usage. This in turn enhances the learning time, error rate and response time. The ability to adapt to darker environments and detect contrast is decreased following the decline in visual and auditory perception and more light is required to see sharply. The colors violet, blue and green are prone to cause visual problems. The fourth barrier of motivation comprises attitudes, beliefs and anxiety to use mHealth applications. Low technology acceptability and computer literacy influence the trust in the own ability and belief in potentially gained benefit.

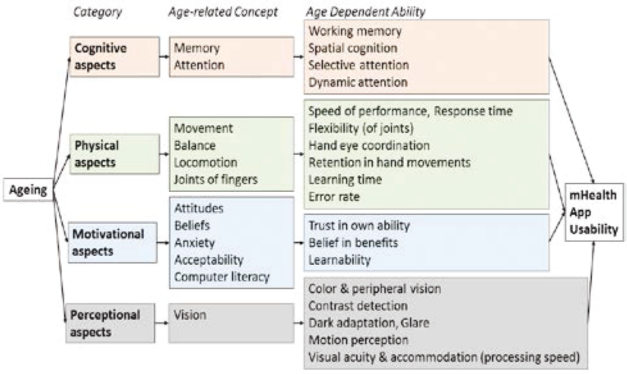

Figure 1: Barriers of older adults that influence the mHealth ease of use – adapted from “Aging barriers influencing mobile health usability for older adults: A literature based framework (MOLD-US),” [17]

According to representative surveys commissioned by Bitkom, three out of ten Germans aged 65+ years use a smartphone [25], while every tenth uses a tablet [26]. In contrast, adoption and usage of mHealth applications is low and inconsistent. This is mainly perceived to be the result of the discrepancy between the application design and the users’ needs [27], since older adults interact differently with information technology than younger generations do [17]. However, mHealth technology bears the potential to overcome the barriers stated above by reducing the cognitive and physical workload by means of the directly controllable interface with one’s fingers.

In conclusion, the vast majority of applications do not match the needs of users 65+ years of age, which points towards the necessity of human-centered design (HCD). To summarize, the recommendations for developing mHealth applications with regard to age-dependent barriers include the following points:

Recommendations based on age-dependent barriers of mHealth application usage:

- Adopt HCD methods to meet the needs of the user
- Take the cognitive, physical, motivational and perceptual barriers into account
- Use interfaces with touchscreens in order to reduce cognitive and physical workload

Age-dependent factors influencing the uptake of mHealth application usage

Factors relating to lower usage of mHealth applications can be age-dependent. To explain this, psychological processes should be looked at: Little self-confidence and being constrained by stereotypical perspectives might result in believing in the personal incapability of ever learning to use technology [28]. According to Kuerbis et al. (2017) [28] older adults across the globe are stereotypically perceived as being unwilling, afraid and unable to use technology such as mobile phones. Maintaining autonomy and independence are the major drivers for older adults to use mHealth.

Additionally, privacy has been shown to be an essential parameter for engagement, especially the older age-groups. To encourage the use of mobile technology in older adults, a supportive training and learning environment to deal with barriers and stigma/stereotypes should be provided. This may involve time to experiment with the device in a pace that fits the individual user [29; 30]. Social support by tutors (professionals or loved ones) could lead up to a positive attitude towards technology and strengthen the belief in the ability to learn and use technology [31]. In general, the training in this age-group could be multifaceted, offered in-person in a familiar environment and be tailored to the specific needs [32]. Supporting manuals should involve lay language and simple step-by-step instructions [33].

A clear purpose of the technology, e.g., to enhance quality of life, independence, well-being, health or safety, may be present in order to reach adoption of mHealth usage in older adults [32; 34]. The use of the device should further be affordable, intuitive, transparent and involving a low perceived learning difficulty. Error recovery can be very easily guided [30]. Feedback about completion of a task or mistakes should be provided. Due to the daily routine of the user, the timing of the intervention is an important factor. Preferably, the application should focus on the morning or afternoon because older adults are often prone to turn off their mobile phones in the late afternoon [35]. Finally, mHealth should be as unobtrusive as possible [36]. This encourages usage, protects privacy and decreases potentially embarrassing situations. To summarize, the recommendations for ensuring the uptake of mHealth application usage in older adults include the following points:

Recommendations concerning the uptake of mHealth application usage are the following:

- Avoid stereotypical thinking
- Focus on autonomy and independence of the user
- Take privacy concerns into account
- Offer supportive training to enhance the self-confidence in successfully using mHealth applications
- Ensure affordability, transparency and low learning difficulty
- Define a clear purpose for usage
- Provide an easy error-recovery, accessibility, transparency and unobtrusiveness
- Consider intervention timing (usually morning until afternoon is a good time)

Persuasive system design strategies for the target group of older adults

Technology that is designed to change a user’s attitude or behavior is called persuasive technology [37]. Persuasion is traditionally understood as the “human communication designed to influence the autonomous judgements and actions of others” [38, p. 7]. To successfully persuade the user to adopt a certain attitude, the user needs to be made aware of relevant arguments [39], which should initiate the need to take action to reach compliance with the new attitude. This is in line with the cognitive dissonance theory and the tendency to motivate attitude change [38; 40], which postulate that the perceived discordance between the user’s newly developed attitude and their performed behavior will drive the individual to reorganize and rethink their behavior in order to restore consistency. To achieve such a reaction, the persuasion context needs to be defined beforehand. According to Oinas-Kukkonen and Harjumaa (2009) [39] the context involves the intent, event and strategy of persuasion.

Oinas-Kukkonen and Harjumaa (2009) suggest 28 principles for PSD, which can be grouped into four support categories [39]. These include 1) the support to carry out the primary task as well as 2) feedback and dialogue support, which keep the user moving toward the target behavior and goals. An example of dialogue support is sending notifications if a goal is achieved [41]. 3) The credibility of a system increases its persuasiveness; trustworthiness and surface credibility are important to older adults and should be covered by the visual appearance of the application [42]. Lastly, 4) social support leverages social influence, which is linked to motivation for behavior/attitude change.

In addition, persuasive strategies include **rewards, reminders and personalized feedback**. Rewards are typically visually displayed. Messages may be delivered as reminders to check the application daily or weekly to encourage continuous usage [43]. Feedback provision is one of the most important features for promoting adherence in older adults [44; 45; 46]. To ensure persistent behavior/attitude change, communication and feedback provision should be delivered by personalized audio and visual cues. In general, communication is the major driver for continuous usage, as long as the linguistic aspects that match the user are taken into account. To summarize, the most frequently used content-related persuasive strategies in mHealth application development to promote an attitude/behavior change in older adults include the following points:

Recommendations concerning content of PSD:
- Give audio, visual and textual feedback
- Provide support in several domains, such as dialogue, feedback and social support
- Include persuasive messages, reminders, and alerts as well as rewards, points and credits
- Set goals and objectives

Designers should be encouraged to use the range of capacities of technology instead of relying on content-driven interventions only making use of BCT [46]. Recent research on PA and diet interventions using PSD strategies was not specifically focused on older adults. Further systematic research is therefore needed to understand which PSD features are suitable to motivate older adults to engage in a healthy and physically active lifestyle. According to Orji and Moffatt (2018) 75% of the reviewed articles regarding persuasive technology in PA reported a fully positive outcome. The most frequently used theory was the TTM in 14% of studies [47].

According to Matthews, Win, Oinas-Kukkonen, and Freeman (2016), data capturing and feedback by means of **sensor technology** has been shown to be a powerful tool to effectively persuade the user towards behavior change [48]. Objectively measured data can be used to tailor the text content of feedback to the individual user [49]. The objective and automatized data collection is of great value to future research given the fact that the common method of self-report is more biased [50]. In the domain of primary task support, **self-monitoring** can be used in forms of manual entry of information by the user (manual logging) or automatized tracking of PA by means of sensor technology [51; 52]. Tunneling comprises strategies to guide the user through the process of behavior change, for example by means of targeted questions and suggesting recommended exercises [53]. In general, social features are ambivalent. Unsuccessful competition might result in disengagement in PA [43], however, social communication and cooperation could also support users in reaching their goals [54; 55]. To summarize, the most important features to consider when developing mHealth applications for older adults according to PSD, include the following points:

Recommendations concerning components:
- Specify the persuasion context beforehand
- Use tracking, monitoring and personalization
- Base development on appropriate socio-cognitive theories, such as the TTM
- Combine PSD with BCT
- Use sensor technologies for data collection, tailored feedback and suggestions
- Be careful in giving the opportunity to share and compare success given the fact that reverse effects are likely to occur

Visual, cognitive and motor features to be considered in user interface development

In order to meet the needs of the user, design choices should reflect the capabilities and limitations of the target group. Respective to the direct influence of the cognitive, perceptual and motivational changes accompanying ageing on the user interface, four different contextual requirements needs to be fulfilled: the user interface should be 1) perceivable, 2) operable, 3) understandable and 4) robust [56]. Petrovčič et al. (2018) empirically analyzed guidelines on the design of age-friendly phones and smartphones [27]. In general, the device should be lightweight, with a large display and a maximum of grip. A tablet-computer, which entails a big screen is most recommended. Beside the lower challenged cognitive and physical workload when older adults use a touchscreen, recent research has additionally shown that older adults were able to achieve tasks faster using a touchscreen compared to mouse and keyboard [28]. Bearing in mind the common barriers older adults encounter, the user interface of mHealth applications should accommodate several fea-

tures with regard to visual, cognitive and motor declines.
Next to a large display, the preferable visual features include by 50% enlarged icons compared to the standard size (at least 12mm). These icons should provide visual, auditory and/or tactical feedback when pressed. Additionally, there may be sufficient space between icons to avoid errors in operating the device [27]. The screen dimming time should be prolonged due to longer reaction times and an option to zoom should be available. Small changes in the application can be avoided and preferably warm colors (e.g., reds, oranges and pinks) should be used [28]. To summarize, the recommendations concerning visual features of the user interface in the development of mHealth applications for older adults include the following points:

Recommendations concerning visual features of the user interface especially for older users:

- Enlarge the display and increase the size of icons by 50% (>12mm)
- Provide visual, auditory and/or tactical feedback when icons are pressed
- Ensure sufficient space between icons
- Prolong the screen dimming time and offer the option to zoom
- Avoid small web page changes and elaborated text (e.g. bolt or italics)
- Use preferably warm colors, e.g., reds, pinks and oranges

With respect to potential cognitive decline, a simple language should be used. Users should be able to navigate through the application via navigation bars and the menu should be limited to a low hierarchy [56]. The combination of text and symbols is recommended, however, neither should rely on the other. The text-based (vocabulary) navigation menu should appear on the upper and left side. Flashing, blinking objects and pop-ups should be avoided [28]. The provision of clear error-messages is important for older users in order to understand what to do to solve upcoming problems. To summarize, the recommendations concerning features of the user interface considering cognitive deficits in the development of mHealth applications for older adults include the following points:

Recommendations concerning the consideration of cognitive declines in user interface development:

- Provide navigation via navigation bars
- Locate vocabulary/ text-based navigation menus on upper and left side
- Avoid flashing, blinking objects and pop-ups
- Limit the menu to a low hierarchy
- Combine text and symbols
- Support recognition rather than recall
- Use a simple language
- Locate relevant information mainly in the center
- Provide clear error-messages

The motor features of the user interface for older adults should include a touchscreen-font of at least 17mm. The gestures to handle the application should preferably neither rely on directional methods (e.g., scroll-bars) nor click and drack methods. Slower respond times in older adults should be taken into account. Furthermore, the text entry via keyboard can be challenging due to the necessity of fine motor skills.
To summarize, the recommendations concerning motor features of the user interface in mHealth application development for older adults include the following points:

Recommendations concerning motor features of the user interface:

- Make sure that the font of the touchscreen is at least 17mm
- Avoid directional gesturing (e.g., scroll-bars) and click and drag methods
- Take slower respond times into account
- Avoid text entry via keyboard

At this point it is considered important to mention that the domains described so far – 1) barriers and limitations, 2) PSD strategies, and 3) user interface recommendations – should always be considered with respect to each other. This broad perspective is used as preparation for the design-stage, which includes usability-testing and co-creation. The calibration of the interaction between all these mechanisms is necessary to guarantee easy accessibility and unobtrusiveness, with the final aim of ensuring an easy use of the mHealth application for older adults.

Behavior change techniques (BCT) in mHealth application development

PA interventions have been shown to be effective in maintaining behavior change over a time period of six months and longer [57]. Yet, the specification of how technological characteristics and underlying techniques and evidence-based theories work together to achieve this effect, is lacking. This knowledge gap highlights an important weakness in mHealth design [58]. However, several researchers have taken steps towards creating frameworks of scientifically grounded BCT combinations and underlying theories to promote behavior change regarding PA and nutrition. Interventions that use BCTs grounded by theory seem to be more effective compared to interventions lacking underlying theory [59]. The theories used most frequently include the control theory, social-cognitive theory, goal-setting theory and self-determination theory [59; 60; 61].
BCTs increase PA behavior significantly [62]. According to the control theory, goal-setting theory and social-cognitive theory, feedback constitutes an important component of behavior change [50]. It ideally builds on the behavioral intervention's objective and is provided in a personalized, available and actionable way. The timing is of high importance, given the fact that mHealth is able of providing feedback immediately at completion of a task. The design framework by Schembre et al. (2018) provides a basis for the development of feedback messages in the domain of mHealth and wearables [50]. A meta-analysis by Ma and Martin Ginis (2018) found self-monitoring to have relevant

effects in PA interventions [61]. The use of self-monitoring in addition to another BCT, including self-regulation, such as intention formation, specific goal-setting, providing feedback on performance and prompting review of behavioral goals, produced significantly larger effects compared to the use of self-monitoring alone [61]. The evidence on characteristics such as duration of the intervention, delivery format (e.g., group or individual), setting (e.g., gym or online), number of included BCTs and person delivering the interventions are mixed. Ma and Martin Ginis (2018) did not find these characteristics to influence the effect of the intervention, whereas other researchers argue that increasing the amount of included BCTs leads to interventions being more effective [61]. Interventions lasting for a longer time period also yield better outcomes and gym or face-to-face settings seem to be more effective [60; 63; 64]. Several researchers suggest the use of **biofeedback** as an effective tool in increasing PA and argue that these are underutilized as a resource for behavior change [50; 57; 65].

Motivation is a proximal determinant of behavior. With regard to the TTM in PSD, self-liberation can help individuals to move from the preparation stage (when intentions are formed) towards the action stage [60]. In general, the recommended effective BCTs with regard to PA and diet when developing mHealth applications for older adults include the following points:

Recommended BCTs proven to be effective in health behavior change:

- Goal setting
- Action planning
- Self-monitoring
- Self-regulation
- Behavior practice/rehearsal
- Review of behavioral goals
- Self-rewarding
- Problem solving (relapse prevention/coping planning)

The COM-B-system is a behavior system, which provides a basis for developing interventions that aim to change behavior [21]. The interaction of the three components capability, opportunity and motivation forms behavior. Beforehand it is recommended to define the target behavior as well as which component(s) need to be changed in order to achieve the intended behavior change.

With regard to older adults aged 60+ years, the two components capability and motivation have been shown to be most problematic [17; 28]. Capability includes the individual's psychological and physical capacity in order to engage in the activity, which demands skills and knowledge [21]. Motivation comprises all brain processes that direct and energize behavior. Beside goals and conscious decision-making, this involves emotional responding, habitual processes and analytical decision-making. BCTs that tackle these components should be integrated into the mHealth interventions. To summarize, the recommendations concerning BCT-supporting features for developing mHealth applications for older adults include the following points:

Recommendations concerning BCT-supporting features in mHealth development:

- Give immediate feedback and/or biofeedback
- Demonstrate or give instructions on how to perform the behavior
- Grade completion of tasks
- Use prompting and cues
- Avoid negative emotions and encourage stress management
- Form groups (if applicable) to support sharing of knowledge and find antecedents
- Provide social support
- Increase motivation and self-liberation to enable the formation of intention
- Basically make use of as many effective BCTs as possible

Management of privacy and data security issues in mHealth application development

Taking recommendations such as automatized data collection and personalization into account raises the question of privacy, security and data management. Although older adults are particularly concerned about privacy issues, the following recommendations are rather applicable to the general population. Several researchers have already drawn on the global vision of implementing mHealth and the emerging issue of biomedical and behavioral data as part of the big-data debate. In that sense, "Personalization of eHealth is a current global vision on how healthcare can become more effective and efficient for people and organizations" [66, p. 281]. It is stated, that patients will have more possibilities to manage and monitor their health. In the future, systems can use big-data to personalize recommendations and even detect potential diseases before symptoms occur. The build-in features, such as GPS, microphones, pulse-sensors etc., are gathering huge amounts of behavioral and biomedical data. Out of a utopian kind of view, once enough data is available and manageable, this might potentially result in optimal behavior patterns, leading to a maximum of health regarding a particular genetic preposition in the domains of activities, work and nutrition [67]. The amount of applications is rapidly growing. mHealth applications can enhance self-management and consequently lead to better health. However, there are also costs and disadvantages connected. The EU law has recently addressed this problem in their latest legislative change [68]. Privacy, security and legislation have always been an issue in data management which comes with digitalization [66]. Mobile devices are present everywhere. They collect data on voice, biomedical information and behavioral patterns, which leads to the question to what extent the user stays free in their decisions and data-management. It is argued, that algorithms lead to diminished freedom of choice as well as real privacy [66]. Furthermore, the misuse of data might result in its usage for advertising or even behavior manipulation, reminding of the Cambridge Analytica case in the year 2017 [69].

To avoid these concerns and to ensure the right of access, erasure and security of data, it should only be stored locally on the device. Data exchange is advised to be possible only after being successfully requested, which provides the end-user the full range of control. Furthermore, the local data needs to be coded so that interest in hacking is diminished due to the long duration of decryption. Communication between devices should contain end-to-end encryption (E2EE) to guarantee maximum safety [70]. Legislation should focus on technology in a more rigorous way, given the fact that many devices are not considered medical applications [66]. Patient record data, which have a high value in terms of free-market economy, may result in discrimination and manipulation as well as a lack in diversity [66]. mHealth applications should therefore only focus on the specific goals of the user and needs to be tested thoroughly. Approved safety, security and effectiveness should result in licensing. Additionally, legislation and policy makers should provide information about these issues to inform the user about potential hazards and benefits. To summarize, recommendations concerning privacy and data security issues in mHealth application development for older adults include the following points:

Recommendations concerning privacy and data management in mHealth development:

- Keep the freedom of choice in mind, especially when developing persuasive mHealth based on algorithms
- Ensure the right for access and erasure of data
- Store data locally on the device by means of 256-bit coding
- Use data exchange only after explicitly requested
- Deliver data via end-to-end encryption

Discussion and prospect

Despite the presence of interest and intention to use technology, the discrepancy between the older adults' needs and the design of today's mHealth applications hinders their uptake and regular usage [27]. Therefore, mHealth application design presents the same barriers and limitations that are common in the targeted age-group [17]. However, because ageing is a very individual process, these limitations in design are not necessarily generalizable.

Based on the reviewed literature, this article provides recommendations concerning five major components to bear in mind when developing a mHealth application for older adults: 1) consideration of age-related barriers and limitations, 2) application of persuasive strategies, 3) adaptation of the user interface, 4) inclusion of BCTs and 5) management of data and privacy issues. Especially focusing on individuals with low digital affinity, a tablet computer is the most recommended device as it provides a large display that matches the perceptual barriers accompanying ageing and reduces the cognitive and physical workload. Apart from adapting technical, mental and physical requirements to the specific target group, persuasive features should be included in the application development, since they represent a major benefit of technology, especially mHealth [46].

Inactive individuals can be frequently triggered by the device, which facilitates behavior and attitude change as well as adherence. This is mostly carried out using persuasive messages, feedback and self-monitoring strategies. Further persuasive features such as reduction and tunneling of content can be used to simplify the technological demand. The provided recommendations with regard to the user interface include enlarged icons, a prolonged screen-dimming time as well as a low system-hierarchy. The recommendations on visual, cognitive and motor features of the user interface present a basis for the design stage and can be fine-tuned by means of formative evaluation with the user. As the user interface should be static, pop-ups are not recommended in the older age-groups, although they are generally thought to be a major tool to persuade individuals towards usage [48]. These features can additionally be implemented in combination with BCTs, preferably supporting the transition from preparation to action stage according to the TTM.

Regarding the methods of self-monitoring of behavior as well as feedback of behavior, the connectivity of mobile devices with biofeedback wearables via bluetooth provides the possibility to provide automatized, immediate and objective feedback, which is argued to increase the effectiveness. Sensor technologies should generally be used to collect data as well as to tailor and personalize information and make individual suggestions. However, this strategy is yet to be scientifically evaluated with regard to PA promotion in older adults. Beside these technical and behavior change recommendations, the provision of a training and learning environment by means of face-to-face communication is also advised, since it can tackle individual differences in technical affinity and may motivate inactive participants to engage with the technology resulting from the increased self-confidence.

Healthy ageing especially gains importance when being confronted with nowadays social, economic and healthcare-specific challenges. mHealth has the potential to provide a cost-effective way of delivering interventions to a large amount of people. Advantages are the high number of potential users as well as the possibility to save human resources. However, the initial investment is likely to be much higher compared to non-digital face-to-face and paper-based interventions. Scientific evidence on cost-effectiveness is scarce and should be part of future research [71].

This literature scan provided insights and explanations of important components in mHealth design for older adults and its findings highlight several research gaps, which should be targeted in the future. However, there are two major limitations apparent in this review article, which need to be kept in mind. Firstly, it has to be taken into account that the selection of reviewed articles was not the results of a systematic literature search. Therefore, the representativeness of existing research cannot be guaranteed, which may limit the accurateness of the recommendations. Future systematic literature reviews and meta-analyses should follow. Secondly, the proposed recommendations are based on scientific literature with regard to the specific domains and lack information on research analyzing possibly interacting effects among the different components. Persuasive features might for example influence the user interface in many ways, which may lower the ease-of-use for older adults and in fact counteract the intended usability.

Implications of this review's findings point towards the idea of co-creation with the user. Future projects would benefit from insights of the design process in the specific domain of PA promotion applications for inactive participants, especially those with low technical affinity. The value specification should be highlighted as a target for qualitative research that can provide important insights for future intervention development. Advanced research designs such as the factorial design experiment and log-data should be conducted in research on this topic more often, and be published accordingly. Moreover, the age-related barriers and limitations may differ between individuals in this generation, which may also hinder adoption because of the discrepancy between the users' needs and design. More studies are needed that focus on these individual differences in mHealth design. This could be a building block for the future in adaptive user interfaces that are personalized with regard to the individual user [72].

Since the development of mHealth applications is a participatory process involving users, designers and stakeholders, it is important to highlight that the provided recommendations only serve as the starting point. To guarantee successful implementation and to match the older adults' needs, a participatory approach and the use of HCD and co-creation are strongly advised. These are especially helpful for ensuring an appropriate technical translation of values by means of continuous formative evaluation. This can be achieved by using prototyping in combination with the think aloud method as well as heuristic evaluations.

Concluding remarks

Digital health application aka mHealth provides a cost-effective way of delivering interventions to older adults in order to promote PA and healthy ageing digitally. Yet, the adoption of applications by this age-group is typically rather low and inconsistent as a result of usability issues. This review article provided recommendations regarding the design of the user interface and applications features, taking into account age-related barriers, the advantage of PSD strategies, the importance of BCTs and the challenge of data security issues. Future research should further focus on this topic and especially analyze sub-groups such as individuals with low digital affinity, to examine the effectiveness and potential of mHealth applications for future development.



Tiara Ratz (r.) hat an der Universität Bremen Public Health (B.A.) und Epidemiologie (M.Sc.) studiert und ist wissenschaftliche Mitarbeiterin an der Jacobs University Bremen. Simon Langener (l.) studiert Health Psychology and Technology (M.Sc.) an der University of Twente. Sonia Lippke (m.) ist Professorin an der Jacobs University Bremen, Department of Psychology and Methods

References

[1] Statistisches Bundesamt (2015): Bevölkerung Deutschlands Bis 2060. 13. koordinierte Bevölkerungsvorausberechnung. Statistisches Bundesamt: Wiesbaden.

[2] Morrison, Val & Bennett, Paul (2016): Introduction to Health Psychology (4 ed.). Pearson Education Limited.

[3] National Research Council (2001): Preparing for an Aging World: The Case for Cross-National Research , Panel on a Research Agenda and New Data for an Aging World, Committee on Population and Committee on National Statistics, Division of Behavioral and Social Sciences and Education. National Academy Press: Washington, DC.

[4] Hamer, Mark; Lavoie, Kim L & Bacon, Simon L (2014): Taking up Physical Activity in Later Life and Healthy Ageing: The English Longitudinal Study of Ageing. In: British Journal of Sports Medicine, 48(3), p. 239-243.

[5] Lee, Yunhwan; Kim, Jinhee; Han, Eun Sook; Chae, Songi; Ryu, Mikyung; Ahn, Kwang Ho & Park, Eun Ju (2015): Changes in Physical Activity and Cognitive Decline in Older Adults Living in the Community. In: Age (Dordrecht, Netherlands), 37(2), p. 20.

[6] Warburton, Darren ER; Nicol, Crystal Whitney & Bredin, Shannon SD (2006): Health Benefits of Physical Activity: The Evidence. In: CMAJ : Canadian Medical Association Journal, 174(6), p. 801-809.

[7] Gheysen, Freja; Poppe, Louise; DeSmet, Ann; Swinnen, Stephan; Cardon, Greet; De Bourdeaudhuij, Ilse; . . . Fias, Wim (2018): Physical Activity to Improve Cognition in Older Adults: Can Physical Activity Programs Enriched with Cognitive Challenges Enhance the Effects? A Systematic Review and Meta-Analysis. In: International Journal of Behavioral Nutrition and Physical Activity, 15(1), p. 63-63.

[8] Krug, Susanne; Jordan, Susanne; Mensink, Gert BM; Müters, Stephan; Finger, Jonas & Lampert, Thomas (2013): Körperliche Aktivität: Ergebnisse Der Studie Zur Gesundheit Erwachsener in Deutschland (Degs1). In: Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz, 56(5-6), p. 765-771.

[9] Smith, Aaron (2014): Usage and Adoption. Older Adults And Technology Use. Retrieved from http://www.pewinternet.org/2014/04/03/usage-and-adoption/ [28 July 2018]

[10] Lippke, Sonia & Storm, Vera (2018): E-Health: Internet-/App-Gestützte Bewegungsförderung. In Handbuch Bewegungs- Und Sportgerontologie. Granacher, Urs/ Mechling, Heinz /Voelcker-Rehage, Claudia (Eds.). Hofman: in press,

[11] Martin, Corby K; Gilmore, L Anne; Apolzan, John W; Myers, Candice A; Thomas, Diana M & Redman, Leanne M (2016): Smartloss: A Personalized Mobile Health Intervention for Weight Management and Health Promotion. In: JMIR mHealth and uHealth, 4(1), p. e18.

[12] Lutter, Timm; Meinecke, Christopher; Tropf, Teresa; Böhm, Klaus & Esser, Ralf (2016): Zukunft Der Consumer Technology – 2017. Bitkom. Retrieved from http://www.digitalestadt.org/bitkom/org/noindex/Publikationen/2017/Studien/2017/CT-Studie/170901-CT-Studie-online.pdf

[13] Muellmann, Saskia; Bragina, Inna; Voelcker-Rehage, Claudia; Rost, Eric; Lippke, Sonia; Meyer, Jochen; . . . Pischke, Claudia R. (2017): Development and Evaluation of Two Web-Based Interventions for the Promotion of Physical

Activity in Older Adults: Study Protocol for a Community-Based Controlled Intervention Trial. In: BMC Public Health, 17(1), p. 1-8.
[14] Rasche, Peter; Wille, Matthias; Bröhl, Christina; Theis, Sabine; Schäfer, Katharina; Knobe, Matthias & Mertens, Alexander (2018): Prevalence of Health App Use among Older Adults in Germany: National Survey. In: JMIR mHealth and uHealth, 6(1), p. e26.
[15] Gao, Chenchen; Zhou, Lanshu; Liu, Zhihui; Wang, Haocen & Bowers, Barbara (2017): Mobile Application for Diabetes Self-Management in China: Do They Fit for Older Adults? In: International Journal of Medical Informatics, 101, p. 68-74.
[16] Hoque, Rakibul & Sorwar, Golam (2017): Understanding Factors Influencing the Adoption of Mhealth by the Elderly: An Extension of the Utaut Model. In: International Journal of Medical Informatics, 101, p. 75-84.
[17] Wildenbos, GA; Peute, Linda & Jaspers, Monique (2018): Aging Barriers Influencing Mobile Health Usability for Older Adults: A Literature Based Framework (Mold-Us). In: International Journal of Medical Informatics, 114(December 2017), p. 66-75.
[18] Schwarzer, Ralf; Lippke, Sonia & Luszczynska, Aleksandra (2011): Mechanisms of Health Behavior Change in Persons with Chronic Illness or Disability: The Health Action Process Approach (Hapa). In: Rehabilitation Psychology, 56(3), p. 161-170.
[19] Prochaska, James O (2013): Transtheoretical Model of Behavior Change. In: Encyclopedia of Behavioral Medicine, p. 1997-2000.
[20] Cihlar, Volker & Lippke, Sonia (2017): Physical activity behavior and competing activities: Interrelations in 55-to-70-year-old Germans. In: Journal of Aging and Physical Activity, 25, 576-586.
[21] Michie, Susan; van Stralen, Maartje Marieke & West, Robert (2011): The Behaviour Change Wheel: A New Method for Characterising and Designing Behaviour Change Interventions. In: Implementation Science, 6(1), p. 42.
[22] Lippke, Sonia & Kuhlmann, Tim (2013): Gesundheitsförderungsmaßnahmen Für Ältere Menschen Mittels Neuer Medien. In: Zeitschrift für Gesundheitspsychologie, 21(1), p. 34-44.
[23] Sugarman, Léonie (2005): Life-Span Development - Frameworks, Accounts and Strategies. Psychology Press, Taylor & Francis Group: London. https://pdfs.semanticscholar.org/17dc/5743a113358e67f9ab0bea69cc1402fc92c0.pdf
[24] Santrock, John W (2015): Life-Span Development. The McGraw-Hill Companies: New York. https://www.mheducation.com/prek-12/product/life-span-development-john-santrock/S9780077861827.html
[25] Bitkom (2016): Smartphones Sind Für Viele Senioren Unverzichtbar. Retrieved from https://www.bitkom.org/Presse/Presseinformation/Smartphones-sind-fuer-viele-Senioren-unverzichtbar.html [29 July 20018]
[26] Bitkom (2015): 1,6 Millionen Senioren Nutzen Tablet-Computer. Retrieved from https://www.bitkom.org/Presse/Presseinformation/16-Millionen-Senioren-nutzen-Tablet-Computer.html [29 July 2018]
[27] Petrovčič, Andraž; Taipale, Sakari; Rogelj, Ajda & Dolničar, Vesna (2018): Design of Mobile Phones for Older Adults: An Empirical Analysis of Design Guidelines and Checklists for Feature Phones and Smartphones. In: International Journal of Human-Computer Interaction, 34(3), p. 251-264.
[28] Kuerbis, Alexis; Mulliken, Adina; Muench, Frederick; A. Moore, Alison & Gardner, Daniel (2017): Older Adults and Mobile Technology: Factors That Enhance and Inhibit Utilization in the Context of Behavioral Health. In: Mental Health and Addiction Research, 2(2)
[29] Arning, Katrin & Ziefle, Martina (2007): Understanding Age Differences in Pda Acceptance and Performance. In: Computers in Human Behavior, 23(6), p. 2904-2927.
[30] Barnard, Yvonne; Bradley, Mike D; Hodgson, Frances & Lloyd, Ashley D (2013): Learning to Use New Technologies by Older Adults: Perceived Difficulties, Experimentation Behaviour and Usability. In: Computers in Human Behavior, 29(4), p. 1715-1724.
[31] Broady, Tim; Chan, Amy & Caputi, Peter (2010): Comparison of Older and Younger Adults‘ Attitudes Towards and Abilities with Computers: Implications for Training and Learning. In: British Journal of Educational Technology, 41(3), p. 473–485.
[32] Damodaran, Leela; Olphert, C Wendy & Sandhu, J (2014): Falling Off the Bandwagon? Exploring the Challenges to Sustained Digital Engagement by Older People. In: Gerontology, 60(2), p. 163-173.
[33] Chen, Ke & Chan, Alan Hoi Shou (2013): Use or Non-Use of Gerontechnology-a Qualitative Study. In: International Journal of Environmental Research and Public Health, 10(10), p. 4645-4666.
[34] Salovaara, Antti; Lehmuskallio, Asko; Hedman, Leif; Valkonen, Paula & Nasanen, Jaana (2010): Information Technologies and Transitions in the Lives of 55-65-Year-Olds: The Case of Colliding Life Interests. In: International Journal of Human Computer Studies, 68(11), p. 803-821.
[35] Foreman, Kalee F; Stockl, Karen M; Le, Lisa B; Fisk, Eric; Shah, Sameer M; Lew, Heidi C; . . . Curtis, Bradford S (2012): Impact of a Text Messaging Pilot Program on Patient Medication Adherence. In: Clinical Therapeutics, 34(5), p. 1084-1091.
[36] Kang, Hyun Gu; Mahoney, Diane F; Hoenig, Helen; Hirth, Victor A; Bonato, Paolo; Hajjar, Ihab & Lipsitz, Lewis A (2010): In Situ Monitoring of Health in Older Adults: Technologies and Issues. In: Journal of the American Geriatrics Society, 58(8), p. 1579-1586.
[37] Fogg, BJ (2003): Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann: San Francisco
[38] Simons, Herbert W; Morreale, Joanne & Gronbeck, Bruce E (2001): Persuasion in Society. SAGE Publications Inc. Retrieved from http://books.google.co.uk/books?id=3t55RAZOPVMC [29 July 2018]
[39] Oinas-Kukkonen, Harri & Harjumaa, Marja (2009): Persuasive Systems Design: Key Issues, Process Model, and System Features. In: Communications of the Association for Information Systems, 24(1), p. 485–500.
[40] Festinger, Leon (1962): A Theory of Cognitive Disso-

nance. Stanford University Press: Stanford, California.
[41] Bond, Dale S; Thomas, J Graham; Raynor, Hollie A; Moon, Jon; Sieling, Jared; Trautvetter, Jennifer; . . . Wing, Rena R (2014): B-Mobile - a Smartphone-Based Intervention to Reduce Sedentary Time in Overweight/Obese Individuals: A within-Subjects Experimental Trial. In: PLoS ONE, 9(6), p. e100821.
[42] Chang, Ting-Ray; Kaasinen, Eija & Kaipainen, Kirsikka (2012): What Influences Users‘ Decisions to Take Apps into Use?: A Framework for Evaluating Persuasive and Engaging Design in Mobile Apps for Well-Being. In: International Conference on Mobile and Ubiquitous Multimedia (MUM)
[43] Harries, Tim; Eslambolchilar, Parisa; Stride, Chris; Rettie, Ruth & Walton, Simon (2013): Walking in the Wild - Using an Always-on Smartphone Application to Increase Physical Activity. In Human-Computer Interaction – Interact 2013. Lecture Notes in Computer Science. Kotzé, Paula/ Marsden, Gary/ Lindgaard, Gitte/ Wesson, Janet/Winckler, Marco (Eds.). Springer: Berlin, Heidelberg, p. 19-36.
[44] Al-Razgan, Muna; Al-Khalifa, Hend; Al-Shahrani, Mona & Alajmi, Hessah (2012): Neural Information Processing. In Neural Information Processing. Iconip 2012. Lecture Notes in Computer Science. Huang, Tingwen/ Zeng, Zhigang/ Li, Chuandong/Leung, Chi-Sing (Eds.). Springer: Berlin, Heidelberg, p. 568–574.
[45] Harada, Susumu; Sato, Daisuke; Takagi, Hironobu & Asakawa, Chieko (2013): Characteristics of Elderly User Behavior on Mobile Multi-Touch Devices. In Human-Computer Interaction – Interact 2013. Lecture Notes in Computer Science. Kotzé, Paula/ Marsden, Gary/ Lindgaard, Gitte/ Wesson, Janet/Winckler, Marco (Eds.). Springer: Berlin, Heidelberg, p. 323-341.
[46] van Gemert-Pijnen, Julia EWC; Peters, Oscar & Ossebaard, Hans C (2013): Improving Ehealth. Eleven International Publishing: The Hague.
[47] Orji, Rita & Moffatt, Karyn (2018): Persuasive Technology for Health and Wellness : State-of-the-Art and Emerging Trends. In: Health Informatics Journal, 24(1), p. 66-91.
[48] Matthews, John; Win, Khin Than; Oinas-Kukkonen, Harri & Freeman, Mark (2016): Persuasive Technology in Mobile Applications Promoting Physical Activity : A Systematic Review. In: Journal of Medical Systems, 40(3), p. 1-13.
[49] Antypas, Konstantinos & Wangberg, Silje C (2014): Combining Users‘ Needs with Health Behavior Models in Designing an Internet- and Mobile-Based Intervention for Physical Activity in Cardiac Rehabilitation. In: JMIR research protocols, 3(1), p. e4.
[50] Schembre, Susan M; Liao, Yue; Robertson, Michael C; Dunton, Genevieve Fridlund; Kerr, Jacqueline; Haffey, Meghan E; . . . Hicklen, Rachel S (2018): Just-in-Time Feedback in Diet and Physical Activity Interventions: Systematic Review and Practical Design Framework. In: Journal of Medical Internet Research, 20(3), p. e106.
[51] Duncan, Mitch; Vandelanotte, Corneel; Kolt, Gregory S; Rosenkranz, Richard R; Caperchione, Cristina M; George, Emma S; . . . Mummery, W Kerry (2014): Effectiveness of a Web- and Mobile Phone-Based Intervention to Promote Physical Activity and Healthy Eating in Middle-Aged Males: Randomized Controlled Trial of the Manup Study. In: Journal of Medical Internet Research, 16(6), p. e136.
[52] He, Zongjian; Luo, Yigui & Liang, Guanqing (2013): Runking: A Mobile Social Persuasion System for Running Exercise. Paper presented at the 2013 Computing, Communications and IT Applications Conference (ComComAp), Hong Kong, China, p. 74–78.
[53] Fukuoka, Yoshimi; Komatsu, Judith; Suarez, Larry; Vittinghoff, Eric; Haskell, William; Noorishad, Tina & Pham, Kristin (2011): The Mped Randomized Controlled Clinical Trial: Applying Mobile Persuasive Technologies to Increase Physical Activity in Sedentary Women Protocol. In: BMC Public Health, 11, p. 933.
[54] Ayubi, Soleh U & Parmanto, Bambang (2012): Persona: Persuasive Social Network for Physical Activity. Paper presented at the Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS, p. 2153–2157.
[55] King, Abby C; Hekler, Eric B; Grieco, Lauren A; Winter, Sandra J; Sheats, Jylana L; Buman, Matthew P; . . . Cirimele, Jesse (2013): Harnessing Different Motivational Frames Via Mobile Phones to Promote Daily Physical Activity and Reduce Sedentary Behavior in Aging Adults. In: PLoS ONE, 8(4), p. e62613.
[56] Díaz-Bossini, José Manuel & Moreno, Lourdes (2013): Accessibility to Mobile Interfaces for Older People. In: Procedia Computer Science, 27, p. 57-66.
[57] Howlett, Neil; Trivedi, Daksha; Troop, Nicholas A & Chater, Angel Marie (2018): Are Physical Activity Interventions for Healthy Inactive Adults Effective in Promoting Behavior Change and Maintenance, and Which Behavior Change Techniques Are Effective? A Systematic Review and Meta-Analysis. In: Translational Behavioral Medicine
[58] Morrissey, Eimear C; Corbett, Teresa K; Walsh, Jane C & Molloy, Gerard J (2016): Behavior Change Techniques in Apps for Medication Adherence: A Content Analysis. In: American Journal of Preventive Medicine, 50(5), p. e143-e146.
[59] Cradock, Kevin A; ÓLaighin, Gearóid; Finucane, Francis M; Gainforth, Heather L; Quinlan, Leo R & Ginis, Kathleen A Martin (2017): Behaviour Change Techniques Targeting Both Diet and Physical Activity in Type 2 Diabetes: A Systematic Review and Meta-Analysis. In: International Journal of Behavioral Nutrition and Physical Activity, 14(1), p. 18.
[60] Knittle, Keegan; Nurmi, Johanna; Crutzen, Rik; Hankonen, Nelli; Beattie, Marguerite & Dombrowski, Stephan U (2018): How Can Interventions Increase Motivation for Physical Activity? A Systematic Review and Meta-Analysis. In: Health Psychology Review, p. 1-20.
[61] Ma, Jasmin K & Martin Ginis, Kathleen A (2018): A Meta-Analysis of Physical Activity Interventions in People with Physical Disabilities: Content, Characteristics, and Effects on Behaviour. In: Psychology of Sport and Exercise, 37, p. 1-13.
[62] Michie, Susan; Richardson, Michelle; Johnston, Marie; Abraham, Charles; Francis, Jill; Hardeman, Wendy; . . . Wood, Caroline E (2013): The Behavior Change Technique Taxonomy (V1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions. In: Annals of Behavioral Medi-

cine, 46(1), p. 81-95.
[63] Goodwin, Laura; Ostuzzi, Giovanni; Khan, Nadia; Hotopf, Matthew H & Moss-Morris, Rona (2016): Can We Identify the Active Ingredients of Behaviour Change Interventions for Coronary Heart Disease Patients? A Systematic Review and Meta-Analysis. In: PLoS ONE, 11(4), p. 1-23.
[64] Van Genugten, Lenneke; Dusseldorp, Elise; Webb, Thomas Llewelyn & Van Empelen, Pepijn (2016): Which Combinations of Techniques and Modes of Delivery in Internet-Based Interventions Effectively Change Health Behavior? A Meta-Analysis. In: Journal of Medical Internet Research, 18(6), p. 1-17.
[65] Samdal, Gro Beate; Eide, Geir Egil; Barth, Tom; Williams, Geoffrey & Meland, Eivind (2017): Effective Behaviour Change Techniques for Physical Activity and Healthy Eating in Overweight and Obese Adults; Systematic Review and Meta-Regression Analyses. In: International Journal of Behavioral Nutrition and Physical Activity, 14(1), p. 1-14.
[66] van Gemert-Pijnen, Lisette; Kelders, Saskia M; Kip, Hanneke & Sanderman, Robbert (2018): Ehealth Research, Theory and Development: A Multi-Disciplinary Approach (1st ed.). Routledge, Tylor & Francis Group.
[67] Bates, David W; Saria, Suchi; Ohno-Machado, Lucila; Shah, Anand & Escobar, Gabriel (2014): Big Data in Health Care: Using Analytics to Identify and Manage High-Risk and High-Cost Patients. In: Health Affairs, 33(7), p. 1123-1131.
[68] European Union (2016): Regulation 2016/679 of the European Parliament and the Council of the European Union. In: Official Journal of the European Communities, 2014(March 2014), p. 1-88.
[69] Grassegger, Hannes & Krogerus, Mikael (2016): Ich Habe Nur Gezeigt, Dass Es Die Bombe Gibt. In: Das Magazin, 48(3), p. 3-7.
[70] Zhang, Rui & Liu, Ling (2010): Security Models and Requirements for Healthcare Application Clouds. Paper presented at the Proceedings - 2010 IEEE 3rd International Conference on Cloud Computing, CLOUD 2010, p. 268–275
[71] de la Torre-Díez, Isabel; López-Coronado, Miguel; Vaca, Cesar; Aguado, Jesús Saez & de Castro, Carlos (2015): Cost-Utility and Cost-Effectiveness Studies of Telemedicine, Electronic, and Mobile Health Systems in the Literature: A Systematic Review. In: Telemedicine and e-Health, 21(2), p. 81-85.
[72] Schwartze, Veit; Trollmann, Frank & Albayrak, Sahin (2011): The End-User Vs. Adaptive User Interfaces. Paper presented at the CEUR Workshop Proceedings. Vol. 828, p. 32–36.s

Impressum

Herausgeber:
Prof. Dr. Paul Klimsa (paul.klimsa(at)tu-ilmenau.de)
Prof. Dr. Heidi Krömker (heidi.kroemker(at)tu-ilmenau.de)

Chefredaktion:
Dipl.-Ing. Mara Seupel (mara.seupel(at)tu-ilmenau.de)

Redaktion:
Dipl.-Ing. Janine Liebal (janine.liebal(at)tu-ilmenau.de)

http://www5.tu-ilmenau.de/zeitschrift-medienproduktion

Anschrift / Besucheradresse:
Technische Universität Ilmenau
FG Kommunikationswissenschaft
Ehrenbergstr. 29
98693 Ilmenau

Technische Universität Ilmenau
FG Medienproduktion
Gustav-Kirchhoff-Str. 1
98693 Ilmenau

PF 10 05 65
98684 Ilmenau

Layout: Dipl.-Ing. Mara Seupel

Cover: © by Mara Seupel; Hintergrund Designed by Freepik
ISSN: 2193-7699
URN: urn:nbn:de:gbv:ilm1-2193-7699_2018012:2

Redaktionsschluss dieser Ausgabe: 22.10.2018

Verantwortlicher für den Inhalt gemäß § 55 Abs. 2 RStV: Prof. Dr. Paul Klimsa und Prof. Dr. Heidi Krömker (Anschrift wie oben)