DESIGNING FOR EMPOWERMENT

An Exploration and Critical Reflection

DISSERTATION

an der Fakultät für Mathematik, Informatik und Statistik
der Ludwig-Maximilians-Universität München

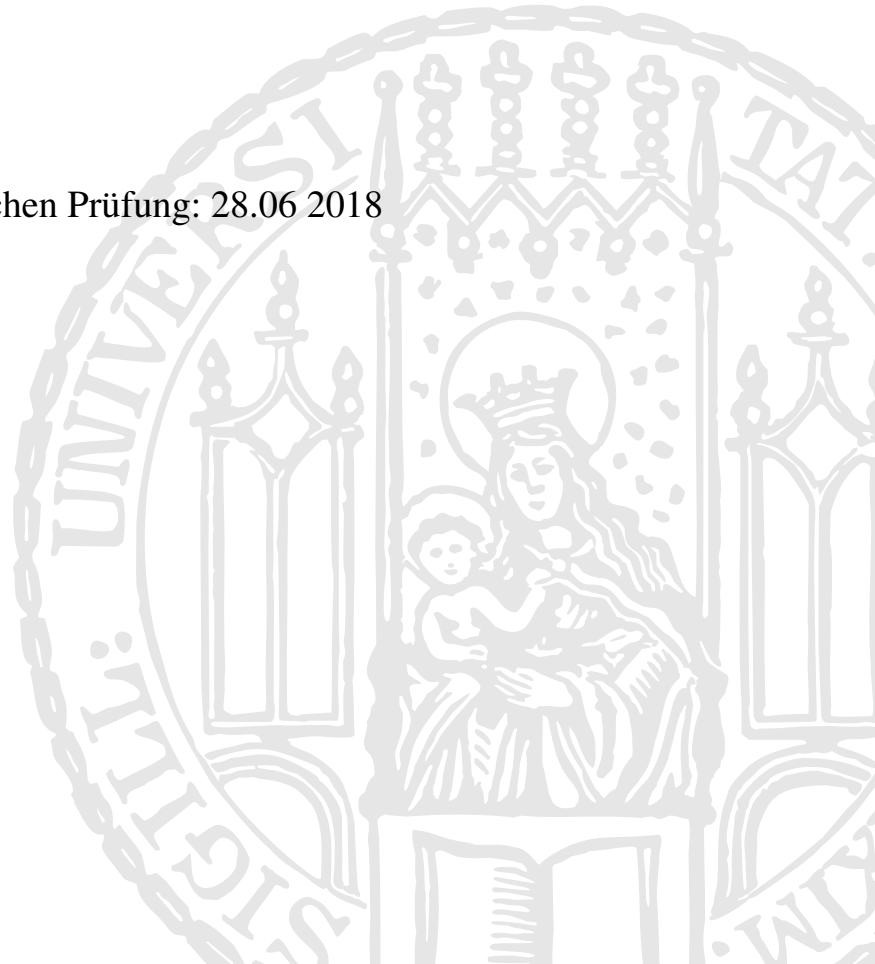
vorgelegt von

HANNA SCHNEIDER
M.Sc. Human-Computer Interaction

München, den 17.04 2018

Erstgutachter:	Prof. Dr. Andreas Butz
Zweitgutachter:	Prof. Dr. Sarah Diefenbach
Drittgutachter:	Prof. Phd Elizabeth Mynatt

Tag der mündlichen Prüfung: 28.06 2018



ABSTRACT

Technology bears the potential to *empower* people - to help them tackle challenges they would otherwise give up on or not even try, to make experiences possible they did not have access to before. One type of such technologies - the application area of this thesis - is health and wellbeing technology (HWT), such as digital health records, physical activity trackers, or digital fitness coach applications. HWTs often claim to *empower* people to live healthier and happier lives. However, there is reason to challenge and critically reflect on these claims and underlying assumptions as more and more researchers are finding that technologies aiming or claiming to be empowering often turn out to be disempowering. This critical reflection is the starting point of this thesis: Can HWTs really *empower* people in their everyday lives? If so, how should we go about designing them to foster empowerment and avoid disempowerment? To this aim, this thesis makes three main contributions:

First, it presents a framework of empowering technologies that aims to introduce conceptual and terminological clarity of *empowerment* in the field of Human-Computer Interaction (HCI). As a literature review conducted for this thesis reveals, the understandings of empowerment in HCI diverge substantially, rendering the term a subsumption of diverse research endeavors. The presented framework is informed by the results of the literature review as well as prior work on empowerment in social sciences, psychology, and philosophy. It aims to help other researchers to analyze conceptual differences between their own work and others' and to position their research projects. In the same way, this thesis uses the proposed framework to analyze and reflect on the conducted case studies.

Second, this thesis explores how HWT can empower people in a number of studies. Technologies that are investigated in these studies are divided into three interaction paradigms (derived from Beaudouin-Lafon's interaction paradigms): Technologies that follow the *computer-as-tool* paradigm include patient-controlled electronic health records, and physical activity trackers; technologies in the *computer-as-partner* paradigm include personalized digital fitness coaches; and technologies in the *computer-as-intelligent-tool* paradigm includes transparently designed digital coaching technology. For each of these paradigms, I discuss benefits and shortcomings, as well as recommendations for future work.

Third, I explore methods for designing and evaluating empowering technology. Therefore, I analyze and discuss methods that have been used in the different case studies to inform the design of empowering technologies such as interviews, observations, personality tests, experience sampling, or the Theory of Planned Behavior. Further, I present the design and evaluation of two tools that aimed to help researchers and designers evaluate empowering technologies by eliciting rich, contextualized feedback from users and fostering an empathic relationship between users and designers.

I hope that my framework, design explorations, and evaluation tools will serve research on empowering technologies in HCI to develop a more grounded understanding, a clear research agenda, and inspire the development of a new class of empowering HWTs.

ZUSAMMENFASSUNG

Technologie für Empowerment — im Deutschen am besten mit Befähigung oder Ermächtigung übersetzt: diese Vision ist sowohl in medizinischen und technischen Fachkreisen als auch in der wissenschaftlichen Literatur im Feld Mensch-Maschine Interaktion (MMI) weit verbreitet. Technologie kann — laut dieser Vision — Menschen helfen Herausforderungen zu meistern, die sie sonst nicht schaffen oder nicht mal versuchen würden, oder Ihnen komplett neue Erfahrungen ermöglichen. Eine Art von "empowernden", also befähigenden Technologien sind Technologien für Gesundheit und Wohlbefinden (health and wellbeing technologies, HWT), wie beispielsweise digitale Krankenakten, Schrittzähler, oder digitale Fitnesstrainer. Sowohl Werbung als auch Forschung über HWTs preist diese häufig als Schlüssel zu einem gesünderen und glücklicheren Leben an. Es gibt aber durchaus Gründe diesen Behauptungen kritisch gegenüberzustehen. So haben bereits einige Forschungsprojekte über vermeintlich "empowernde" Technologien ergeben, dass diese eher entmächtigen — also Ihre Nutzer mehr einschränken als Ihnen mehr Möglichkeiten zu verschaffen. Eine kritische Reflexion der Annahme, dass HWTs ihre Nutzer empowern stellt den Ausgangspunkt dieser Dissertation dar: Können HWTs ihre Nutzer wirklich empowern? Falls dem so ist, wie sollten sie am besten gestaltet werden? Der Beitrag meiner Dissertation zur Beantwortung dieser Fragen wird in drei Teilen präsentiert:

Im ersten Teil stelle ich ein konzeptuelles Framework vor, mit dem Ziel terminologische Klarheit im Bereich Empowerment in MMI zu fördern. Eine Literaturanalyse im Rahmen dieser Dissertation hat ergeben, dass die Verwendungen des Begriffs "Empowerment" in der MMI Literatur sehr stark voneinander abweichen. Beispielsweise wird der Begriff in Literatur über Technologien für Barrierefreiheit anders verstanden als in Literatur über Technologien für bürgerliches Engagement. Folglich schert das Schlagwort "Technologien für Empowermen", das in Präsentationen und Denkschriften weit verbreitet ist, komplett unterschiedliche Ansätze über einen Kamm. Das Framework, das in dieser Dissertation vorgestellt wird, zeigt die Unterschiede und Gemeinsamkeiten bei der Verwendung des Empowermentbegriffs auf. Es entstand als Resultat der Literaturanalyse und integriert gleichzeitig Erkenntnisse von Empowermenttheorien die in Sozialwissenschaften, Psychologie und Philosophie diskutiert wurden. In dieser Dissertation wird das vorgestellte Framework verwendet, um die präsentierten Studien über HWTs einzuordnen und zu diskutieren.

Im zweiten Teil präsentiere ich verschiedene empirische und technische Studien mit dem Ziel zu verstehen wie HWTs Menschen empowern können. Die Technologien, die dabei untersucht werden teile ich in drei Interaktionsparadigmen ein (die von den Interaktionsparadigmen von Beaudouin-Lafon abgeleitet sind): Technologien im Paradigma *Computer-als-Werkzeug* sind beispielsweise digitale Krankenakten und Schrittzähler; Technologien im Paradigma *Computer-als-Partner* sind beispielsweise digitale personalisierte Fitnesstrainer und Technologien im Paradigma *Computer-als-intelligentes-Werkzeug* sind beispielsweise transparent gestaltete digitale personalisierte Gesundheitsberater oder Fitnesstrainer. Vor- und Nachteile von Technologien in diesen drei Paradigmen werden diskutiert und Empfehlungen für zukünftige Forschung in diesen Bereichen abgeleitet.

Im dritten Teil, untersuche ich, welche Methoden für die Gestaltung und Evaluierung von empowernden Technologien geeignet sind. Einerseits diskutiere ich die Vor- und Nachteile der Methoden, die in den einzelnen Untersuchungen von HWTs (im zweiten Teil) verwendet wurden, wie zum Beispiel Interviews, Observationen, die Experience Sampling Methode oder Fragebögen basierend auf der Theorie des geplanten Verhaltens. Andererseits berichte ich über die Gestaltung und Entwicklung von zwei Applikationen mit dem Ziel Forschern und Designern die Evaluation von empowernden Technologien zu erleichtern. Konkret hat die erste Applikation das Ziel es Testnutzern zu ermöglichen immer und überall für sie wichtige Aspekte des Nutzererlebnisses an das Entwicklungsteam weiterzugeben. Bei der Entwicklung der zweiten Applikation stand dagegen die Förderung von Empathie zwischen Nutzern und Designern im Vordergrund.

Ich hoffe, dass das vorgestellte Framework, die Studien über HWTs und Evaluationswerkezeuge die Forschung über empowernde Technologien voranbringen, zu einer klaren Forschungsagenda beitragen, und die Entwicklung von neuartigen HWTs anregen werden.

ACKNOWLEDGMENTS

First and foremost, I would like to thank **Andreas** Butz, for supervising my growing up as PhD student with much generosity, giving me the freedom to make my own mistakes and putting me back on the right track when I might have been about to loose it. I highly respect how you balance hard work for quality research and teaching with truly caring about the people you work with. Further, I would like to thank **Alex** Wiethoff, **Wendy** Mackay, **Michel** Beaudouin-Lafon, and **Ann** Blandford for inspiring and encouraging me to embark on the adventure of perusing a PhD in the first place. **Julie** Wagner, thank you for walking the first baby steps as PhD toddler with me (and for becoming the kind of friend who always brings unexpected and crazy things into your life). **Siân** Lindley, thank you for giving me the chance to conduct research in the vivid and inspiring MSR HXD environment and for showing me how HCI research can have product impact. Also I would like to thank my external referees **Sarah** Diefenbach and **Elizabeth** Mynatt for reviewing my thesis.Without these people I would not be about to graduate as PhD today.

Further, I would like to thank the amazing people that I can call colleagues and friends for making our lab the best work place *ever*: I start with the first batch of people who worked here when I started and finished before me: **Sarah** Tausch, thank you for spreading love and laughter, for sharing amusing stories and truthful thoughts, for dance moves, for being a great room and tent mate and a lovely friend to hang out with. **Ema** von Zezschwitz, thanks for proofing that a crazy amount of partying and remarkable good work are not mutually exclusive. **Henri** Palleis, thank you for your patience with me as constantly question-asking and telephoning PhD newbie. **Simon** Stusak, thanks for all the after-show free beer and great Shakira-Bar conversations, **Sebastian** Löhmann for a great hand-over of Concept Development and Interaction Design, advice on expereince design in general and for unlimited friendliness and **Alina** Hang for being kind enough to sort 300 exams with me when other people enjoy their evenings.

And all the people whose great company I enjoyed in my last PhD year(s) until now: **Malin** Eiband, my research partner-in-crime, it's been a blast to work and hang out with you. **Renate** Häuslschmid, with your always-open ears and heart for all the creatures on this planet you really spread the good vibes at our lab. **Ceenu** George, I love your sense of humor and the inner peace you radiate (most of the time). **Daniel** Buschek thanks for teaching me and my students some of your machine learning techniques and for all the amusing jokes. **Tobi** Seitz, thank you for the music, the fun, the chocolate, the hipster vibes, and the all-nighters. **Axel** Hösl, your self-irony and your very in-depth thinking (with some twists, turns, and leaps) are a blast and always surprise me with new perspectives on everyday stuff. **Daniel** Ullrich, thank you for vivid discussions on everything and anything, for thinking along with me in research projects and beyond – and thanks for the continuous supply of cookies. **Mariam** Hassib, thanks for sharing the same research interests and for being the kind, honest and fun person you are. **Mo** Mohamed **Khamis**, thanks for spreading all the enthusiasm and encouraging words when things do not go so well. **Florain** Lachner, thanks for your contagious laughter and for the great and super reliable team work. **Maria** Fysaraki,

thanks for pitching in for the tutor seminar and your interdisciplinary perspective on things. **Christian** Mai, you definitely add to the lab spirit in a way I can't put into words. Thanks, **Michael** Braun, for organizing events and sharing enthusiasm for beer, **Bastian** Pfleging for always providing best advice on train tickets, bargaining, and legal issues, **Bernhard** Slawik, for spreading enthusiasm for crazy research projects, **Christina** Schneegaß for pitching in supervising our students when I was on a research stay abroad and **Pino** for all the cuddles, **Sarah** Aragon Bartsch for being a great travel organizer, **Nađa** Terzimehić for sharing all your food tips, e.g., where to get great Burrata, **Sarah** Theres Völkel for your help organizing the IDC and your straight-forwardness (highly appreciated!), and thanks **Gesa** Wiegand for being a patient and super relaxed climbing partner.

Thanks **Rainer** Fink for bearing with me and fixing my computer after my malicious downloading behaviors. Thank you, **Franziska** Schwamb, for supporting us in so many ways and for all your kind and encouraging words. **Florian** Alt, thank you for all the teaching on how the business of research works and strategic advice. Finally, I'd like to thank **Heinrich** Hußmann for making our lab the great place to work that it is – by bringing all these great people together and steering the lab in gentle and thoughtful ways.

Also, I would like to thank all my excellent students, it was a pleasure to work with you: Katharina Frison, Robert Müller, Kathrin Schauer, Nicole Lippner, Lisa Simon, Stina Schick, Maximilian Lammel, Dominic Slezak, Mareike Haug, Julian Fazekas-Con, Bernhard Vogler, Miriam Mayer, Alexandra Ronge, Johannes Schuster, Nora Unterbruner, Nadja Meier, Juli Sikorska, Tanja Wijngaarden, Benedikt Mayer, Una Radovanovic, Julien Breunig, and Julia Wayrauther.

I had the pleasure to work with several people outside of our lab, namely Clemens Stachl, Mark Bilandzic, Peter Just, Renato Pereira, Bea Vad, Johannes Huber, Alexander Peters, Sarah Diefenbach. Thank you for sharing the interest in our research topics and contributing with your perspectives and expertise.

Finally, I would like to thank all my friends who supported me during the last years and who never fail to make my life more fun and meaningful. Special thanks go to Fabius Steinberger and Frederik Brudy for discussions on research ideas and mutual proof-reading favors.

Last but not least, **Sophie** Furtner-Schneider, thank you for always believing in me no matter what, **Albert** Schneider, for all your support, and your humorous perspective on life. **Lina** Schneider, thank you for being my soul sister and for navigating and celebrating this adventure called life together. **Kilian** Moser, my partner-in-crime and in life, thank you for being hilarious every day, for all the shared adventures (some of which are called research), thank you for your patience and your love and for making me feel home anywhere we go.

TABLE OF CONTENTS

1
Introduction

The vision to *empower* people with technology has appeared in numerous HCI keynotes [51, 85] and articles [5, 17, 68, 44]. Beyond the HCI community it has been discussed in disciplines such as computer ethics [37] and medicine [71] and appeared in many technology companies' mission statements (e.g., Facebook[1], Microsoft[2], Tumblr[3], and Twitter[4]). It conveys the message that technology can create new possibilities and experiences and help people to achieve their goals, where they did not have the means to do so before.

One type of technologies often described as empowering are health and wellbeing technologies (HWT) - the application area of this thesis. The state of our physical and mental health determines our abilities - our "power". Consequently, health problems, such as diabetes, dementia, or depression can be a very disempowering experience [8]. Researchers in both medical and computer science hence hope that technology can help people to prevent or overcome this disempowerment, in other words to better care for their physical and mental health. The number of different technologies designed for this purpose is steadily increasing. It ranges from sensors that track body signals such as respiration, physical activity, nutrition, and sleep to health records or platforms that keep track of a person's illness trajectory and provide behavioral recommendations. Designing such technologies in ways that are empowering is, nevertheless, difficult and highly complex: HWT that aimed to empower was also found to be disempowering, for example, because it framed people as worse off [68] or offered more help than needed [24, 46]. To address such challenges, this thesis aims (1) to establish conceptual and terminological clarity of *empowerment* in HCI, (2) to explore how HWT can empower people, and (3) to explore methods for designing and evaluating empowering technologies. Below, I will elaborate on these three objectives and explain the theoretical motivation, the research question, and the contribution for each of them.

[1] https://www.facebook.com/pg/facebook/about/, accessed on 04.04.2018

[2] https://www.microsoft.com/en-us/about/default.aspx, accessed on 04.04.2018

[3] https://staff.tumblr.com/post/50902268806/news, accessed on 04.04.2018

[4] https://about.twitter.com/en-us/company.html, accessed on 04.04.2018

1.1 Conceptualization of Empowerment

Despite the various passionate calls for technology that empowers people in HCI [5, 17, 44, 51, 68, 85], we still lack a common terminology, a clear research agenda as well as guidelines and best practices for the design of empowering technologies. Currently, the growing body of work on this topic in HCI uses "empowerment" inconsistently to describe diverse research approaches. Broadly, publications using this term can be divided into three groups: The first and probably biggest group of publications on empowering technologies does not articulate a definition of empowerment leaving it up to the reader's interpretation; in a second group, authors explicate their own understandings of empowerment; and in a third and very small group, authors make use of theories and frameworks on empowerment. Notably, the definitions presented in publications in the second group (that reflect author's own understanding of empowerment) vary widely: Meschtscherjakov et al. [55], for example, define of empowerment as "creating an efficacious and capable self", Erete and Burrell [22], define empowerment as being "able to influence change by engaging in decision-making processes with city officials and law enforcement agencies", while Mellis and Buechley [54] focus solely on the relationship between system and user and view empowerment as users' "ability and confidence to control the technology in their life". Comparing these few explicit definitions illustrates how wide understandings of empowering technology fall apart.

The understandings of empowerment among publications in the third group is similarly inconsistent as theories and frameworks take very different approaches as well: Zimmerman's [96] model, for example, views empowerment as a psychological process an individual can go through, contextual factors and available support allowing. In HCI this theory has been employed to investigate how parents with children with special needs can be empowered [3]. In contrast, Hardy and Leiba-O'Sullivan's [31] four-dimensional model of empowerment investigates if/how one actor/group exerts power over another. In HCI this theory has been employed to investigate power imbalances in Open Source Software development projects [67]. Beyond these examples, Ammari and Schienebeck's observation that HCI has not yet leveraged the rich conceptual work in empowerment literature still holds true. Hence, HCI researchers who are looking to ground their designs in existing work are faced with the difficult challenge to decide which understanding, theory, or framework of empowerment suits their project best and how their research relates to or differs from other research in this area. Oosterlaken [59], therefore, pointed out that concrete checklists and design tools are needed that bridge the gap between theoretical work on empowerment and concrete design projects.

In summary, the conceptual unclarity that is present in HCI research on empowering technology makes it difficult to establish and evolve a clear research agenda and to validate, combine, and abstract learnings from past research projects. Moreover, it complicates design work that aims to integrate empowerment as a value or objective. Hence, the first goal of this thesis is to introduce structure and guidance in this field and to answer the research question:

RQ1: *How can we derive a more holistic conceptualization of empowerment in HCI that integrates existing work on empowering technologies with research on empowerment in related fields?*

Contribution. To introduce conceptual and terminological clarity in this field, this thesis contributes a four-dimensional framework of HCI research on empowerment, which we derived from a review of prior work on empowerment in philosophy, psychology, and social sciences and 54 CHI full papers using the terms "empower" or "empowerment" (see [76]). The framework can help to clarify and advance HCI research on empowerment in multiple ways: First, when analyzing their own research through the lens of this framework, researchers are likely prompted to critically reflect on their own understanding of power and empowerment as the framework asks them, for example, to distinguish between different concepts of power, psychological components they focus on, or the persistence of power they are aiming to foster. Those are likely questions they might not have fully considered before. In this process, they can also engage with the literature on empowerment (in philosophy, psychology, or social sciences) that the framework points towards, which can help them to define and sharpen their own understanding and to plan their future research. Second, the framework helps researchers to understand how their own research relates to those of others. Their research might, for example, focus on a similar goal (e.g., to empower women in rural areas) but differ from related research because it focuses on *persistent* instead of *transient* empowerment. In this way, a framework-guided analysis of related work might allow researchers to identify gaps and opportunities for future work. Finally, on a broader scale, the framework helps to compare and consolidate results from multiple research projects, for example, to analyze how lines of research with a shared understanding of empowerment are established, grow, and change over time. In our research, we demonstrated this by describing and characterizing eight different lines of research on empowerment in HCI that we identified in the reviewed paper set (see [76]). In the realm of this thesis, I use this framework to clarify the understanding of empowerment that I use as a basis to explore empowering HWTs. Further, in the final discussion and reflection part of this thesis (Chapter 3) I discuss my case studies again using the framework categories.

Definition of empowerment within this thesis. The basic model used in this thesis to explore the design of empowering technologies is based on Sen and Nussbaum's capability approach (CA) [57, 84]. Recently, several authors in computer ethics, philosophy and technology for development (ICDT4D) discussed the potential impact of the CA on the design of technologies (e.g., Johnston [37] and Oosterlaken [59]). I agree with their argument and follow their calls to operationalize the CA for technology design.

According to the CA, the freedom to achieve well-being is of primary moral importance and can be understood in terms of people's capabilities, that is, their realistic opportunities to do and be what they have reason to value. Understood in this way, an increase in capabilities is equivalent to empowerment. Capabilities represent the power of the individual (or group) to avoid harms, pursue valued forms of living, and to make reasoned determinations of what

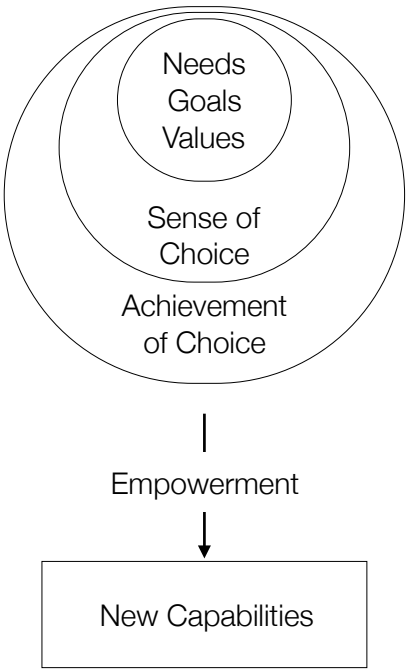


Figure 1.1: Model for designing empowering technologies that incorporates three main components that are necessary for empowerment, according to the Capability Approach by Sen and Nussbaum [57, 84]: (1) individual's needs, goals and values, (2) sense of choice, and (3) achievement of choice. Empowerment ultimately results in new capabilities to "lead the lives one has reason to value".

is to be valued [37]. In other words, they represent the choices the individual has – but note that not all choices are relevant but only those "among valued alternatives" [37]. The ethical maxim of the CA implies that a just society is one in which the opportunity to develop and express capabilities is provided to all.

Several scholars discussed the potential of the CA to inform technology design [37, 41, 59, 58] and emphasized the need and the difficulty to operationalize it at the same time. To this end, Alsop and Heinsohn [2] presented a framework to measure empowerment in the context of developmental projects and Kleine [41] presented the Choice Framework to help evaluate how information and communication technology (ICT) impacts empowerment again in the domain of development. Both are however less suitable to inform the design of technologies [58]. For this purpose, Oosterlaken [58] proposes to consolidate important learnings in the form of check-lists and similar design tools. To take a first step into this direction and at the same time preserve the versatile nature of the CA (with that I mean that it emphasizes the need to recognize diversity of contexts and humans), I extracted several important and informative components of the CA in a model for designing empowering technologies visualized in Figure 1.1: Three components (represented by the three circles) are essential for any technologies that aim to empower, that is to create new capabilities (represented by the box on the bottom): First, the choices created need to be aligned with user's needs, goals,

and values (innermost circle). Second, users need to acquire a sense of choice before they can realize it (middle circle). Third, contextual and environmental factors need to allow users to achieve the choice (outermost circle). Based on this theoretically-grounded model for designing empowering technologies, this thesis goes on to explore design possibilities in the domain of empowering HWT.

1.2 Empowering Health and Wellbeing Technologies

In recent years, an abundance of HWTs has been presented in both industry and academia. Most of them rely mainly on tracking health data, presenting it to the user and facilitating goal setting [13]. It has, however, rarely been investigated if and how such technologies actually *empower* people. Instead, the focus of most studies has been on technology acceptance, abandonment, or user engagement. Researchers have for example discussed the quick abandonment of self-tracking devices as problematic [12, 66]. To increase retention, most designers and researchers focused on reducing the cognitive effort necessary to use HWTs. To name a few examples, Klasnja et al. [40] described the advantages of using context-aware systems to recommend food or activity choices most beneficial for the user's health and wellbeing in a specific situation. Taking a similar approach, Bentley et al. [7] designed health mashups, a data collection and analysis platform that calculates correlations between health, happiness and influencing factors such as weather, sleep, and food. Based on this information users can then adjust their behaviors and choices to increase their wellbeing. Similarly, Rabbi et al. [66] designed MyBehavior, a smartphone application that combines behavior tracking with recommendation algorithms and as a result suggests beneficial food and physical activity choices optimized to the user's daily routine. These applications have in common that they use data collection and processing to help users implement behavior changes that are believed to be beneficial for their health and wellbeing.

However, there is increasing evidence that the above mentioned HTWs often lead to a frustrating user experience, which can in turn be detrimental for users' health and wellbeing: Health tracking technologies were found to decrease joy associated with daily activities such as running [48], to make people more pessimistic about their health condition [53], to cause or increase feelings of anxiety, failure or self-hatred [49], and to increase symptoms [14, 90]. These findings indicate that many HWTs are at odds with fundamental aspects of empowerment (as described in Section 1.1). As a consequence, several authors have raised concerns that technology that aims or claims to empower can end up disempowering people [47, 92].

To address these issues and concerns, this thesis set out to investigate how HWT can be designed to avoid frustrating and disempowering experiences. The approach of this thesis is in line with so-called "value sensitive design", which incorporates conceptual, empirical, and technical investigations [25]. The fundamental conceptual work in this thesis has already been mentioned in Section 1.1 and includes the framework of empowering technologies and the model for design. With this model for designing empowering technologies (see Figure 1.1), "empowerment" is put in the center of design. The second part of this thesis

aims to explore the possibilities to design HWTs for empowerment in empirical and technical investigations, or in other words to address RQ2:

> **RQ2:** *How can empowering HWTs be designed that acknowledge both individual needs, goals, and values as well as environmental constraints while fostering users' sense of choice?*

Contribution. I conducted a number of empirical and technical case studies to investigate RQ2. They all aim to implement one or multiple elements of the above presented design model in HWTs and indicate promising approaches and pitfalls. For example, several case studies focus on how technologies can be personalized to acknowledge users' personal needs', goals', and values. Other case studies focus on fostering users' knowledge and sense of choice, while again others focus on understanding the influence of contextual factors on users' ability to care for their health and wellbeing. I subsume the array of case studies in three interaction paradigms because they serve as clear and strong metaphors and catch properties of technology that I believe are vital for their empowering and disempowering qualities (e.g., can/should technology be in power of decision?). The paradigms are inspired and partly based on the interaction paradigms described by Beaudouin-Lafon [6]: *computer-as-tool*, *computer-as-partner*, *computer-as-media*. For the purpose of structuring the case studies in this thesis, I remove the paradigm *computer-as-media* and add a new one: *computer-as-intelligent-tool*. According to Beaudouin-Lafon, the *computer-as-media* paradigm "uses the computer as a medium by which humans communicate with each other." Technology that allows people to communicate for example with their doctors or with people who suffer from similar health problems can likely create new capabilities (i.e. empower people by the definition presented above). However, I do not describe this paradigm in detail, as the HWTs investigated in this thesis did not focus on this aspect. In exchange, I added a new paradigm – *computer-as-intelligent-tool*, which I describe below along with *computer-as-tool* and *computer-as-partner*:

computer-as-tool: In Beaudouin-Lafon's words technology in this paradigm "extends human capabilities through a (very sophisticated) tool, just as the invention of the wheel allowed us to transport heavy loads over long distances" [6]. HWT that follow this paradigm typically provide data tracking and analysis features that allow users to investigate their own health data.

computer-as-partner: In Beaudouin-Lafon's words this paradigm "embodies anthropomorphic means of communication in the computer, such as natural language, so that users can delegate tasks" [6]. HWTs that follow this paradigm aim to provide a digital coach that takes users' individuality into account and adapts, for example, motivational strategies, recommendations or communication style to suspected needs of the user.

computer-as-intelligent-tool: I added this paradigm to combine the advantages of the above presented ones, namely the technical possibilities of *computer-as-partner* with the ultimate power of decision that users possess in *computer-as-tool*. In this paradigm, computational

possibilities are leveraged to help people best achieve their goals. It is, however, at the same time equally important to maintain system transparency, foster users' awareness and embrace their decision power. HWT that follow this paradigm are intelligent personal coaching systems that disclose their functioning on demand.

	(A) ***computer-as-tool***	**(B)** ***computer-as-partner***	**(C)** ***computer-as-intelligent-tool***
Approach	Data enables evidence-based rational decisions and therefore allows people to work more effectively towards their health and wellbeing goals.	Systems learn about users' individual needs and adapt, for example, motivational strategies, recommendations or communication style accordingly.	Scrutability and transparency aim to foster critical reflection, autonomy, and appropriate levels of trust.
Investigated research question	How do HWT based on data tracking and feedback empower users?	How can HWT be designed as a coach that adjusts to users' needs and goals?	How can personalized HWT be designed to support the right level of trust and autonomy?
Case studies & publications	Patient-controlled electronic health records [P2], physical activity trackers [P3]	Personalized fitness coach [P4, P6] and personal data visualizations [P5]	Investigations of users' mental models [P8, P9], designing transparent coaching systems [P7]
Benefits	Ability to self-manage health data previously managed by doctors; Can foster awareness/knowledge about own health.	Account for individuality; Result in positive user experience and are more effective in fostering behavior change	Foster critical reflection, self-determination and appropriate levels of trust.
Shortcomings	Can result in anxiety, frustrating user experience	Can result in overtrust and decreased self-determination	Potentially overwhelm users
Questions for future research	**How can such tools be designed to meet needs of a wider range of users?** How can they support an empowering user experience (*feeling*)? How can they support users to better cope with daily health-related problems (*knowing*)? How can data tracking and feedback mechanisms better foster self-knowledge (*persistent* empowerment)?	**Are users interested in hidden/opaque personalization algorithms? How can personalized HWT be designed to support the right level of trust and self-determination?** How can *persistent* empowerment be fostered?	**How much information are users interested in?** Are there situations in which transparency harms the user experience? How can *persistent* empowerment be fostered?

Table 1.1: Summary of case studies divided in three interaction paradigms summarizing the rationale of the approach, the research question investigated, references to case studies, benefits and shortcomings of technologies in the paradigm (as apparent in the case studies) and emerging questions for future research. In the row 'Questions for future research', questions that have been investigated in case studies in the same or a different paradigm have been highlighted in bold.

For each of these paradigms, Table 1.1 summarizes the related research questions, publications, benefits and shortcomings, as well as questions that emerged during case studies in one of the paradigms. I highlight the main benefits and challenges for the following discussion: Benefits of technologies in the *computer-as-tool* paradigm include that they helped some users to self-manage and analyze their health data, but on the negative side, others experienced frustration and anxiety, as the technology did not fit to their personal needs, goals, and values. On the positive side, studies on technology in the *computer-as-partner* paradigm support the feasibility of adapting technologies to the needs, goals, and values of a wider range of users and demonstrate both a theory-driven and a statistical method to derive suitable personalization strategies. On the negative side, the fact that systems in this paradigm make decisions for users (e.g., which exercise program or communication style is adequate for a user) can impede their sense of choice. Moreover, users tend to overtrust

intelligent systems, which is problematic in case of system errors [15, 33]. Technologies in the *computer-as-intelligent-tool* paradigm aim to mitigate these shortcomings by making the systems' inner workings transparent and scrutable. On the downside, explanations can also be overwhelming and deteriorate the user experience. With these case studies and with analyzing them for empowering and disempowering attributes I lay out potential paths to design empowering HWT.

For more details on corresponding publications see Chapter 2 and for an in-depth discussion on learnings and directions for future work in this area see Chapter 3.

1.3 Methods for Designing and Evaluating Empowering Technologies

The third objective in this thesis addresses the need for methods and tools to (a) design and (b) evaluate empowering technologies – addressed in RQ3a and RQ3b respectively. Even though there is an abundance of design and evaluation methods in HCI [93], to date, there are no investigations or reports on which methods and tools are suitable for empowering technologies.

(a) According to the previously introduced model (see Figure 1.1), methods for the design of empowering technologies need to help designers to understand how users' individual needs, goals, and values can be met, as well as how technology design and contextual factors influence users' choice and their sense of choice. Hence, research question RQ3a asks for methods that meet these requirements:

> **RQ3a:** *Which existing methods are suitable to inform the design of empowering technologies?*

(b) Selecting methods for the evaluation of empowerment is difficult – empowerment has been recognized as a construct especially difficult to evaluate [41, 96]. The evaluation metrics and frameworks presented by Alsop and Heinsohn [2] or Kleine [41] define several criteria to assess, such as outcome, structure, and agency. However, how these aspects can or should be assessed is not further clarified. Scales and questionnaires are likely unsuitable as they suggest a static level of empowerment, which is at odds with the definition of the construct [41, 84, 96]. Rather, empowerment needs to be defined and expressed by the individuals to be empowered in their own ways [41, 96]. Kleine [41] therefore used extensive ethnographic studies in a developmental project to assess the constructs defined by the Choice Framework. However, for most designers and researchers time and budget constraints do not allow for such extensive ethnographic studies [34, 38, 91]. Hence, there is a need for practicable methods and tools that meet the constraints of technology design projects [58]. The literature on empowerment can inform the requirements for such tools

and methods: (1) empathy between designers and potential users is vital to fully understand if users' needs, values, and goals are met [52, 57, 84, 95]; (2) users should be able to express their feedback, experiences, and opinions flexibly [41, 96]; (3) to understand how environmental factors influence empowerment, suitable methods need to capture context [57, 84, 96]; (4) as empowerment is a dynamic process, capturing its development over time is crucial [96]; and (5) finally methods need to be practicable to be implemented by design teams [34, 38, 91]. This thesis aims to explore how digital evaluation tools can be designed to best meet these needs:

> **RQ3b:** *How can digital tools be designed to help designers understand how technology empowers people?*

Contribution. To explore RQ3a, this thesis presents a selection of methods to inform the design of empowering technologies that have been applied in the presented case studies. The methods explored are summarized in Chapter 3 along with a discussion of their advantages and disadvantages. Together, this discussion provides a "toolbox" for designers from which to choose suitable methods. However, as these methods have been selected to meet the needs of the presented case studies other methods are likely useful as well and I welcome future work to extend this method selection.

To explore RQ3b, this thesis contributes the design, development, and evaluation of two tools: The first tool is CrowdUX, a light-weight mobile application to capture free-form user stories and feedback in context, over an extended period of time. CrowdUX showed to collect more meaningful, richer user stories than traditional user studies and was easy to implement in constrained design projects [77]. Hence, it met most of the derived needs for tools to evaluate empowerment. In a next step, we wanted to explore how digital tools could be designed to better mediate an empathic relationship between participants and designers, which would likely allow designers to gain a deeper understanding of users' needs, goals, and values over time [69]. To explore this question, we developed a second digital tool that allows designers to gain a lively picture of users' experiences via visualizations of personas and user journeys as well as flexible filters to search through and explore feedback quickly and efficiently. Both tools were developed in a participatory design process together with a design agency. Early evaluations in focus groups and pilot studies confirmed that design teams are interested in using them. However, future work needs to investigate if and how both tools in combination are able to mediate the development of empathic relationships and to evaluate a wide range of empowering technologies.

1.4 Summary and Overview of the Thesis

The aim of this thesis is to explore the design of empowering HWT. In particular, I presented three objectives of this thesis: First, introducing conceptual clarity to the field of empowering technology in HCI, second, investigating how existing and new HWT can empower people, and, third, exploring suitable methods and tools to design and evaluate empowering technologies.

Chapter 2 briefly introduces the publications included in this thesis and clarifies how they contribute to the overall research aims.

Chapter 3 positions and discusses the results of this thesis with respect to the outlined research questions and highlights areas for future work.

2
Publications

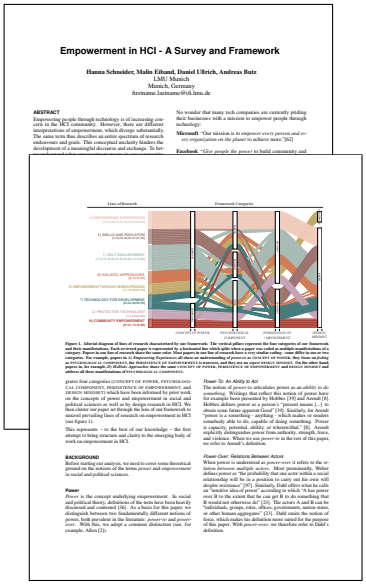
Having explained the main questions and structure of this dissertation, I will now introduce in more detail the papers included. Table 2.1 gives an overview of publications and is meant to help readers identify papers relevant to their interest or to a specific topic. Following the table, I have included summaries of the publications that contribute to this paper-based dissertation – accompanied by a preview of the first page(s) of the original publication where available. This should give the reader a more detailed impression of the contents of each paper, and offer further guidance on what to read. I have re-written the original abstracts to clarify how they contribute to the overall objectives of this thesis. Because most publications resulted from work I conducted supported by or in collaboration with my supervisors, colleagues and students, I use the scientific *"We"* throughout this chapter. The original publications and a table that clarifies the contributions of all authors (Table B.1) are available in the Appendix B.

2.1 Conceptualization of Empowerment

The first publication [P1] in this thesis functions as background and related work chapter and provides the theoretical and conceptual basis of this thesis. It addresses research question RQ1:

> **RQ1:** *How can we derive a more holistic conceptualization of empowerment in HCI that integrates existing work on empowering technologies with research on empowerment in related fields?*

[P1] Empowerment in HCI - A Survey and Framework


Empowerment in HCI - A Survey and Framework

Hanna Schneider, Malin Eiband, Daniel Ullrich, Andreas Butz
LMU Munich
Munich, Germany
firstname.lastname@ifi.lmu.de

ABSTRACT

Summary. The aim of this paper is to introduce conceptual clarity in an increasingly important but unstructured and diverse facet of HCI research: the design of empowering technologies. Currently, there are different interpretations of empowerment, which diverge substantially. The same term thus describes an entire spectrum of research endeavors and goals, which hinders the development of a meaningful discourse and exchange. To better understand what empowerment means in the HCI community, we reviewed 54 CHI full papers using the terms *empower* and *empowerment*. Based on our analysis and informed by prior writings on power and empowerment, we constructed a framework that serves as a lens to analyze notions of empowerment in current HCI research. In our paper, we both discuss the implications of these understandings of empowerment on approaches to technology design and offer recommendations for future work. Please note that other papers in this thesis do not apply the terminology that this paper suggests and do not reference the presented framework. This is because, the need for this framework emerged as a reflection on the different projects in this dissertation: They all aimed to empower users with HWTs but took very different routes to empowerment. This framework is therefore used in the discussion of this thesis (Chapter 3) to analyze and compare the presented case studies.

Schneider, H., Eiband, M., Ullrich, D., and Butz, A. (2018a). Empowerment in HCI - A Survey and Framework. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 244:1–244:14, New York, NY, USA. ACM, doi:10.1145/3173574.3173818

	RQ		Title of Paper and Publication Venue	Research Method	Primary contribution
[P1]	RQ1		"Empowerment in HCI - A Survey and Framework" in *CHI'18*	Structured literature review (N=54)	Analysis of related work on empowerment in HCI and beyond and presentation of framework of empowering technologies
[P2]	RQ2	A	"Patients Know Best: Qualitative study on how families use patient-controlled personal health records" in *JMIR*	Semi-structured qualitative field study (N=27)	Analysis of PCEHR users' needs clustered into four groups (controller, collaborators, cooperators, and avoiders)
[P3]		A	"Self-Knowledge Through Numbers and the Operationalization of Learning" in *UbiComp '16*	3 weeks user study with step trackers (N=3)	Learnings from pilot study, initial framework of learning in Personal Informatics
[P4]		B	"Understanding the Mechanics of Persuasive System Design: A Mixed-Method Theory-driven Analysis of Freeletics" in *CHI '16*	Theory of planned behavior, individual differences (N=643)	Structural equation models of fitness coach users motivation clustered in followers, hedonists, achievers
[P5]		B	"Your Data, Your Vis: Personalizing Personal Data Visualizations" in *Interact '17*	Controlled experiment, personality test (N=36)	Preferences for personal data visualizations correlate with personality
[P6]		B	"Adapting at Runtime: Exploring the Design Space of Pers. Fitness Coaches" in *IUI '17*		Research strategy to systemically design personalized fitness coaches
[P7]		C	"Bringing Transparency Design into Practice" in *IUI '18*	Participatory Action Design Research (N=40)	Stage-based participatory process for integrating transparency into real-world systems
[P8]		C	"Investigating Perceptions of Personalization and Privacy in India" in *Interact '17*		Planning, methods, and logistics of fieldtrip
[P9]		C	"Privacy and Personalization: The Story of a Cross-Cultural Field Study" in *ACM Interactions*	Interviews, observation, drawing task (N=16)	Learnings from fieldtrip in India and recommendations
[P10]		C	"Narrative vs Pragmatic: Two Perspectives on the Design of Expl. in Intelli. Systems" in *IUI '17*		Comparisons of two opposed perspectives on transparency in intelligent systems
[P11]	RQ3		"CrowdUX: A Case for Using Widespread and Lightweight Tools in the Quest for UX in *DIS '16*	comparison of feedback collection methods (N=30)	Mobile feedback collection tool fared best in collecting rich user stories and context
[P12]			"Nurturing Empathy between UX Design Teams and Users in Digitally-Mediated User Research" submitted to *NordiCHI '18*	prototype design and evaluation (N=26)	Analysis of design opportunities to foster empathic relationships between users and designers through digitally mediated tools

Table 2.1: Overview of publications included in this thesis abbreviated [P1] - [P12] and their methods and primary contributions.

2.2 Empowering Health and Wellbeing Technologies

To explore RQ2, I present several publications [P2-P10] grouped into the three interaction paradigms: A) *computer-as-tool* [P2-P3], B) *computer-as-partner* [P4-P6], and C) *computer-as-intelligent-tool* [P7-P10] (as introduced in Section 1.2). Collectively, they aim to explore RQ2:

> **RQ2:** *How can empowering HWT be designed that acknowledge both individual needs, goals, and values as well as environmental constraints while fostering users' sense of choice?*

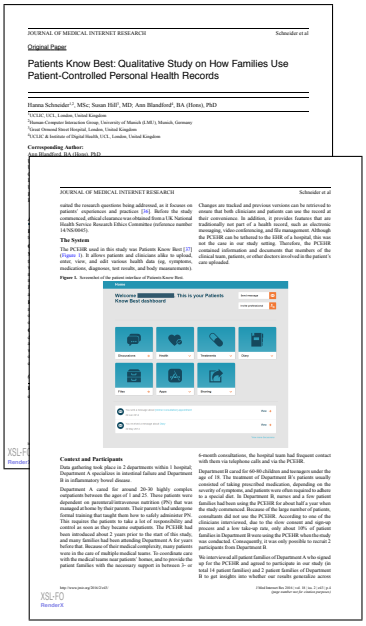
Application areas in the presented case studies vary (e.g., from a clinical healthcare setting to health and fitness applications that aim to foster behavior change). They have been selected strategically to answer the research question at hand but also to adjust to resources and constraints (see 2.2.4 for further details on limitations and constraints during research planning).

2.2.1 A) Computer-as-Tool

Two publications study technologies that follow the *computer-as-tool* paradigm: P2 investigates how patient-controlled electronic health records (PCEHRs) meet patient families' needs and P3 investigates if users of physical activity trackers become more aware of their physical activity level. Both technologies focus on collecting and storing health-related data and providing feedback. Researchers hope that these functionalities foster users' health knowledge, awareness, and allow them to make better, more informed choices directed towards fulfilling their needs, and pursuing their goals and values.

[P2] Patients Know Best: Qualitative study on how families use patient-controlled personal health records

Summary. Self-management technologies, such as PCEHRs, have the potential to help people manage and cope with disease. However, we currently know little about the lived experiences of patients who work with such tools. The first case study paper in this thesis aims to close this gap and reports a field study that investigates patient families' lived experiences of working with PCEHRs. We conducted a semi-structured qualitative field study with patient families and clinicians at a children's hospital in the UK that uses a PCEHR. All families were managing the health of a child with a serious chronic condition, who was typically under the care of multiple clinicians. As data gathering and analysis progressed, it became clear that while much of the literature assumes that patients are willing and waiting to take more responsibility for and control over their health management (eg, with PCEHRs), only a minority of participants in our study responded in this way.


Patients Know Best: Qualitative Study on How Families Use Patient-Controlled Personal Health Records

Their experiences with the PCEHR were diverse and seemed to be strongly shaped by their coping styles. Theory on coping identifies a continuum of coping styles, from approach to avoidance oriented, and proposes that patients' information needs depend on their style. We, hence, identified three groups of patient families and an outlier, distinguished by their coping style and their PCEHR use. We refer to the outlier as controlling, and the three groups as collaborating, cooperating, and avoiding. The PCEHR met the needs of controller and collaborators better than the needs of cooperators and avoiders. In our paper, we further draw on the Self-Determination Theory to propose ways in which a PCEHR design might better meet the needs of avoidance-oriented users. We highlight the need for families to also relinquish control at times, and propose ways in which PCEHR design might support a better distribution of control, based on effective training, ease of use, comprehensibility of data security mechanisms, timely information provision (recognizing people's different needs), personalization of use, and easy engagement with clinicians through the PCEHR.

Schneider, H., Hill, S., and Blandford, A. (2016b). Patients Know Best: Qualitative Study on How Families Use Patient-Controlled Personal Health Records. *J Med Internet Res*, 18(2):e43, doi:10.2196/jmir.4652

[P3] LOL: Levels of Learning Through Personal Informatics


LOL: Levels of Learning Through Personal Informatics

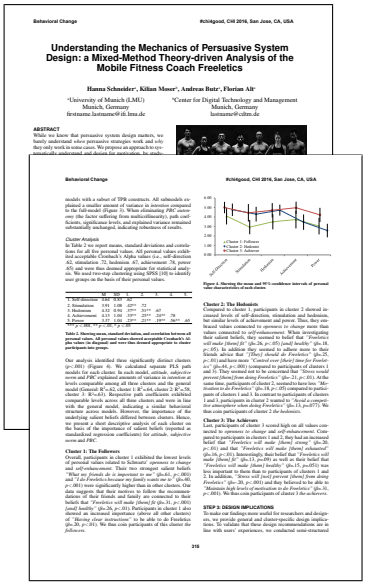
Summary. Users of self-tracking (such as tracking steps) tend to abandon the technology after a few months of using it. Previous user research suggests that users have "learned enough" and feel they no longer benefit from the technology. However, what exactly does "learned enough" entail? What, when, and how do users actually learn? This paper reports our initial efforts to investigate these questions. We (a) present a small-scale mixed-method pilot study in which we explored learning with step trackers; (b) suggest four levels of learning that Personal Informatics tools can foster: data level, routine level, correlational level, and problem-screening level; and (c) discuss how future research can use and extend this initial framework to study what and how people learn with self-tracking technology.

Schneider, H. (2016a). LOL: Levels of Learning Through Personal Informatics. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct*, UbiComp '16, pages 510–515, New York, NY, USA. ACM, doi:10.1145/2968219.2968313

2.2.2 B) Computer-as-Partner

Three publications follow the *computer-as-partner* paradigm [P4-P6]. They share the vision to develop a digital coach that adapts to the individual needs of the user. In this vision the diversity of humans and their needs, goals and values (which is central in the model for designing empowering technologies, see Figure 1.1) is acknowledged and accommodated. To explore the feasibility of this vision, P4 investigates how motivational strategies of persuasive technologies can be adapted to users' personal values, P5 explores how personal health data visualizations can be tailored to users' personalities, and P6 discusses how the huge design space of personalized fitness coaches can be systematically explored.

[P4] Understanding the Mechanics of Persuasive System Design: A Mixed-Method Theory-driven Analysis of Freeletics


Behavioral Change #chigood, CHI 2016, San Jose, CA, USA

Understanding the Mechanics of Persuasive System Design: a Mixed-Method Theory-driven Analysis of the Mobile Fitness Coach Freeletics

Hanna Schneider[1], Kilian Moser[1], Andreas Butz[1], Florian Alt[2]

[1]University of Munich (LMU) Munich, Germany firstname.lastname@ifi.lmu.de

[2]Center for Digital Technology and Management Munich, Germany lastname@cdtm.de

ABSTRACT

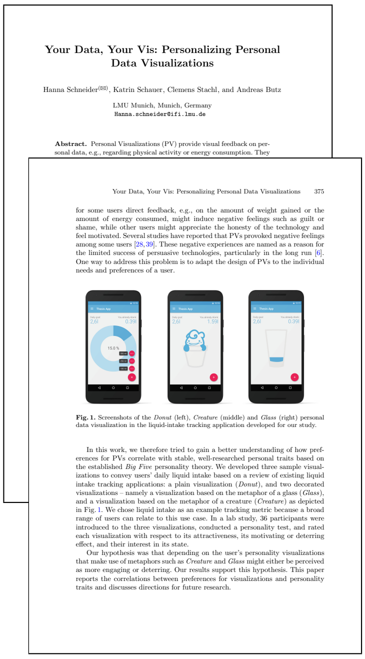
Behavioral Change #chigood, CHI 2016, San Jose, CA, USA

Summary. Persuasive technologies aim to help people take better or healthier decisions for example concerning their food intake or exercise behavior. However, as people are motivated to change their behavior for different reasons, one-size-fits-all approaches to supporting them in their behavior change might not be appropriate. We, hence, propose an approach to systematically understand users' motivation and to personalize behavior change technology, by studying the relationship between personal values and the fundamental building blocks of motivation using the theory of planned behavior (TPB). With this method, we quantitatively analyzed the attitudes, beliefs, and values of 643 mobile fitness coach users and found that overall capacity (i.e., perceived ability to exercise) had the biggest effect on users' motivation. We further identified three distinct user groups, namely followers, hedonists, and achievers characterized by their personal value profiles and their motivation to exercise. With insights from semi-structured interviews (N=5) we derived design implications for tailoring technology to the three groups. We hope that practitioners and researchers can use our theory-based mixed-method research design to better understand user behavior in persuasive applications.

Schneider, H., Moser, K., Butz, A., and Alt, F. (2016c). Understanding the Mechanics of Persuasive System Design: A Mixed-Method Theory-driven Analysis of Freeletics. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, CHI '16, pages 309–320, New York, NY, USA. ACM, doi:10.1145/2858036.2858290

[P5] Your Data, Your Vis: Personalizing Personal Data Visualizations

Summary. Personal Visualizations (PV) provide visual feedback on personal data, e.g., regarding physical activity or energy consumption. They are a vital part of many behavior change technologies (BCT) and can influence users' attitude towards both the technology and the behaviour change positively as well as negatively. In commercial products and research projects, feedback has, for example, been presented with counts and graphs, stylized displays, metaphoric displays, as narrative information, data physicalisations, and in the form of living plants. Users' perceptions and preferences regarding different PVs seem to vary strongly, rendering a one-size-fits-all approach unsuitable. To investigate whether preferences for certain PVs coincide with personality or gender, we conducted a lab study with three example PVs: *Donut*, *Glass*, and *Creature*. Indeed, the results of our lab study are a first indicator that there is a relationship between personality traits and preferences for different PVs. High scores on extraversion and openness, for example, positively correlated with a preference for *Creature*. In contrast, high scores in conscientiousness negatively correlated with a preference for *Creature*. Further research is necessary to better understand how truly personalized PVs can be realized, which, in turn, might fit better into people's lives and thereby be more effective.


Your Data, Your Vis: Personalizing Personal Data Visualizations

Hanna Schneider(✉), Katrin Schauer, Clemens Stachl, and Andreas Butz

LMU Munich, Munich, Germany
Hanna.schneider@ifi.lmu.de

Abstract. Personal Visualizations (PV) provide visual feedback on personal data, e.g., regarding physical activity or energy consumption. They

Your Data, Your Vis: Personalizing Personal Data Visualizations 375

for some users direct feedback, e.g., on the amount of weight gained or the amount of energy consumed, might induce negative feelings such as guilt or shame, while other users might appreciate the honesty of the technology and feel motivated. Several studies have reported that PVs provoked negative feelings among some users [28,39]. These negative experiences are named as a reason for the limited success of persuasive technologies, particularly in the long run [6]. One way to address this problem is to adapt the design of PVs to the individual needs and preferences of a user.

Fig. 1. Screenshots of the *Donut* (left), *Creature* (middle) and *Glass* (right) personal data visualization in the liquid-intake tracking application developed for our study.

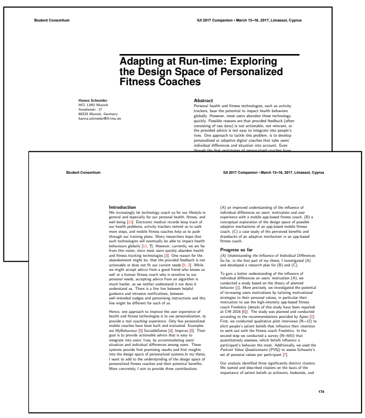
In this work, we therefore tried to gain a better understanding of how preferences for PVs correlate with stable, well-researched personal traits based on the established *Big Five* personality theory. We developed three sample visualizations to convey users' daily liquid intake based on a review of existing liquid intake tracking applications: a plain visualization (*Donut*), and two decorated visualizations – namely a visualization based on the metaphor of a glass (*Glass*), and a visualization based on the metaphor of a creature (*Creature*) as depicted in Fig. 1. We chose liquid intake as an example tracking metric because a broad range of users can relate to this use case. In a lab study, 36 participants were introduced to the three visualizations, conducted a personality test, and rated each visualization with respect to its attractiveness, its motivating or deterring effect, and their interest in its state.

Our hypothesis was that depending on the user's personality visualizations that make use of metaphors such as *Creature* and *Glass* might either be perceived as more engaging or deterring. Our results support this hypothesis. This paper reports the correlations between preferences for visualizations and personality traits and discusses directions for future research.

Schneider, H., Schauer, K., Stachl, C., and Butz, A. (2017b). *Your Data, Your Vis: Personalizing Personal Data Visualizations*, pages 374–392. Springer International Publishing, Cham, doi:10.1007/978-3-319-67687-6_25

[P6] Adapting at Run-time: Exploring the Design Space of Personalized Fitness Coaches

Summary. Personal health and fitness technologies, such as activity trackers, bear the potential to impact health behaviors globally. However, most users abandon these technologies quickly. Possible reasons are that provided feedback (often consisting of raw data) is not actionable, not relevant, or the provided advice is not easy to integrate into people's lives. One approach to tackle this problem, is to develop personalized or adaptive digital coaches that take users' individual differences and situation into account. Even though the first prototypes of personalized coaches have been presented and evaluated, this research is still in its infancy. This conceptual paper discusses an approach to systematically design a personalized fitness coach by (a) investigating the influences of individual


Student Consortium IUI 2017 Companion • March 13–16, 2017, Limassol, Cyprus

Adapting at Run-time: Exploring the Design Space of Personalized Fitness Coaches

Hanna Schneider
HCI, LMU Munich
Amalienstr. 17
80333 Munich, Germany
hanna.schneider@ifi.lmu.de

Abstract
Personal health and fitness technologies, such as activity trackers, bear the potential to impact health behaviors globally. However, most users abandon these technology quickly. Possible reasons are that provided feedback (often consisting of raw data) is not actionable, not relevant, or the provided advice is not easy to integrate into people's lives. One approach to tackle this problem, is to develop personalized or adaptive digital coaches that take users' individual differences and situation into account. Even

Student Consortium IUI 2017 Companion • March 13–16, 2017, Limassol, Cyprus

Introduction
We increasingly let technology coach us for our lifestyle in general and especially for our personal health, fitness, and well-being [11]: Electronic medical records keep track of our health problems, activity trackers remind us to walk more steps, and mobile fitness coaches help us to push through our training plans. Many researchers hope that such technologies will eventually be able to impact health behaviours globally [11, ?]. However, currently, we are far from this vision, since most users quickly abandon health and fitness tracking technologies [3]. One reason for the abandonment might be, that the provided feedback is not actionable or does not fit our current needs [5, 2]. While we might accept advice from a good friend who knows us well or a human fitness coach who is sensitive to our personal needs, accepting advice from an algorithm is much harder, as we neither understand it nor does it understand us. There is a fine line between helpful guidance and intrusive notifications, between well-intended nudges and patronising instructions and this line might be different for each of us.

Hence, one approach to improve the user experience of health and fitness technologies is to use personalization, to provide a real *coaching experience*. Only few personalized mobile coaches have been built and evaluated. Examples are MyBehaviour [5] SociableSense [4], Inspirun [9]. Their goal is to provide actionable advice that is easy to integrate into users' lives, by accommodating users' situation and individual differences among users. These systems provide first promising results and first insights into the design space of personalized systems.In my thesis, I want to add to the understanding of the design space of personalized fitness coaches and their potential benefits. More concretely, I aim to provide three contributions:

(A) an improved understanding of the influence of individual differences on users' motivation and user experience with a mobile app-based fitness coach, (B) a conceptual exploration of the design space of possible adaptive mechanisms of an app-based mobile fitness coach, (C) a case study of the perceived benefits and drawbacks of an adaptive mechanism in an app-based fitness coach.

Progress so far
(A) Understanding the Influence of Individual Differences
So far, in the first part of my thesis, I investigated (A) and developed a research plan for (B) and (C).

To gain a better understanding of the influence of individual differences on users' motivation (A), we conducted a study based on the theory of planned behavior [1]. More precisely, we investigated the potential of increasing users motivations by tailoring motivational strategies to their personal values, in particular their motivation to use the high-intensity app-based fitness coach Freeletics (details of this study have been reported at CHI 2016 [6]). The study was planned and conducted according to the recommendations provided by Ajzen [1]: First, we conducted qualitative pilot interviews (N=12) to elicit people's salient beliefs that influence their intention to work out with the fitness coach Freeletics. In the second step we conducted a survey (N=643) that quantitatively assesses, which beliefs influence a participant's behavior the most. Additionally, we used the *Portrait Value Questionnaire* (PVQ) to assess Schwartz's set of personal values per participant [7].

Our analysis identified three significantly distinct clusters. We named and described clusters on the basis of the importance of salient beliefs as achievers, hedonists, and

174

differences on behaviors and motivations, (2) mapping and conceptually exploring the design space, (3) and iteratively prototyping and testing adaptations of personalized fitness coaches in a user-centered design process.

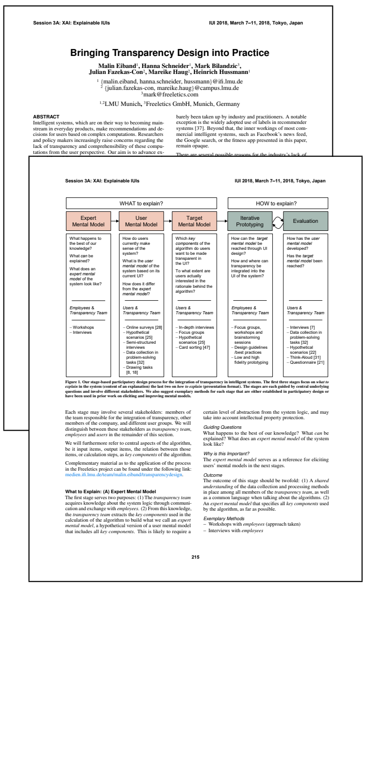
Schneider, H. (2017). Adapting at Run-time: Exploring the Design Space of Personalized Fitness Coaches. In *Proceedings of the 22nd International Conference on Intelligent User Interfaces Companion*, IUI '17 Companion, pages 173–176, New York, NY, USA. ACM, doi:10.1145/3030024.3038280

2.2.3 C) Computer-as-Intelligent-Tool

Five papers [P7-P10] follow the *computer-as-intelligent-tool* paradigm. As discussed earlier, it aims to combine advantages of the first two paradigms – *computer-as-partner* and *computer-as-tool*. In this paradigm adapting technology to users' individual needs is assumed to be beneficial (as established in the *computer-as-partner* paradigm). However, on the negative side, intelligent personalized systems bear the risk to diminish users' sense of choice as users tend to overtrust and naively rely on them [15, 33]. Technology in the *computer-as-intelligent-tool* paradigm aims to prevent this overtrust and to foster users' sense of choice by allowing users to scrutinize the systems' functioning. We published five papers on this topic: P7 presents a design process that resulted from a design project in collaboration with the personalized digital fitness coach Freeletics with the aim to make personalization more transparent. P8 and P9 relate to a field trip that we conducted in conjunction with the INTERACT conference 2017 to understand perceptions of personalized systems in both Germany and India.Finally, P10 is a workshop paper that compares two perspectives on making systems transparent: A normative and a pragmatic view.

[P7] Bringing Transparency Design into Practice

Summary. Intelligent systems, which are on their way to becoming mainstream in everyday products, make recommendations and decisions for users based on complex computations. Researchers and policy makers increasingly raise concerns regarding the lack of transparency and comprehensibility of these computations from the user perspective. Our aim is to advance existing UI guidelines for more transparency in complex real-world design scenarios involving multiple stakeholders. To this end, we contribute a participatory stage-based process for designing transparent interfaces incorporating perspectives of users, designers, and providers, which we developed and validated with a commercial intelligent fitness coach. With our work, we hope to provide guidance to practitioners and to pave the way for a pragmatic approach to transparency in intelligent systems.


Session 3A: XAI: Explainable IUIs IUI 2018, March 7–11, 2018, Tokyo, Japan

Bringing Transparency Design into Practice

Malin Eiband[1], Hanna Schneider[1], Mark Bilandzic[3], Julian Fazekas-Con[2], Mareike Haug[2], Heinrich Hussmann[1]
[1] {malin.eiband, hanna.schneider, hussmann}@ifi.lmu.de
[2] {julian.fazekas-con, mareike.haug}@campus.lmu.de
[3] mark@freeletics.com
[1,2] LMU Munich, [3] Freeletics GmbH, Munich, Germany

ABSTRACT
Intelligent systems, which are on their way to becoming mainstream in everyday products, make recommendations and decisions for users based on complex computations. Researchers and policy makers increasingly raise concerns regarding the lack of transparency and comprehensibility of these computations from the user perspective. Our aim is to advance ex-

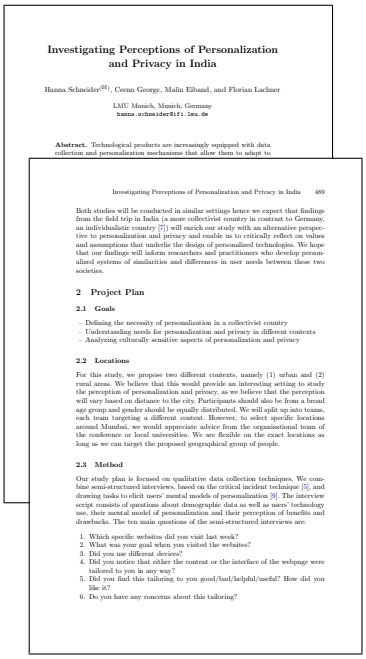
barely been taken up by industry and practitioners. A notable exception is the widely adopted use of labels in recommender systems [37]. Beyond that, the inner workings of most commercial intelligent systems, such as Facebook's news feed, the Google search, or the fitness app presented in this paper, remain opaque.

Session 3A: XAI: Explainable IUIs IUI 2018, March 7–11, 2018, Tokyo, Japan

Eiband, M., Schneider, H., Bilandzic, M., Fazekas-Con, J., Haug, M., and Hussmann, H. (2018a). Bringing Transparency Design into Practice. In *23rd International Conference on Intelligent User Interfaces*, IUI '18, pages 211–223, New York, NY, USA. ACM, doi:10.1145/3172944.3172961

[P8] Investigating Perceptions of Personalization and Privacy in India

Summary. Technological products are increasingly equipped with data collection and personalization mechanisms that allow them to adapt to an individual user's needs. However, the value and perception of these practices for users is still unclear. To investigate users' mental models of personalization as well as perceived benefits and drawbacks, we conducted field studies in both Germany and India. Our aim was to generate a rich understanding of the perspectives of both a collectivist and an individualistic society on personalization and privacy. By investigating differences in user needs of collectivist and individualistic societies we aim to inform design practices of for example privacy settings, transparency design and data collection and analysis strategies in general. This paper proposes and describes a field trip that was conducted in Mumbai, India, collocated with the Interact 2017 conference. It summarizes the methods and logistics that we used in our field trip: semi-structured interviews based on the critical incident technique and drawing tasks.



Investigating Perceptions of Personalization and Privacy in India

Hanna Schneider(✉), Ceenu George, Malin Eiband, and Florian Lachner

LMU Munich, Munich, Germany
hanna.schneider@ifi.lmu.de

Abstract. Technological products are increasingly equipped with data collection and personalization mechanisms that allow them to adapt to

Investigating Perceptions of Personalization and Privacy in India 489

Both studies will be conducted in similar settings hence we expect that findings from the field trip in India (a more collectivist country in contrast to Germany, an individualistic country [7]) will enrich our study with an alternative perspective to personalization and privacy and enable us to critically reflect on values and assumptions that underlie the design of personalized technologies. We hope that our findings will inform researchers and practitioners who develop personalized systems of similarities and differences in user needs between these two societies.

2 Project Plan

2.1 Goals

– Defining the necessity of personalization in a collectivist country
– Understanding needs for personalization and privacy in different contexts
– Analyzing culturally sensitive aspects of personalization and privacy

2.2 Locations

For this study, we propose two different contexts, namely (1) urban and (2) rural areas. We believe that this would provide an interesting setting to study the perception of personalization and privacy, as we believe that the perception will vary based on distance to the city. Participants should also be from a broad age group and gender should be equally distributed. We will split up into teams, each team targeting a different context. However, to select specific locations around Mumbai, we would appreciate advice from the organisational team of the conference or local universities, We are flexible on the exact locations as long as we can target the proposed geographical group of people.

2.3 Method

Our study plan is focused on qualitative data collection techniques. We combine semi-structured interviews, based on the critical incident technique [5], and drawing tasks to elicit users' mental models of personalization [9]. The interview script consists of questions about demographic data as well as users' technology use, their mental model of personalization and their perception of benefits and drawbacks. The ten main questions of the semi-structured interviews are:

1. Which specific websites did you visit last week?
2. What was your goal when you visited the websites?
3. Did you use different devices?
4. Did you notice that either the content or the interface of the webpage were tailored to you in any way?
5. Did you find this tailoring to you good/bad/helpful/useful? How did you like it?
6. Do you have any concerns about this tailoring?

Schneider, H., George, C., Eiband, M., and Lachner, F. (2017a). *Investigating Perceptions of Personalization and Privacy in India*, pages 488–491. Springer International Publishing, Cham, doi:10.1007/978-3-319-68059-0_57

[P9] Privacy and Personalization: The Story of a Cross-Cultural Field Study

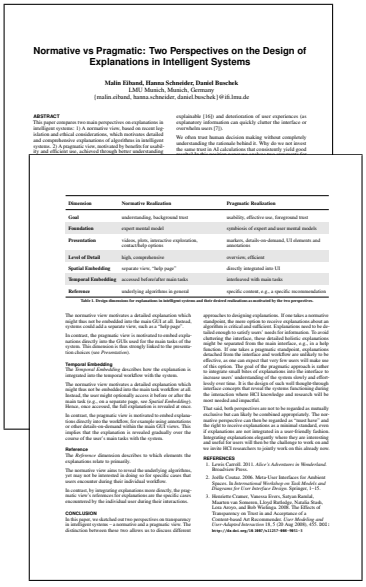

SPECIAL TOPIC

PRIVACY AND PERSONALIZATION:

Summary. As proposed in P8, we had the chance to conduct a two-days field trip in Mumbai, India, in September 2017. Ten researchers and practitioners from different cultures and backgrounds participated in the field research and exchanged their diverse perspectives on the subject of privacy and personalization. In this feature article that appears in the ACM interactions magazine in May 2018, we recount our experiences from the different perspectives of both German and Indian researchers from the initial idea to planning and conducting the field trip in collaboration with locals. The purpose of the article is to provide insights and motivation, as well as details on planning and conducting an inter-cultural field trip for researchers who consider starting a similar endeavor. We share our learnings and recommendations and tell a story about diverse perspectives, inspiration, and great human encounters.

Schneider, H., Lachner, F., Eiband, M., George, C., Shah, P., Parab, C., Kukreja, A., Hussmann, H., and Butz, A. (2018b). Privacy and Personalization: The Story of a Cross-cultural Field Study. *Interactions*, 25(3):52–55, doi:10.1145/3197571

[P10] Normative vs Pragmatic: Two Perspectives on the Design of Explanations in Intelligent Systems


Normative vs Pragmatic: Two Perspectives on the Design of Explanations in Intelligent Systems

This paper compares two main perspectives on explanations in intelligent systems: 1) A normative view, based on recent legislation and ethical considerations, which motivates detailed and comprehensive explanations of algorithms in intelligent systems. 2) A pragmatic view, motivated by benefits for usability and efficient use, achieved through better understanding of the system. We introduce and discuss design dimensions for explanations in intelligent systems and their desired realizations as motivated by these two perspectives. We conclude that while the normative view ensures a minimal standard as a "right to explanation", the pragmatic view is likely the more challenging perspective and will benefit the most from knowledge and research in HCI to ensure a usable integration of explanations into intelligent systems and to work on best practices to do so.

Eiband, M., Schneider, H., and Buschek, D. (2018b). Normative vs Pragmatic: Two Perspectives on the Design of Explanations in Intelligent Systems. http://explainablesystems.comp.nus.edu.sg/wp-content/uploads/2018/02/exss_7_eiband.pdf

2.2.4 Case Study Constraints and Limitations

Every research project is not only shaped by its objectives, but also by the resources available and constraints. Blandford et al. [9] recommend to report these constraints even though it is not yet common practice as it may help readers to assess why decisions for certain methods and study samples have been taken. In this thesis, several constraints have influenced the preparation and implementation of the presented studies:

First, I moved from technologies applied in a health care setting or in the course of a treatment to studying health and fitness applications, which aim to help people to stay fit and healthy (often described as behavior change or persuasive technologies; both terms have been used in the published papers). Developing and testing new technologies in a healthcare environment is highly difficult and constrained and would have implied long time spans to obtain ethical clearance.

Second, the personalization strategies presented in this thesis would need to be tested with bigger sample sizes and A/B testings to validate if they result in a better user experience or help users achieve their goals quicker. A study by Orji [61] yielded significant positive results confirming the effectiveness of personalization of a health game in a controlled environment with 802 participants (assigned to two user groups to adapt to). To test the effectiveness of personalization strategies proposed in this thesis, an even larger study sample would have been necessary. This is because, the effectiveness of health and wellbeing technologies needs to be tested in the field and over the long term [39] and because personalization strategies in this thesis aimed to adapt technology to three user groups [81] or continuous personality scales [82]. Because realizing a study with the required sample size was not possible in a research setting, I partnered with companies who already have an existing user base. It was, however, due to practical constraints never possible to conduct an A/B testing of proposed personalization mechanisms.

Finally, two projects on adapting health technologies to users' current states have not been presented in this thesis, as they did not yield the results we hoped for. The first was an experience sampling study collecting 3,193 naturalistic self-reports on self-control states from 78 subjects, along with logging the participants' phone usage [94]. After an extensive analysis of the data, we concluded that self-control states cannot be inferred from phone usage in our data set even though this data set is reasonably complete, high-quality, and large (compared to similar studies [65]). This does not mean that changes in personal self-control or or mood cannot be detected from phone usage data at all but it is likely necessary to collect data from a larger user base over a longer period of time. In the second project, we explored the value of a large data set collected with the digital fitness machines of eGym. Our aim was to create user profiles based on users' strength and exercising behavior that could

in turn be used to personalize the training plan and the interface with respect to their current needs and goals. Unfortunately entries on personal characteristics of users (e.g., their goals) were very sparse in the available data set and users' exercising behavior was only recorded in monthly intervals. Deriving automated adaptations of an individual's training plan from the collected data was hence not feasible [86].

2.3 Methods for Designing and Evaluating Empowering Technologies

The third objective of this thesis was to explore tools and methods suitable for the design and evaluation of empowering technologies. Methods to inform the design have been included in most of the case studies presented in Section 2.2. To avoid redundancy, they are not included in this section. To answer and reflect on RQ3a —

> **RQ3a:** *Which existing methods are suitable to inform the design of empowering technologies?*

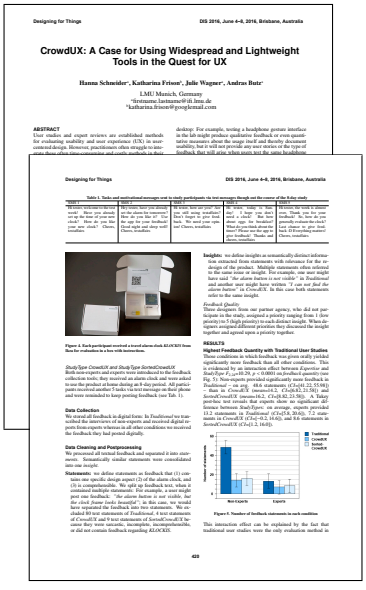
these methods are summarized and discussed in Section 3.3.

RQ3b addressed the need for practicable methods that can help to evaluate empowering user experiences:

> **RQ3b:** *How can digital tools be designed to help designers understand how technology empowers people?*

Two publications in this thesis address this research question and explore the suitability of digital tools to remotely collect rich user stories:

[P11] CrowdUX: A Case for Using Widespread and Lightweight Tools in the Quest for UX


Designing for Things DIS 2016, June 4–8, 2016, Brisbane, Australia

CrowdUX: A Case for Using Widespread and Lightweight Tools in the Quest for UX

Hanna Schneider*, Katharina Frison†, Julie Wagner*, Andreas Butz*

LMU Munich, Germany
*firstname.lastname@ifi.lmu.de
†katharina.frison@googlemail.com

ABSTRACT

Designing for Things DIS 2016, June 4–8, 2016, Brisbane, Australia

Table 1. Tasks and motivational messages sent to study participants via text messages though out the course of the 5-day study.

Figure 4. Each participant received a bowl alarm clock ALLOCKS from Ikea for evaluation in a box with instruction.

Figure 7. Number of feedback statements in each condition

Summary. User studies and expert reviews are established methods for evaluating usability and user experience (UX) in user-centered design. However, practitioners often struggle to integrate these often time-consuming and costly methods in their design processes. As technological products and services are becoming increasingly mobile, their contexts of use are increasingly diverse and less predictable. While this changing context is hard to capture in lab studies, the same mobile technologies also provide possibilities for new study methods. In this paper we advocate lightweight mobile tools for crowdsourcing UX feedback. In cooperation with a design agency, we built two apps that allow users to express feedback with text, ratings and pictures whenever using a product. The second app assigns feedback to categories, while the first does not. In a case study we compared the quantity, relevance, and nature of the feedback collected with both UX evaluation apps to

traditional evaluation methods. The feedback collected with the apps was considered highly useful by designers and provided more user stories and context than traditional evaluations.

Schneider, H., Frison, K., Wagner, J., and Butz, A. (2016a). CrowdUX: A Case for Using Widespread and Lightweight Tools in the Quest for UX. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, DIS '16, pages 415–426, New York, NY, USA. ACM, doi:10.1145/2901790.2901814

[P12] Nurturing Empathy between UX Design Teams and Users in Digitally-Mediated User Research


Nurturing Empathy between UX Design Teams and Users in Digitally-Mediated User Research

Leave Authors Anonymous
for Submission
City, Country
e-mail address

Leave Authors Anonymous
for Submission
City, Country
e-mail address

Leave Authors Anonymous
for Submission
City, Country
e-mail address

Leave Authors Anonymous
for Submission
City, Country
e-mail address

ABSTRACT

Summary. Creating an empathic, holistic understanding of the user experience and communicating it within the design team is a constant challenge in UX design projects. This paper explores the potential of digital tools to support designers and researchers in this task. We explored the needs of different stakeholders in semi-structured interviews and hosted an ideation workshop to generate design ideas for suitable software tools. Based on the resulting insights and ideas, we implemented a first prototype that balances individual feedback visualizations with detailed user profiles, a user journey and a communication feature. The prototype was assessed in seven focus groups with a total of 26 participants and with the AttrakDiff questionnaire. We found that our concept is particularly useful to analyze big data sets for long term studies at relatively late stages of the design process, establish a relationship with users and to support collaboration within teams. The persona view, the user journey view and flexible filters allowed designers to gain a lively picture of users' experiences. Future work is needed to better understand how digitally-mediated empathic relationships evolve over the long term.

Lachner, F., Schneider, H., Simon, L., and Butz, A. (2018). Nurturing Empathy between UX Design Teams and Users in Digitally-Mediated User Research. In *10th Nordic Conference on Human-Computer Interaction*. doi:10.1145/3240167.3240182

3
Discussion and Future Work

The main objective of this thesis is to explore the design of empowering HWT. HWTs have been described as empowering, because our health heavily impacts our "power" – our ability to fulfill our needs and achieve our goals[1]. In recent years, technological advances in both physiological sensing and data analysis fueled hopes that technology can help people to improve or maintain physical and mental health. However, there are reasons to critically investigate if HWTs really empower people as recent research has also found them to be disempowering [47, 92].

Hence, this thesis started out with a critical reflection on the terminology of empowering technologies. I presented a framework based on an analysis of related work that clarifies commonalities and differences between understanding of empowerment in HCI research. To clarify the understanding of empowerment in this thesis, I presented a model for designing empowering technologies derived from Sen and Nussbaums's CA [57, 84] (see Sections 1.1 and 2.1). To explore the design of empowering HWT, I conducted several case studies, briefly introduced in Section 2.2. Finally, I explored methods and tools suitable to design and evaluate empowering technologies, see Section 2.3. In this final chapter I reflect on my specific contributions to the three research questions introduced in Chapter 1 and highlight what remains to be done. I end the discussion with several concluding remarks.

[1] Power has been defined in different ways and is here understood as *power-to* [1] based on Sen and Nussbaum's CA [57, 84]. See [P1] for an elaboration on different notions of power.

3.1 Conceptualization of Empowerment

Empowerment has enjoyed increasing popularity in HCI [5, 17, 44, 51, 68, 85] but remained poorly defined (as demonstrated in Section 1.1). At the same time, researchers in other fields have presented several approaches to conceptualize and operationalize empowerment (e.g., [37, 59, 83, 96]). For example, Zimmerman's [96] empowerment theory has been influential in developmental and community psychology, and Sen and Nussbaum's CA [83] has helped to conceptualize empowerment in welfare economics, international development and human rights. Those have, however, not been taken up by HCI researchers [3] (notable exceptions are [3, 67]). Hence, there is a gap to be closed: HCI research on empowering technologies needs to catch up on the conceptual work on empowerment that already exists and to start adopting and adapting existing theories and frameworks to the needs of HCI projects.

The first objective of this thesis was to address this gap and introduce conceptual clarity in HCI research on empowerment by leveraging existing empowerment theories. To this end, this thesis contributes a framework that clarifies how existing HCI research on empowering technologies differs from each other and relates to existing theories on empowerment (such as [1, 83, 96]). Namely, the framework integrates two concepts of power (as described by [1]), three psychological components of empowerment (as described by [96]), two qualities of persistence (as discussed in [96]), and two design mindsets that characterize approaches to empowering technologies (also discussed by [23, 35, 72]). To the best of my knowledge, this presents the first analysis of the current state of HCI research on empowerment and the first attempt to integrate it with existing theories on empowerment.

With this framework, differences and commonalities of empowering technologies presented in HCI research can be effectively analyzed and described. In the corresponding publication P1, we exemplary sketched out eight lines of research with different understandings of empowerment that emerged in our literature analysis. Furthermore, researchers can use this framework to clearly define their own understanding of empowerment and identify research and theories that resonate with their understanding. Beyond these applications, our framework aims to serve as a basis for an in-depth discourse on the design of empowering technologies. Important points of discussion for future research include how a need for empowerment can or should be diagnosed and how empowerment can be measured. Furthermore, further research is needed to investigate how the concept of empowerment relates to similar concepts such as enabling technology [70], or choice architecture [36] and whether our framework and terminology are applicable to these research branches without adaptations. Concretely, a more comprehensive literature review might include a wider set of keywords and a variety of publication venues (e.g., Designing Interactive Systems, Information Technology and International Development). Such a review would present an opportunity to further test the generalizability of our framework and to consolidate learnings from research projects that share e.g., a focus on *transient* empowerment or an understanding of *power-over*. Moreover, it can reveal unexplored areas of empowerment, e.g., a lack of technologies that support *persistent* empowerment for older adults with cognitive impairments.

Finally, future research needs to investigate how privacy and security requirements can be integrated into the model for designing empowering technologies. HWT often collect large amounts of personal data, which can in the case of accidental and intentional broadcasting have devastating effects. A recent example is the broadcasting of anonymized running tracks by the company Strava, which also revealed locations of secret military bases[2]. When such privacy and security incidents occur, technology that aims to empower can instead expose and jeopardize users [87]. An adapted design model for empoweirng technologies might integrate a privacy-by-design approach (see recommendations for privacy-by-design [56]) and transparent and usable privacy management interfaces (e.g., as suggested by [26, 42, 64]).

3.2 Empowering Health and Wellbeing Technologies

The second research question addresses the design of empowering HWTs and aims to identify pitfalls and best practices. HWTs are an important domain for empowering technologies as health problems fundamentally limit our abilities. However, while many HWTs aim or claim to empower few have explicitly addressed or analyzed empowerment [P1]. Moreover, there is increasing evidence that technologies that aim or claim to empower can turn out to be disempowering, especially in the domain of health and wellbeing [47, 92]. In this regard, several scholars have pointed out that details of design are crucial [37, 59, 60] and that these need to be explored in empirical and technical investigations [25, 59]. I followed this approach in this thesis, with a number of empirical and technical studies.

The various case studies have been categorized in three interaction paradigms summarized in Table 1.1. The first two of the three paradigms have been derived from paradigms by Beaudouin-Lafon [6]: technologies in the *computer-as-tool* paradigm rely on health data tracking and providing feedback. In the *computer-as-partner* paradigm, technology is viewed as a "partner in crime" that communicates with the user and adapts e.g., to the user's motivation or personality. Through these adaptations systems aim to foster a positive user experience as far as possible and to help users' achieve their individual health and wellbeing goals in their own pace. HWTs in the *computer-as-intelligent-tool* paradigm integrate personalization and adaptation but are – in contrast to technology in the *computer-as-partner* paradigm – perceived as tools rather than partners. This meas that system designers focus on maintaining transparency and foster users' sense of choice. Figure 3.1 highlights the model components on which technologies in the respective paradigms focus – based on the model for designing empowering technologies introduced in Section 1.1.

The studies in the three paradigms (see Table 1.1) are put into the wider context of empowering technology by analyzing them through the lens of the framework. The alluvial diagram in Figure 3.2 presents the studies coded by framework categories and color-coded by interaction paradigm (*computer-as-tool* in light red [P2-P3], *computer-as-partner* in gray

[2] https://www.theguardian.com/commentisfree/2018/jan/29/strava-app-mapping-every-move

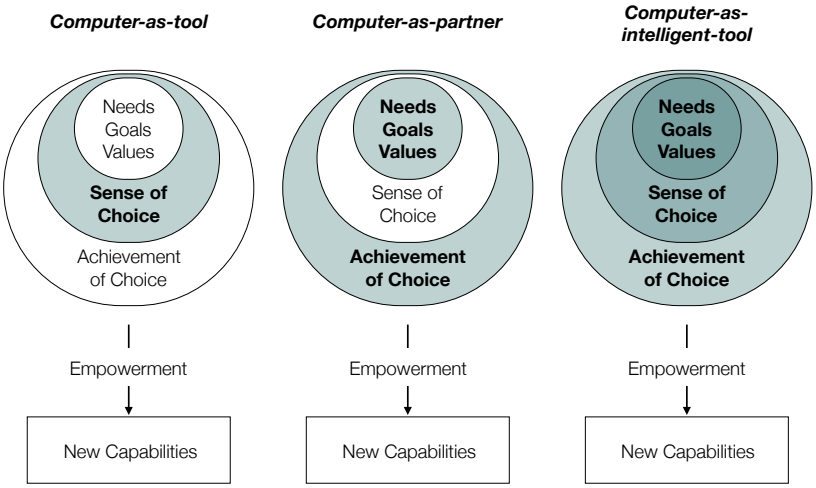


Figure 3.1: A comparison of the model components (highlighted in blue/gray) on which technologies in the three paradigms *computer-as-tool*, *computer-as-partner*, and *computer-as-intelligent-tool* focus. The underlying model is based on Sen and Nussbaum's [57, 84] CA and has been introduced in Section 1.1.

[P4-P6], and *computer-as-intelligent-tool* in green). It shows, for example, that studies in the *computer-as-tool* and *computer-as-partner* paradigm were based on an understanding of power as an extensible resource, while studies in the *computer-as-intelligent-tool* paradigm understood power as negotiable between human and system. For example the PCEHR in P2 (*computer-as-tool*) focused on helping patient families to better understand and manage their health (extending their power, *power-to*) instead of moving the decision power from doctors to patients (*power-over*). The latter, designing a system to facilitate the negotiation of decision power in treatments is also thinkable but was not in focus of the technology developed. In contrast, studies in the *computer-as-intelligent-tool* paradigm investigated if intelligent, personalized systems take decision power away from users by determining the supposedly most beneficial option for them. Hence, they focus on the negotiation of power between system and user (*power-over*). Technologies in *computer-as-tool* and *computer-as-intelligent-tool* focused on helping users extend their knowledge and understanding (*knowing*). For example, the PCEHR allowed users to access and scrutinize their personal health data and the transparently designed fitness coach allowed users to scrutinize the rational behind workout recommendations. In contrast, technologies in *computer-as-partner* (most notably the personalized fitness coach without transparency) focused on acknowledging users' individual needs (*feeling*) and helping them to achieve their goals (*doing*). With respect to PERSISTENCE OF EMPOWERMENT, only the study on learning with physical activity trackers [74] focused explicitly on *persistent* empowerment, while all others focused on *transient* or neither. Finally, a few studies focused on a *participatory* mindset, while most studies tested and explored hypotheses derived from the literature (*expert*). The complete coding of case studies (that Figure 3.2 is based on) is available in the appendix A. This analysis of studies through the lens of this framework provides an overview of aspects of empowerment well

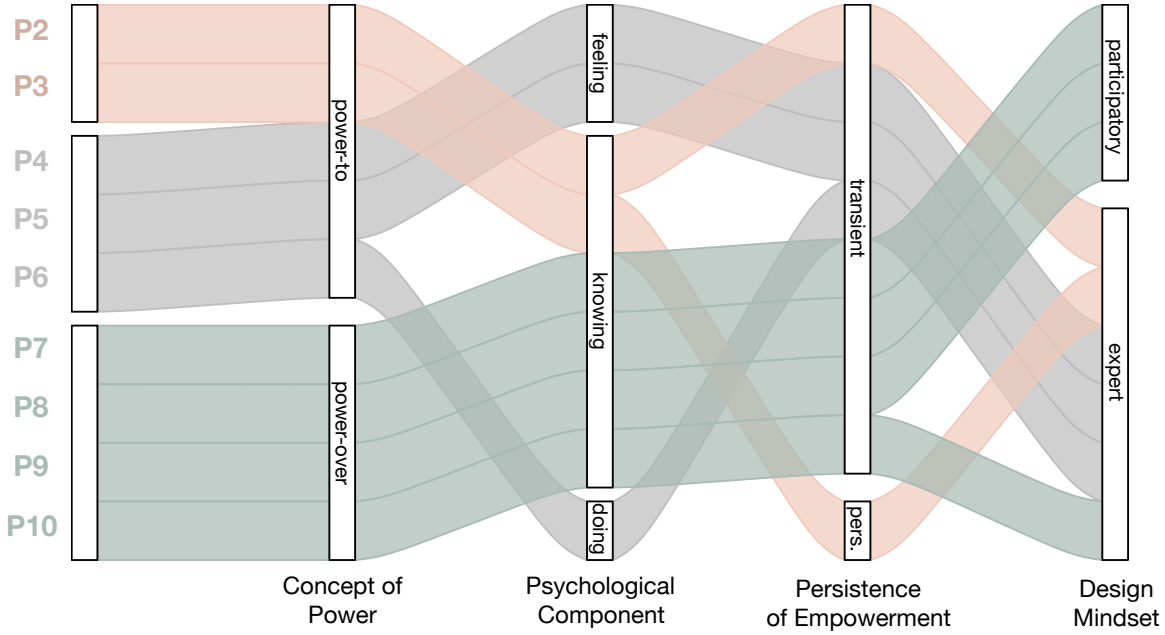


Figure 3.2: Alluvial diagram visualizes projects in this thesis coded through the framework of empowering technologies. Projects in the *computer-as-tool* paradigm are coded in light red [P2-P3], projects in the *computer-as-partner* paradigm are coded in gray [P4-P6], and projects in the *computer-as-intelligent-tool* paradigm are coded in green.

explored in this thesis and helped to identify promising directions for future work, presented in the sections below.

First, future research needs to explore the advantages and disadvantages of the two concepts of power (*power-to* and *power-over*). Depending on which perspective is chosen, the same technology might be regarded as empowering or disempowering. For example, persuasive, personalized health coaches (as in [75, 81]), might be regarded as empowering as they enable users to reach their health and wellbeing goals more easily (*power-to*) or as disempowering as they deteriorate users' self-determination (*power-over*). On the one hand, a potential disadvantage of focusing on *power-over* is that it might lead to designs that aim to take power away from people, communities, or organizations without proper understanding of the other party's needs and concerns [30]. On the other hand, a potential disadvantage of *power-to* is that it might fail to recognize if technology takes away power from users (e.g., if it hides information from users). To avoid both effects, it is important to clearly define power and empowerment in the given context and to analyze how this power is increased or negotiated between all actors involved including the technological system.

Second, future research needs to explore compatibility of empowerment in the three psychological components (*feeling*, *knowing*, and *doing*). The case studies on empowering HWTs in this thesis showed that these three components of empowerment can indeed be conflicting: For example, providing users with personal health data will likely increase their awareness

of their current health status (empowerment in respect to *knowing*). However, this awareness can, in turn, increase their feelings of frustration and anxiety (disempowerment in respect to *feeling*) [79]. Within the concept of empowerment in this thesis, it was assumed that negative feelings (e.g., frustration and anxiety) contradict empowerment. However, while this assumption seems reasonable in many cases, the costs of negative feelings might be outweighed by benefits in respect to *knowing* and *doing* in other cases. In such situations designers might want to accept that technology causes uncomfortable feelings or intentionally design for them. A notable example of such a design principle is frictional feedback that has been introduced by Laschke et al. [45]. Frictional feedback intentionally disturbs or confronts users during routine tasks to prompt reflection. For example Keymoment [45] drops the users' bike keys when he/she is about to grasp the car key. However, deciding in which cases it is acceptable to cause negative feelings and weighing benefits and costs is challenging as discussed by Diefenbach et al. [18] and future research is necessary to develop appropriate metrics and practices.

Third, future research needs to explore and evaluate the persistence of empowerment. As visualized in Figure 3.2, we expected empowerment to be *transient* in most case studies. A disadvantage of all HWTs that focus on *transient* empowerment is the potential dependency that they foster: Once the technology is taken away or broken users are potentially even more disempowered than they were before using the technology in the first place as they might have forgotten or "unlearned" how to manage a situation without the technology [11]. Take for example navigation software e.g., Google Maps: While people had used skillful, analogue ways to navigate for hundreds of years (e.g., with compass, maps, or remembering important landmarks), the pervasiveness of smartphones and navigation applications like Google Maps renders such skills unnecessary so that people's analogue navigation skills slowly vanish. Similarly, if people rely on technology to tell them how healthy/unhealthy they have been today, they might loose their natural sensitivity and trust in their bodily signals regulated by sophisticated biological systems. To further explore the persistence of empowerment it is crucial to define and operationalize empowerment and to measure it before, during and after system use. One of the presented studies, for example aimed to measure increased ability to self-assess physical activity through the use of activity trackers and measured this self-assessment with experience sampling before, during and after system use [74]. Due to the low number of devices and participants this study did not lead to conclusive results. However, future work might extend this approach and explore ways to measure persistence of empowerment. This might be even more complex for technologies in the *computer-as-partner* paradigm. Using adaptive/intelligent HWTs will hopefully lead to changes in users' behaviors, which would in turn lead to changes in the adaptive HWT. If users will learn in this process or loose their ability and skills is an important topic for future research. In this thesis the approach taken to foster an improved understanding of the content of the recommendation and the technology is transparent system design (as implemented in *computer-as-intelligent-tool*). However, systematically investigating the persistence of transparent systems over the short-, mid-, and long-term is again a topic for future research. Finally, future research might explore different forms of *persistent* empowerment, e.g., self-

knowledge and bodily awareness (empowerment in respect to *knowing*) or fostering skills and habit formation as in [88, 89] (empowerment in respect to *doing*).

3.3 Methods for Designing and Evaluating Empowering Technologies

The third objective of this thesis was to investigate methods to (a) design and (b) evaluate empowering technologies. To answer RQ3a, e.g., to explore methods that can inform the design of empowering technologies, a spectrum of methods has been applied in the different projects of this thesis. These methods address the four aspects of the model for designing empowering technologies derived from the CA, as depicted in Figure 3.3:

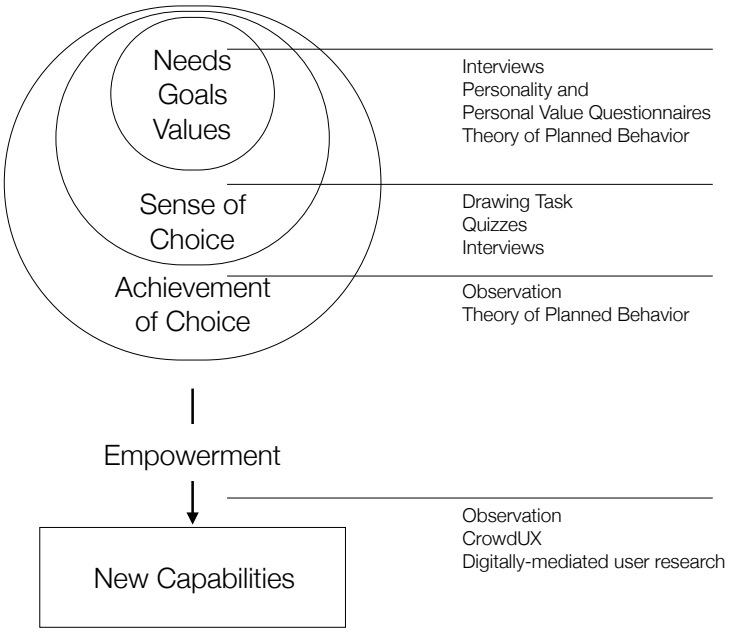


Figure 3.3: The different methods used in this thesis for designing and evaluating empowering technologies mapped to the model introduced earlier.

(1) For new capabilities to be empowering they need to origin from individuals' needs, goals, and values. Several studies of mine investigated how technology can accommodate users' individual needs and values (e.g., **in-depth interviews** in P2) and adapt to individual differences (e.g., **personality** and **personal value questionnaires** in P3 and P4). In P3 I used a combination of the **Theory of Planned Behavior** and the **Portrait Value Questionnaire** to understand how personal values and contextual factors influence users' motivation and personal needs. This combination of methods proved highly potent to derive theoretically-informed personalization mechanisms (similar to the theoretically-informed personalization of computer games presented by Orji et al. [62]). Because the Theory of Planned Behavior

comes with a recipe explaining how to elicit beliefs that influence motivation of a specific user group in a specific context, it combines the advantages of open-ended data collection methods (such as interviews) with the rigor of structured questionnaires. Personal value questionnaires and personality questionnaires have been selected as they are established psychological instruments backed up by an array of research studies. However, a disadvantage of these instruments is that they introduce complexity, e.g., the **Big Five Personality questionnaire**, that we used in P4, defines five main dimensions and 27 subdimensions. Each design aspect of a system (e.g., the motivational strategy as in P3 or the data visualization as in P4) could be adapted to one or multiple dimensions of personality, leading to a wide array of personalization options as discussed in P5. Few of the resulting personalization options will lead to significant improvements in the user experience or the efficiency of the system. Hence, determining the most fruitful personalization option is critical. P5 suggests a systematic process to do so. In summary, applying these methods to understand users' needs, goals, and values helped me to determine how empowerment would look like for a specific user group. While I would recommend other researchers to start designing for empowerment with techniques to understand the user groups' needs, goals, and values, the range of suitable methods is not limited to the ones listed here.

(2) The second set of methods aimed to understand users' sense of choice when interacting with technology. In my studies, I focused on sense of choice in respect to users' health and wellbeing decisions (which food, exercise or treatment choices are available, suitable or beneficial) and their interaction with technologies (which benefits does the technology offer, what do I agree to when using it?). The selected methods focused on eliciting users' understanding – so-called mental models – of a systems' functioning and included a **Drawing Task** – in P7, P8, and P9 – in which users are asked to articulate their understanding of a technology with explanations and sketching and **Quizzes** in P7. These techniques have been triangulated with **Interviews** in P2, P7, P8, and P9. Main difficulties of these methods include adapting instructions and guidance to participants' language and terminology and avoiding that users feel tested or "stupid" because they are not experts in the domain of interest (e.g., health or technology use). In P7, results of these methods indicated that users overtrusted the supposedly intelligent coaching technology, missed transparency and wanted to understand the systems' inner working better – a phenomenon has been associated with other technologies in the *computer-as-partner* paradigm [33, 15]. Hence, we used a **Participatory Action Design Research** process to develop appropriate explanations in the user interface.

(3) Methods that have been applied to better understand contextual factors that support or hinder users in implementing valued choices included **observations**, e.g., in P2, and again the **Theory of Planned Behavior**. A main advantage of observations is that they can reveal influences and constraints that individuals themselves are not aware of or already used to. They are, however, time intensive and results are difficult to generalize. The Theory of Planned Behavior proofed to be especially valuable to understand contextual factors that influence individuals' conscious decisions – as understanding these behavioral structures is the main purpose of the theory. However, researchers need to be aware that applying the

theory thoroughly requires, first, to recruit a sample of 10-20 participants for interviews to elicit core beliefs of the user group, second, constructing a questionnaire based on these core beliefs, third, recruiting a big enough group of participants, and, fourth, analyzing results with a structural equation model.

Even though these are certainly not the only methods suitable to inform the design of empowering technologies this presents an initial set of methods – a toolbox that other research can choose from, build on, and extend. These methods have been selected based on the needs and constraints of the presented case studies. Hence, I invite future research to test the applicability of these methods in other research projects focusing on empowering technologies and to extend the presented toolbox as they see fit. If researchers decide to employ different methods than the ones employed in this thesis, the presented model of designing empowering technologies aims to offer guidance in the selection of methods: Designers and researchers may want to look for methods to understand individuals' needs, goals, and values; their awareness; and contextual influences, i.e. resources and constraints.

(4) RQ3b addresses the challenge to evaluate empowering technologies, which has been well acknowledged by many theorists on empowerment. To this end, we developed and evaluated two tools: **CrowdUX** a light-weight mobile tool that allows users to give contextualized UX feedback anytime and anywhere and a **digital platform** that is designed to foster an empathic relationship between designers and users (in the following called **EmpathyUX**). CrowdUX showed to collect more meaningful, richer user stories than traditional user studies and was easy to implement in constrained design projects, while EmpathyUX allowed designers to gain a lively picture of users' experiences via visualizations of personas, participants' journey and flexible filters to search through and explore feedback quickly and efficiently. Together these tools aim to establish trust and empathy between researchers and designers and to provide users full freedom and flexibility in the ways that they wish to express their experience with a technology. Both systems have, however, only been employed and tested in contained settings, namely a field study and a focus group. Here, future research is needed to test the usefulness of the proposed tools and methods for other real-world evaluation use cases. Both tools have been developed as proof of concept and, hence, focused on a very limited set of features. I therefore welcome work that aims to adapt, expand, and improve the interaction concepts of both tools. For example, the ways that empathic messages can be exchanged between designers and users to show best appreciation and to support trust might be enhanced with details about the context in which the message was written. Finally, evaluating the experience of individuals providing feedback has not received enough attention yet: Do users feel their input is valued; do they feel they contribute to a project that is worth their time? After all, empowering products will more likely result from a design process in which all stakeholders feel valued and empowered as well [23].

3.4 Closing Remarks

> *"We tend to discuss the principles of form and composition, the principles of aesthetics, the principles of usability, the principles of market economics and business operations, or the mechanical and technological principles that underpin products. In short, we are better able to discuss the principles of the various methods that are employed in design thinking than the first principles of design, the principles on which our work is ultimately grounded and justified. The evidence of this is the great difficulty we have in discussing the ethical and political implications of design."*
>
> (Buchanan, 2001)

To topic of this thesis – empowerment in technology design – fits to an emerging interest in values in design that is prevalent in both HCI research and practice. The text quoted[3] above by Buchanan [10] originally addressed the design community but similarly applied to HCI research up until recently [27]: HCI has traditionally focused on usability and the fit between humans and machines (so-called first wave HCI) and later on information flow optimization informed by cognitive theory (second wave HCI) [28]. However, recently, a third wave in HCI has emerged that puts explicit focus on meaning and "values in design" [32], such as agency, identity, empowerment, and social justice (see for example [5, 25, 27, 35]). Discussions on the values and first principles of design are now not only taking place in the academic community. Several people in the technology industry have started initiatives to draw attention to unethical technologies and design practices. For example, Harry Brignull coined the term "dark patterns" to spread awareness of "tricks used in websites and apps that make you buy or sign up for things that you didn't mean to". The term has recently also been taken up by researchers [27]. On a similar note, Tristan Harris, formally ethicist at Google, founded the "time well spent" movement[4]. Its aim is to spread awareness of "screens [that] threaten our fundamental agency. Maybe we are "choosing," but we are choosing from persuasive menus driven by companies who have different goals than ours"[5]. As alternative solution, Harris envisions empowering technologies: "Imagine a digital *bill of rights* outlining design standards that forced the products that billions of people used to support empowering ways to navigate towards their goals". But how exactly would these empowering technologies look like? This thesis explored this question with a focus on the domain of health and wellbeing technologies.

At first sight, it seems as the recommendations, which HWTs offer, are well aligned with our own goals and values – surely most people want to live their lives as healthy and happily as possible. However, scholars such as Deborah Lupton have also raised doubts about

[3] This quote was previously used by Oosterlaken [58] to discuss the usefullness of the CA for technology design.

[4] http://timewellspent.io

[5] http://www.tristanharris.com/essays/

this alignment: She argues that optimizing certain measurable health metrics (e.g., steps, nutrients, cigarettes, alcohol, or sugar consumption) disregards non-measurable human experiences such as pain and dizziness or joy, relaxation and fun [50]). Veinot [92] argues that nudging users towards one supposedly right behavior is limiting freedom and choice instead of maximizing it. And the historian Harari [29] sketches out the end of humans' free will, which is replaced by algorithmic calculations of the most beneficial choices. However, he acknowledges that this dystopian vision is only one possibility and it is up to the technology designers and developers of our times to steer in which direction we are heading. In this thesis, I discussed several directions described as *computer-as-tool*, *computer-as-partner*, and *computer-as-intelligent-tool* and argue that transparent design of intelligent HWTs allow the interested user to scrutinize the system's rational and to make an informed decision. While the presented case studies focus on HWTs, several tools I presented might be useful beyond this application domain: The framework of empowering technologies [P1] and the model of designing for empowerment (see Figure 1.1) can help researchers to define their understanding of empowerment and their strategies to design for it, while the presented evaluation tools might help to understand users' perspectives on empowering technologies. I hope that these contributions serve other researchers as inspiration and design resources. Moreover, I hope that they will contribute to a more grounded understanding and a clear research agenda on empowering technologies in HCI. After all, in light of Harari's [29] dystopian vision, it seems that more research and initiatives advancing empowering technology design are urgently needed.

LIST OF FIGURES

LIST OF TABLES

BIBLIOGRAPHY

[1] Allen, A. (2016). Feminist Perspectives on Power. In Zalta, E. N., editor, *The Stanford Encyclopedia of Philosophy*. Metaphysics Research Lab, Stanford University, fall 2016 edition. https://plato.stanford.edu/archives/fall2016/entries/feminist-power/.

[2] Alsop, R. and Heinsohn, N. (2005). Measuring empowerment in practice: Structuring analysis and framing indicators. In *Policy Research Working Paper*, volume 3510. World Bank Publications, Washington, DC, USA. https://openknowledge.worldbank.org/handle/10986/8856.

[3] Ammari, T. and Schoenebeck, S. (2015). Networked Empowerment on Facebook Groups for Parents of Children with Special Needs. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 2805–2814, New York, NY, USA. ACM, doi:10.1145/2702123.2702324.

[4] Auerbach, S. M. (2000). Should patients have control over their own health care?: Empirical evidence and research issues. *Annals of Behavioral Medicine*, 22(3):246–259, doi:10.1007/BF02895120.

[5] Bardzell, S. (2010). Feminist HCI: Taking Stock and Outlining an Agenda for Design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '10, pages 1301–1310, New York, NY, USA. ACM, doi:10.1145/1753326.1753521.

[6] Beaudouin-Lafon, M. (2004). Designing Interaction, Not Interfaces. In *Proceedings of the Working Conference on Advanced Visual Interfaces*, AVI '04, pages 15–22, New York, NY, USA. ACM, doi:10.1145/989863.989865.

[7] Bentley, F., Tollmar, K., Stephenson, P., Levy, L., Jones, B., Robertson, S., Price, E., Catrambone, R., and Wilson, J. (2013). Health Mashups: Presenting Statistical Patterns Between Wellbeing Data and Context in Natural Language to Promote Behavior Change. *ACM Trans. Comput.-Hum. Interact.*, 20(5):30:1–30:27, doi:10.1145/2503823.

[8] Bickmore, T. W., Pfeifer, L. M., and Jack, B. W. (2009). Taking the Time to Care: Empowering Low Health Literacy Hospital Patients with Virtual Nurse Agents. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '09, pages 1265–1274, New York, NY, USA. ACM, doi:10.1145/1518701.1518891.

[9] Blandford, A., Adams, A., Attfield, S., Buchanan, G., Gow, J., Makri, S., Rimmer, J., and Warwick, C. (2008). The PRET A Rapporter framework: Evaluating digital libraries from

the perspective of information work. *Information Processing & Management*, 44(1):4 – 21, doi:10.1016/j.ipm.2007.01.021.

[10] Buchanan, R. (2001). Human Dignity and Human Rights: Thoughts on the Principles of Human-Centered Design. *Design Issues*, 17(3):35–39, doi:10.1162/074793601750357178.

[11] Carr, N. (2017). Closing Keynote: Computers, Automation and the Human Future. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, CHI EA '17, pages 4–4, New York, NY, USA. ACM, doi:10.1145/3027063.3056456.

[12] Clawson, J., Pater, J. A., Miller, A. D., Mynatt, E. D., and Mamykina, L. (2015). No Longer Wearing: Investigating the Abandonment of Personal Health-tracking Technologies on Craigslist. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, UbiComp '15, pages 647–658, New York, NY, USA. ACM, doi:10.1145/2750858.2807554.

[13] Consolvo, S., Klasnja, P., McDonald, D. W., and Landay, J. A. (2014). Designing for Healthy Lifestyles: Design Considerations for Mobile Technologies to Encourage Consumer Health and Wellness. *Foundations and Trends in Human-Computer Interaction*, 6(34):167–315, doi:10.1561/1100000040.

[14] Craven, M. P., Selvarajah, K., Miles, R., Schnädelbach, H., Massey, A., Vedhara, K., Raine-Fenning, N., and Crowe, J. (2013). User Requirements for the Development of Smartphone Self-reporting Applications in Healthcare. In Kurosu, M., editor, *Human-Computer Interaction. Applications and Services*, pages 36–45, Berlin, Heidelberg. Springer Berlin Heidelberg, doi:10.1007/978-3-642-39262-7_5.

[15] Davis, J. (2009). Design Methods for Ethical Persuasive Computing. In *Proceedings of the 4th International Conference on Persuasive Technology*, Persuasive '09, pages 6:1–6:8, New York, NY, USA. ACM, doi:10.1145/1541948.1541957.

[16] Deadman, J., Leinster, S., Owens, R., Dewey, M., and Slade, P. (2001). Taking responsibility for cancer treatment. *Social Science and Medicine*, 53(5):669 – 677, doi:10.1016/S0277-9536(00)00369-5.

[17] Dertouzos, M. L. (1990). Redefining Tomorrow's User Interface (Plenary Address). In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '90, pages 1–, New York, NY, USA. ACM, doi:10.1145/97243.97244.

[18] Diefenbach, S., Kapsner, A., Laschke, M., Niess, J., and Ullrich, D. (2016). Technology for Behavior Change–Potential, Challenges, and Ethical Questions. *Journal of Interactive Media*, pages 195–201, doi:10.1515/icom-2016-0025.

[19] Eiband, M., Schneider, H., Bilandzic, M., Fazekas-Con, J., Haug, M., and Hussmann, H. (2018a). Bringing Transparency Design into Practice. In *23rd International Conference on Intelligent User Interfaces*, IUI '18, pages 211–223, New York, NY, USA. ACM, doi:10.1145/3172944.3172961.

[20] Eiband, M., Schneider, H., and Buschek, D. (2018b). Normative vs Pragmatic: Two Perspectives on the Design of Explanations in Intelligent Systems. http://explainablesystems.comp.nus.edu.sg/wp-content/uploads/2018/02/exss_7_eiband.pdf.

[21] Epstein, D. A., Caraway, M., Johnston, C., Ping, A., Fogarty, J., and Munson, S. A. (2016). Beyond Abandonment to Next Steps: Understanding and Designing for Life After Personal Informatics Tool Use. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, CHI '16, pages 1109–1113, New York, NY, USA. ACM, doi:10.1145/2858036.2858045.

[22] Erete, S. and Burrell, J. O. (2017). Empowered Participation: How Citizens Use Technology in Local Governance. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, CHI '17, pages 2307–2319, New York, NY, USA. ACM, doi:10.1145/3025453.3025996.

[23] Ertner, M., Kragelund, A. M., and Malmborg, L. (2010). Five Enunciations of Empowerment in Participatory Design. In *Proceedings of the 11th Biennial Participatory Design Conference*, PDC '10, pages 191–194, New York, NY, USA. ACM, doi:10.1145/1900441.1900475.

[24] Flicker, L. (1999). Dementia Reconsidered: the Person Comes First. *BMJ*, 318(7187):880, doi:10.1136/bmj.318.7187.880a.

[25] Friedman, B., Kahn, P., and Borning, A. (2002). Value sensitive design: Theory and methods.

[26] Goecks, J., Edwards, W. K., and Mynatt, E. D. (2009). Challenges in Supporting End-user Privacy and Security Management with Social Navigation. In *Proceedings of the 5th Symposium on Usable Privacy and Security*, SOUPS '09, pages 5:1–5:12, New York, NY, USA. ACM, doi:10.1145/1572532.1572539.

[27] Gray, C. M., Kou, Y., Battles, B., Hoggatt, J., and Toombs, A. L. (2018). The Dark (Patterns) Side of UX Design. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 472–483, New York, NY, USA. ACM, doi:10.1145/3173574.3174108.

[28] Grudin, J. (2005). Three faces of human-computer interaction. *IEEE Annals of the History of Computing*, 27(4):46–62, doi:10.1109/MAHC.2005.67.

[29] Harari, Y. N. (2016). *Homo Deus: A brief history of tomorrow*. Random House.

[30] Harding, M., Knowles, B., Davies, N., and Rouncefield, M. (2015). HCI, Civic Engagement & Trust. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 2833–2842, New York, NY, USA. ACM, doi:10.1145/2702123.2702255.

[31] Hardy, C. and Leiba-O'Sullivan, S. (1998). The Power Behind Empowerment: Implications for Research and Practice. *Human Relations*, 51(4):451–483, doi:10.1177/001872679805100402.

[32] Harrison, S., Sengers, P., and Tatar, D. (2011). Making epistemological trouble: Third-paradigm HCI as successor science. *Interacting with Computers*, 23(5):385–392, doi:10.1016/j.intcom.2011.03.005.

[33] Hoffman, R. R., Johnson, M., Bradshaw, J. M., and Underbrink, A. (2013). Trust in Automation. *IEEE Intelligent Systems*, 28(1):84–88, doi:10.1109/MIS.2013.24.

[34] Hoßfeld, T., Keimel, C., Hirth, M., Gardlo, B., Habigt, J., Diepold, K., and Tran-Gia, P. (2014). Best practices for QoE crowdtesting: QoE assessment with crowdsourcing. *IEEE Transactions on Multimedia*, 16(2):541–558, doi:10.1109/TMM.2013.2291663.

[35] Iivari, N. and Kuutti, K. (2017). Critical Design Research and Information Technology: Searching for Empowering Design. In *Proceedings of the 2017 Conference on Designing Interactive Systems*, DIS '17, pages 983–993, New York, NY, USA. ACM, doi:10.1145/3064663.3064747.

[36] Jameson, A., Berendt, B., Gabrielli, S., Cena, F., Gena, C., Vernero, F., and Reinecke, K. (2014). Choice Architecture for Human-Computer Interaction. *Foundations and Trends in Human-Computer Interaction*, 7(12):1–235, doi:10.1561/1100000028.

[37] Johnstone, J. (2007). Technology as empowerment: a capability approach to computer ethics. *Ethics and Information Technology*, 9(1):73–87, doi:10.1007/s10676-006-9127-x.

[38] Kittur, A., Chi, E. H., and Suh, B. (2008). Crowdsourcing User Studies with Mechanical Turk. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '08, pages 453–456, New York, NY, USA. ACM, doi:10.1145/1357054.1357127.

[39] Klasnja, P., Consolvo, S., and Pratt, W. (2011). How to Evaluate Technologies for Health Behavior Change in HCI Research. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '11, pages 3063–3072, New York, NY, USA. ACM, doi:10.1145/1978942.1979396.

[40] Klasnja, P. and Pratt, W. (2012). Healthcare in the pocket: Mapping the space of mobile-phone health interventions. *Journal of Biomedical Informatics*, 45(1):184 – 198, doi:10.1016/j.jbi.2011.08.017.

[41] Kleine, D. (2009). ICT4What? - using the Choice Framework to operationalise the capability approach to development. In *2009 International Conference on Information and Communication Technologies and Development (ICTD)*, pages 108–117. doi:10.1109/ICTD.2009.5426717.

[42] Kobsa, A., Knijnenburg, B. P., and Livshits, B. (2014). Let's Do It at My Place Instead?: Attitudinal and Behavioral Study of Privacy in Client-side Personalization. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '14, pages 81–90, New York, NY, USA. ACM, doi:10.1145/2556288.2557102.

[43] Lachner, F., Schneider, H., Simon, L., and Butz, A. (2018). Nurturing Empathy between UX Design Teams and Users in Digitally-Mediated User Research. In *10th Nordic Conference on Human-Computer Interaction*. doi:10.1145/3240167.3240182.

[44] Ladner, R. E. (2008). Access and Empowerment: Commentary on "Computers and People with Disabilities". *ACM Trans. Access. Comput.*, 1(2):11:1–11:5, doi:10.1145/1408760.1408765.

[45] Laschke, M., Diefenbach, S., and Hassenzahl, M. (2015). "Annoying, but in a nice way": An inquiry into the experience of frictional feedback. *International Journal of Design*, 9(2):129–140. Available: `http://www.ijdesign.org/index.php/IJDesign/article/view/2099`.

[46] Lazar, A., Cornejo, R., Edasis, C., and Piper, A. M. (2016a). Designing for the Third Hand: Empowering Older Adults with Cognitive Impairment Through Creating and Sharing. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, DIS '16, pages 1047–1058, New York, NY, USA. ACM, doi:10.1145/2901790.2901854.

[47] Lazar, A., Edasis, C., and Piper, A. (2016b). Technology to Empower or Disempower: Design Tensions Within the Context of Art Therapy. *The Gerontologist*, 56:660, doi:10.1093/geront/gnw162.2683.

[48] Lee, V. R. and Drake, J. (2013). Digital Physical Activity Data Collection and Use by Endurance Runners and Distance Cyclists. *Technology, Knowledge and Learning*, 18(1):39–63, doi:10.1007/s10758-013-9203-3.

[49] Lupton, D. (2013). Quantifying the body: monitoring and measuring health in the age of mHealth technologies. *Critical Public Health*, 23(4):393–403, doi:10.1080/09581596.2013.794931.

[50] Lupton, D. (2014). Self-tracking Cultures: Towards a Sociology of Personal Informatics. In *Proceedings of the 26th Australian Computer-Human Interaction Conference on Designing Futures: The Future of Design*, OzCHI '14, pages 77–86, New York, NY, USA. ACM, doi:10.1145/2686612.2686623.

[51] Mann, S. (1998). Wearable computing as means for personal empowerment. Keynote Address for *The First International Conference on Wearable Computing*, ICWC'98, Available: `http://www.eyetap.org/wearcam/icwc98/keynote.html`.

[52] Mattelmäki, T. and Battarbee, K. (2002). Empathy probes. In J.Gregory and I.Wagner, editors, *Proceedings of the 2nd Biennial Participatory Design Conference*, PDC '2, pages 266–271. Available: `http://ojs.ruc.dk/index.php/pdc/article/view/265/257`.

[53] McNaney, R., Balaam, M., Holden, A., Schofield, G., Jackson, D., Webster, M., Galna, B., Barry, G., Rochester, L., and Olivier, P. (2015). Designing for and with People with Parkinson's: A Focus on Exergaming. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 501–510, New York, NY, USA. ACM, doi:10.1145/2702123.2702310.

[54] Mellis, D. A. and Buechley, L. (2014). Do-it-yourself Cellphones: An Investigation into the Possibilities and Limits of High-tech Diy. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '14, pages 1723–1732, New York, NY, USA. ACM, doi:10.1145/2556288.2557309.

[55] Meschtscherjakov, A., Wilfinger, D., and Tscheligi, M. (2014). Mobile Attachment Causes and Consequences for Emotional Bonding with Mobile Phones. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '14, pages 2317–2326, New York, NY, USA. ACM, doi:10.1145/2556288.2557295.

[56] Mulligan, D. K. and Bamberger, K. A. (2013). What Regulators Can Do to Advance Privacy Through Design. *Commun. ACM*, 56(11):20–22, doi:10.1145/2527185.

[57] Nussbaum, M. (2001). *Women and human development: The capabilities approach*, volume 3. Cambridge University Press.

[58] Oosterlaken, E. T. (2013). *Taking a capability approach to technology and its design: A philosophical exploration*. PhD thesis, Delft University of Technology (TU Delft), Delft, The Netherlands.

[59] Oosterlaken, I. (2009). Design for Development: A Capability Approach. *Design Issues*, 25(4):91–102, doi:10.1162/desi.2009.25.4.91.

[60] Oosterlaken, I. (2012). The Capability Approach, Technology and Design: Taking Stock and Looking Ahead. In Oosterlaken, I. and van den Hoven, J., editors, *The Capability Approach, Technology and Design*, pages 3–26. Springer Netherlands, Dordrecht, doi:10.1007/978-94-007-3879-9_1.

[61] Orji, R., Mandryk, R. L., and Vassileva, J. (2017). Improving the Efficacy of Games for Change Using Personalization Models. *ACM Trans. Comput.-Hum. Interact.*, 24(5):32:1–32:22, doi:10.1145/3119929.

[62] Orji, R., Mandryk, R. L., Vassileva, J., and Gerling, K. M. (2013). Tailoring Persuasive Health Games to Gamer Type. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '13, pages 2467–2476, New York, NY, USA. ACM, doi:10.1145/2470654.2481341.

[63] Orji, R., Vassileva, J., and Mandryk, R. L. (2014). Modeling the efficacy of persuasive strategies for different gamer types in serious games for health. *User Modeling and User-Adapted Interaction*, 24(5):453–498, doi:10.1007/s11257-014-9149-8.

[64] Patil, S., Page, X., and Kobsa, A. (2011). With a Little Help from My Friends: Can Social Navigation Inform Interpersonal Privacy Preferences? In *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work*, CSCW '11, pages 391–394, New York, NY, USA. ACM, doi:10.1145/1958824.1958885.

[65] Pielot, M., Dingler, T., Pedro, J. S., and Oliver, N. (2015). When Attention is Not Scarce - Detecting Boredom from Mobile Phone Usage. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, UbiComp '15, pages 825–836, New York, NY, USA. ACM, doi:10.1145/2750858.2804252.

[66] Rabbi, M., Aung, M. H., Zhang, M., and Choudhury, T. (2015). MyBehavior: Automatic Personalized Health Feedback from User Behaviors and Preferences Using Smartphones. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, UbiComp '15, pages 707–718, New York, NY, USA. ACM, doi:10.1145/2750858.2805840.

[67] Rajanen, M. and Iivari, N. (2015). Power, Empowerment and Open Source Usability. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 3413–3422, New York, NY, USA. ACM, doi:10.1145/2702123.2702441.

[68] Rogers, Y. and Marsden, G. (2013). Does He Take Sugar?: Moving Beyond the Rhetoric of Compassion. *interactions*, 20(4):48–57, doi:10.1145/2486227.2486238.

[69] Roto, V., Väätäjä, H., Jumisko-Pyykkö, S., and Väänänen-Vainio-Mattila, K. (2011). Best Practices for Capturing Context in User Experience Studies in the Wild. In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, MindTrek '11, pages 91–98, New York, NY, USA. ACM, doi:10.1145/2181037.2181054.

[70] Roulstone, A. (1998). *Enabling Technology: Disabled People, Work and New Technology*. Taylor & Francis, Inc., Bristol, PA, USA, 1st edition.

[71] Samoocha, D., Bruinvels, J. D., Elbers, A. N., Anema, R. J., and van der Beek, J. A. (2010). Effectiveness of Web-based Interventions on Patient Empowerment: A Systematic Review and Meta-analysis. *J Med Internet Res*, 12(2):e23, doi:10.2196/jmir.1286.

[72] Sanders, L. (2008). On Modeling: An Evolving Map of Design Practice and Design Research. *interactions*, 15(6):13–17, doi:10.1145/1409040.1409043.

[73] Schneider, H. (2016a). LOL: Levels of Learning Through Personal Informatics. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct*, UbiComp '16, pages 510–515, New York, NY, USA. ACM, doi:10.1145/2968219.2968313.

[74] Schneider, H. (2016b). Self-knowledge Through Numbers and the Operationalization of Learning. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct*, UbiComp '16, pages 189–192, New York, NY, USA. ACM, doi:10.1145/2968219.2971402.

[75] Schneider, H. (2017). Adapting at Run-time: Exploring the Design Space of Personalized Fitness Coaches. In *Proceedings of the 22nd International Conference on Intelligent User Interfaces Companion*, IUI '17 Companion, pages 173–176, New York, NY, USA. ACM, doi:10.1145/3030024.3038280.

[76] Schneider, H., Eiband, M., Ullrich, D., and Butz, A. (2018a). Empowerment in HCI - A Survey and Framework. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 244:1–244:14, New York, NY, USA. ACM, doi:10.1145/3173574.3173818.

[77] Schneider, H., Frison, K., Wagner, J., and Butz, A. (2016a). CrowdUX: A Case for Using Widespread and Lightweight Tools in the Quest for UX. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, DIS '16, pages 415–426, New York, NY, USA. ACM, doi:10.1145/2901790.2901814.

[78] Schneider, H., George, C., Eiband, M., and Lachner, F. (2017a). *Investigating Perceptions of Personalization and Privacy in India*, pages 488–491. Springer International Publishing, Cham, doi:10.1007/978-3-319-68059-0_57.

[79] Schneider, H., Hill, S., and Blandford, A. (2016b). Patients Know Best: Qualitative Study on How Families Use Patient-Controlled Personal Health Records. *J Med Internet Res*, 18(2):e43, doi:10.2196/jmir.4652.

[80] Schneider, H., Lachner, F., Eiband, M., George, C., Shah, P., Parab, C., Kukreja, A., Hussmann, H., and Butz, A. (2018b). Privacy and Personalization: The Story of a Cross-cultural Field Study. *Interactions*, 25(3):52–55, doi:10.1145/3197571.

[81] Schneider, H., Moser, K., Butz, A., and Alt, F. (2016c). Understanding the Mechanics of Persuasive System Design: A Mixed-Method Theory-driven Analysis of Freeletics. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, CHI '16, pages 309–320, New York, NY, USA. ACM, doi:10.1145/2858036.2858290.

[82] Schneider, H., Schauer, K., Stachl, C., and Butz, A. (2017b). *Your Data, Your Vis: Personalizing Personal Data Visualizations*, pages 374–392. Springer International Publishing, Cham, doi:10.1007/978-3-319-67687-6_25.

[83] Sen, A. (1993). Capability and Well-Being. In *The Quality of Life*, chapter 1, pages 30–35. Clarendon Press, Oxford, doi:10.1093/0198287976.003.0005.

[84] Sen, A. (2001). *Development as freedom*. Oxford Paperbacks.

[85] Shneiderman, B. (1990). Human Values and the Future of Technology: A Declaration of Empowerment. *SIGCAS Comput. Soc.*, 20(3):1–6, doi:10.1145/97351.97360.

[86] Slezak, D. (2016). Exploratory Data Analysis and Visualization of a Large-Scale Fitness Data Set. Master's thesis, LMU Munich, Munich, Germany.

[87] Stanford, V. (2002). Pervasive health care applications face tough security challenges. *IEEE Pervasive Computing*, 1(2):8–12, doi:10.1109/MPRV.2002.1012332.

[88] Stawarz, K., Cox, A. L., and Blandford, A. (2014). Don't Forget Your Pill!: Designing Effective Medication Reminder Apps That Support Users' Daily Routines. In *Proceedings of the 32Nd Annual ACM Conference on Human Factors in Computing Systems*, CHI '14, pages 2269–2278, New York, NY, USA. ACM, doi:10.1145/2556288.2557079.

[89] Stawarz, K., Cox, A. L., and Blandford, A. (2015). Beyond Self-Tracking and Reminders: Designing Smartphone Apps That Support Habit Formation. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 2653–2662, New York, NY, USA. ACM, doi:10.1145/2702123.2702230.

[90] Storni, C. (2010). Multiple Forms of Appropriation in Self-Monitoring Technology: Reflections on the Role of Evaluation in Future Self-Care. *International Journal of Human–Computer Interaction*, 26(5):537–561, doi:10.1080/10447311003720001.

[91] Väänänen-Vainio-Mattila, K., Roto, V., and Hassenzahl, M. (2008). Towards practical user experience evaluation methods. *EL-C. Law, N. Bevan, G. Christou, M. Springett & M. Lárusdóttir (eds.) Meaningful Measures: Valid Useful User Experience Measurement (VUUM)*, pages 19–22.

[92] Veinot, T. (2010). *Power to the Patient? A Critical Examination of Patient Empowerment Discourses*, pages 30–41. Palgrave Macmillan UK, London, doi:10.1057/9780230292543_3.

[93] Vermeeren, A. P., Kort, J., Cremers, A., and Fokker, J. (2008). Comparing UX Measurements, a case study. In *Proceedings of the International Workshop on Meaningful Measures: Valid Useful Experience Measurement, Reykjavik, Iceland, June*, volume 18, pages 72–78.

[94] Vogler, B. (2016). Predicting Self-Control States Using Smartphone Usage Data. Master's thesis, LMU Munich, Munich, Germany.

[95] Wright, P. and McCarthy, J. (2008). Empathy and Experience in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '08, pages 637–646, New York, NY, USA. ACM, doi:10.1145/1357054.1357156.

[96] Zimmerman, M. A. (1995). Psychological empowerment: Issues and illustrations. *American Journal of Community Psychology*, 23(5):581–599, doi:10.1007/BF02506983.

Appendices

A
Coding of Case Studies

Below, I elaborate on the coding of case studies in this thesis that the alluvial diagram in Figure 3.2 is based on.

CONCEPT OF POWER: Case studies in the paradigms *computer-as-tool* (P2, P3) and *computer-as-partner* [P4, P5, P6] are based on an understanding of *power-to*. That means that power is regarded as an extensible resource. In contrast, in studies in the paradigm *computer-as-intelligent-tool* [P7, P8, P9, P10] power can be regarded as negotiated between user and system (similarly to the notion of empowerment described as "Protective Technology" in P1, system has *power-over*): Transparency is regarded as a means to allow users to understand and control the system to some extent. Systems that lack transparency and e.g., infringe users' privacy or show a selected subset of options (see [27]) to influence users' decisions, are regarded as disempowering.

PSYCHOLOGICAL COMPONENT: The two studies in the paradigm *computer-as-tool* focused on users' understanding of their own health (empowerment in respect to *knowing*) and refrained from an explicit investigation of the other two psychological components of empowerment (*feeling* and *doing*). In fact, P2 found that it is questionable and understudied if PCEHRs also result in users' *feeling* empowered and being able to better cope with daily health-related problems (*doing*). Studies in the *computer-as-partner* paradigm [P4, P5] investigated if personalized HWTs can accommodate users' individual needs better (*feeling*) and thus foster behavior change more effectively than non-personalized systems (*doing*). The results of P4 and P5 as well as related work [62, 63] support this hypothesis. On the negative side, personalized systems (as discussed above) can disempower in respect to *knowing* if personalization algorithms are opaque. Hence, studies in the *computer-as-intelligent-tool* paradigm, namely P7, P8, P9, and P10 investigated if transparency can mitigate this disempowerment (again focusing on *knowing*).

PERSISTENCE OF EMPOWERMENT: The PCEHR studied in P2 mainly empowers users during system use, e.g., when test results are provided, interpreted, and put into context of previous test results (*transient* empowerment). Even though users might acquire medical knowledge that will benefit them after system use this is regarded as side effect rather than the main purpose of the system. In contrary, P3 focused on *persistent* empowerment: The study investigated if the continuous provision of sensor data can help users to develop their unconscious awareness of their daily activities and their sensibility to bodily signals. In line with this hypothesis, it has been reported that people are able to figure how many calories they have burned after using a physical activity tracker for a while [21]. Such improved self-knowledge or awareness would lead to *persistent* empowerment as it is expected to benefit users even after they stopped wearing the sensors or using the technology. However, results of this study were not conclusive (qualitative findings indicated improved ability to self-assess physical activity but this was not reflected in quantitative measures). Personalized HWTs, as investigated in P4, P5, and P6, aim to help people make better decisions in a given situation and hence foster mainly *transient* empowerment. Studies in the paradigm *computer-as-intelligent-tool* [P7, P8, P9, P10] also focus on *transient* empowerment: the goal of transparency is to allow users to make more informed decisions during system use. If transparency in AI system leads to learning effects that last over time (*persistent*) is a question for future research.

DESIGN MINDSET: P2 and P3 were both based on an *expert* mindset. Self-management tools like the PCEHR largely build on assumptions prevalent in Western medicine, e.g. that a patient's being or feeling in control of a disease is beneficial for treatment and that self-management tools foster this being or feeling in control [4, 16]. The hypothesis of P3 (continuous sensor data can improve users' ability to self-assess their daily physical activity) has been derived from scientific findings and discussions with experts rather than a participatory design process. Similarly, personalization strategies in P4 and P5 have been derived from related work, reflecting again an *expert* mindset. Taking a *participatory* mindset to the design of personalization introduces several methodological challenges for future research. In P6, I therefore suggested to systematically explore the design space of personalization in a participatory manner with design tools such as the morphological box. Studies in the *computer-as-intelligent-tool* paradigm, namely P7, P8, and P9 were based on a *participatory* mindset, as understanding users' sense-making process when interacting with personalized systems is vital to design for transparency. P10 is a theoretical and hence *expert* mindset-based discussion of transparency in intelligent systems.

B

Original Publications

Table B.1 clarifies my own and others' contributions to the publications included in this thesis. After the table, links to the original papers are included in the presented order P1 - P12. Please refer to the published versions.

	My Contribution	Contributions of others
[P1]	I came up with the original research idea and strategy; Further, I collected the set of publications, read them in a first coding iteration and coded papers again systematically after framework categories had been defined; Further, I was the leading author of the resulting publication.	The framework emerged in discussions with my colleagues Malin Eiband and Daniel Ullrich; Malin Eiband helped to code papers according to the framework categories and contributed substantially the the resulting publication; Daniel Ullrich contributed a section on ethical maxims in the discussion; Andreas Butz supervised the project and edited the paper for clarity and readability
[P2]	I came up with the study design; lead the procedure to obtain ethical clearance; Collected and analyzed study data and was the leading author of the resulting publication.	The research idea emerged in discussions with Ann Blandford and Susan Hill. Ann Blandford supervised the data collection and analysis and contributed in several discussions to the final coding of the collected data as presented in the published paper as well as commented and edited the published paper.
[P3]	I came up with the original research idea and study design; I supervised the implementation of the data collection application and as well as the data collection and analysis; and I authored the resulting workshop publication.	Robert Müller implemented the application used for data collection, conducted the study, and analyzed the data in his BA thesis.
[P4]	I came up with original research idea together with Kilian Moser; I supervised the the pre-study and main study design and implementation; I analyzed the resulting data together with Kilian Moser and I was the leading author of the resulting publication.	The students Miriam Mayer and Alexandra Ronge conducted the pre-study and the main study. Kilian Moser contributed substantially to the resulting publication and Florian Alt and Andreas Butz edited and commented on earlier versions of the manuscript.
[P5]	I contributed idea and developed the study design in collaboration with Clemens Stachl and Katrin Schauer; I supervised the implementation of the prototype and the implementation of the study; I analyzed the resulting data and was the leading author of the resulting publication.	Katrin Schauer implemented the research prototype and conducted the study. Clemens Stachl contributed in various discussions to the study design, provided the personality test, and contributed to the resulting publication. Andreas Butz supervised the project and edited the paper for clarity and readability
[P6]	I authored this position paper.	
[P7]	I came up with the original research idea together with Mark Bilandzic; I supervised the development and implementation of the concept and prototype together with Malin Eiband; Malin Eiband and me contributed equally to the formalization of the design process presented in the paper; I contributed substantially to the resulting publication.	The students Mareike Haug and Julian Fazecas-Con designed and implemented the prototype; Mark Bilandzic, Peter Just, and Renato Pereira of the industry partner Freelectics contributed in numerous discussions and brainstormings with their domain knowledge and expertise; Malin Eiband supervised the development process and the study design (especially during my three-months research stay abroad) and was the leading author.
[P8]	I came up with the original research idea and was leading author of the proposal.	Ceenu George and Malin Eiband contributed in several discussions to the research strategy and to the proposal.
[P9]	I planned and conducted the field trip together with Florian Lachner; I was the leading author of the resulting publication.	Florian Lachner contributed significantly to the planning and implementation of the field trip; all field trip participants contributed to the data collection; all co-authors contributed to the publication with writing about their perspective on the field trip or their expertise.
[P10]	I developed the idea and the concept of this publication together with Malin Eiband and Daniel Buschek. Each of us contributed a section to the position paper.	
[P11]	I developed the original research idea and study design together with Julie Wagner and Katharina Frison; I supervised the implementation of the prototype and the planning and implementation of the study; I analyzed the collected data and was the leading author of the publication.	Julie Wagner and Katharina Frison contributed substantially to the initial concept and the study design; Katharina Frison implemented the prototype and conducted the study in her MA thesis. Juli Wagner helped editing and commented on earlier versions of the manuscript.
[P12]	I developed the idea together with Johannes Huber of the industry partner design affairs. I supervised the development of the prototype, the study planning and study implementation together with Florian Lachner; I contributed significantly to the publication.	Lisa Simon developed the prototype and conducted the study in her MA thesis. Florian Lachner supervised the study planning and study implementation (especially during my three-months research stay abroad) and was the leading author of the publication.

Table B.1: Overview of publications included in this thesis and clarification of contributions.

[P1] Schneider, H., Eiband, M., Ullrich, D., and Butz, A. (2018a). Empowerment in HCI - A Survey and Framework. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 244:1–244:14, New York, NY, USA. ACM, doi:10.1145/3173574.3173818

[P2] Schneider, H., Hill, S., and Blandford, A. (2016b). Patients Know Best: Qualitative Study on How Families Use Patient-Controlled Personal Health Records. *J Med Internet Res*, 18(2):e43, doi:10.2196/jmir.4652

[P3] Schneider, H. (2016a). LOL: Levels of Learning Through Personal Informatics. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct*, UbiComp '16, pages 510–515, New York, NY, USA. ACM, doi:10.1145/2968219.2968313

[P4] Schneider, H., Moser, K., Butz, A., and Alt, F. (2016c). Understanding the Mechanics of Persuasive System Design: A Mixed-Method Theory-driven Analysis of Freeletics. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, CHI '16, pages 309–320, New York, NY, USA. ACM, doi:10.1145/2858036.2858290

[P5] Schneider, H., Schauer, K., Stachl, C., and Butz, A. (2017b). *Your Data, Your Vis: Personalizing Personal Data Visualizations*, pages 374–392. Springer International Publishing, Cham, doi:10.1007/978-3-319-67687-6_25

[P6] Schneider, H. (2017). Adapting at Run-time: Exploring the Design Space of Personalized Fitness Coaches. In *Proceedings of the 22nd International Conference on Intelligent User Interfaces Companion*, IUI '17 Companion, pages 173–176, New York, NY, USA. ACM, doi:10.1145/3030024.3038280

[P7] Eiband, M., Schneider, H., Bilandzic, M., Fazekas-Con, J., Haug, M., and Hussmann, H. (2018a). Bringing Transparency Design into Practice. In *23rd International Conference on Intelligent User Interfaces*, IUI '18, pages 211–223, New York, NY, USA. ACM, doi:10.1145/3172944.3172961

[P8] Schneider, H., George, C., Eiband, M., and Lachner, F. (2017a). *Investigating Perceptions of Personalization and Privacy in India*, pages 488–491. Springer International Publishing, Cham, doi:10.1007/978-3-319-68059-0_57

[P9] Schneider, H., Lachner, F., Eiband, M., George, C., Shah, P., Parab, C., Kukreja, A., Hussmann, H., and Butz, A. (2018b). Privacy and Personalization: The Story of a Cross-cultural Field Study. *Interactions*, 25(3):52–55, doi:10.1145/3197571

[P10] Eiband, M., Schneider, H., and Buschek, D. (2018b). Normative vs Pragmatic: Two Perspectives on the Design of Explanations in Intelligent Systems. `http://explainablesystems.comp.nus.edu.sg/wp-content/uploads/2018/02/exss_7_eiband.pdf`

[P11] Schneider, H., Frison, K., Wagner, J., and Butz, A. (2016a). CrowdUX: A Case for Using Widespread and Lightweight Tools in the Quest for UX. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, DIS '16, pages 415–426, New York, NY, USA. ACM, doi:10.1145/2901790.2901814

[P12] Lachner, F., Schneider, H., Simon, L., and Butz, A. (2018). Nurturing Empathy between UX Design Teams and Users in Digitally-Mediated User Research. In *10th Nordic Conference on Human-Computer Interaction*. doi:10.1145/3240167.3240182

Eidesstattliche Versicherung

(Siehe Promotionsordnung vom 12.07.11, § 8, Abs. 2 Pkt. 5)

Hiermit erkläre ich an Eidesstatt, dass die Dissertation von mir selbstständig und ohne unerlaubte Beihilfe angefertigt wurde.

München, den 17. April 2018

Hanna Schneider