Consumer Health Information Technology

Motivation, Ability, and Opportunity in the Contexts of Older People and Fitness Tracking Technology

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Dedicated to my family.

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Robert Rockmann

Zusammenfassung (German Summary)

Der Erhalt und die Förderung von Gesundheit und Wohlbefinden der Gesellschaft gehört den erklärten Zielen der Vereinten Nationen (United Nations 2015). Der altersbezogene Strukturwandel, wandelnde Lebensstile, sowie zunehmender Bewegungsmangel stellen jedoch eine zunehmende Herausforderung für Individuen, Gesellschaft und Gesundheitssysteme dar (Gianchandani 2011). Zu Unterstützung von Gesundheit und Wohlbefinden wird der Consumer Health IT (engl. verbraucherorientierte Gesundheits-IT) – definiert als „Werkzeuge und Artefakte, die Informationssysteme nutzen, um eine Person bei der Bewältigung ihrer gesundheitlichen Bedürfnisse zu unterstützen“ (Agarwal et al. 2011, p. 59) – eine tragende Rolle beigemessen. Consumer Health IT soll dabei als „personalisierte Informationsquelle und Entscheidungshilfe zur Überwachung des Wohlbefindens, zur Krankheitsprävention und zur Versorgung für informierte und engagierte Verbraucher" (Demiris 2016, S. 46) dienen.

In der Forschung ist allerdings bislang wenig darüber bekannt, wie durch die Nutzung von Consumer Health IT gesundes Verhalten und Wohlbefinden tatsächlich unterstützt werden kann. Auch wenn erste Studien vielversprechende Wirkungen aufzeigen (z.B. Kelley et al. 2011; Yan and Tan 2014), so fehlt es bislang an einem ganzheitlichen Verständnis darüber, welche Faktoren zu einer effektiven Nutzung von Consumer Health IT beitragen. Entsprechend zielt diese Dissertation auf die Beantwortung der folgenden übergreifenden Forschungsfrage ab:

Wie kann Consumer Health IT gesundes Verhalten und Wohlbefinden unterstützen?

Zur Beantwortung dieser übergreifenden Frage analysiert die vorliegende Dissertation zunächst den Forschungsstand des Themengebiets Consumer Health IT und identifiziert drei übergreifende Komponenten, die zur Nutzung von Consumer Health IT und somit zur potenziellen Erreichung der Ziele beitragen: Motivation, Fähigkeit, und Opportunität. Die Komponente ‚Motivation‘ umfasst die gesundheitsbezogenen Bedürfnisse und Ziele des Nutzers. Die Komponente ‚Fähigkeit‘ umfasst die IT-bezogenen Fähigkeiten, wie beispielsweise Computer Selbstwirksamkeit, als auch die gesundheitsbezogenen Fähigkeiten, wie beispielsweise Gesundheitskompetenz, des Nutzers. Letztlich beschreibt die Komponente ‚Opportunität‘ die Art der IT und deren Funktionen und Features, die Möglichkeiten zur potentiellen Unterstützung von Gesundheit und Wohlbefinden bieten.

Um das Zusammenspiel dieser drei Komponenten und deren Auswirkungen auf gesundes Verhalten und Wohlbefinden besser zu verstehen, fokussiert die vorliegende Dissertation zwei Forschungskontexte mit hoher gesellschaftlicher Signifikanz und individuellen Herausforderung in Praxis und Forschung: 1) die alternde Gesellschaft und 2) Fitness Tracking Technologien.

Der Kontext der alternden Gesellschaft bezieht sich auf den immer größer werdenden Anteil von Menschen über 50 Jahre. Das Altern ist oft mit dem Auftreten chronischer Krankheiten assoziiert (Campbell 2008), was nicht nur eine Belastung für den alternden Menschen selbst, sondern auch eine Herausforderung für viele Gesundheitssysteme darstellt (Pew Research Center 2013; Statistisches Bundesamt 2017). Auch wenn Consumer Health IT Potenziale für diese Zielgruppe birgt, ist die aktuelle Literatur vom Bild geprägt, dass mangelnde IT-bezogene Fähigkeiten der älteren Menschen eine Barriere zur Nutzung darstellen. Um Ursachen und Konsequenzen der IT-bezogenen Fähigkeiten im Alter besser zu verstehen, zeigt die Dissertation dabei auf, dass der frühere Arbeitsplatz eine wichtige Quelle zur Aneignung dieser

Fähigkeiten darstellt und Menschen von diesen Erfahrungen auch im Ruhestand noch profitieren können. Ferner zeigen die Ergebnisse jedoch auch, dass IT-bezogene Fähigkeiten oftmals nur eine indirekte Rolle in der Nutzung von Consumer Health IT durch ältere Menschen spielen. So zeigen die Ergebnisse beispielsweise, dass die Nutzung von Online-Gesundheitsinformationen im Alter, wesentlich stärker durch die wahrgenommene Nützlichkeit von Consumer Health IT zur Unterstützung der eigenen Gesundheit und durch das explorative IT Verhalten – insbesondere im höheren Alter – der Zielgruppe determiniert ist. Beide Faktoren werden dabei von den Gesundheitsbedürfnissen und Gesundheitskompetenzen verstärkt. Die Ergebnisse dieses Kontextes tragen zu einem besseren Verständnis zur Nutzung von IT im Alter in der Forschung bei. So trägt der hier identifizierte Faktor „Früherer Arbeitsplatz“ zu den spezifischen Quellen der IT-bezogenen Selbstwirksamkeit im Alter bei und durch Analyse des tatsächlichen Nutzungsverhalten erweitert diese Dissertation den Forschungsstand um die Postadoptionsperspektive. Damit einhergehend erweitert diese Dissertation die Rolle des explorativen IT Verhaltens um kontextspezifische Determinanten und altersbezogene Moderatoren. Für Praxis und Politik implizieren die Ergebnisse, dass eine IT Nutzung bei älteren Menschen am Arbeitsplatz vor dem Ruhestand zum späteren Wohlbefinden beiträgt und somit zu fördern ist. Ferner sollten ältere Menschen in den Medien zum „Ausprobieren“ von IT angeregt werden.

Der Kontext der Fitness Tracking Technologien bezieht sich auf die unzureichende regelmäßige Bewegung der Menschen (WHO 2018). Fitness Tracking Technologien umfassen tragbare Geräte (Wearables wie z.B. Fitbit) oder Softwareanwendungen (z.B. Strava) und haben das Ziel Menschen zu mehr Bewegung zu motivieren. Auch wenn Fitness Tracking Technologien derzeit hohes öffentliches Interesse erzeugen (Statista 2018), so ist in der Forschung wenig über deren tatsächliche Wirksamkeit bekannt, insbesondere da Studien durchaus gemischte Auswirkungen auf Motivation und Bewegung festhalten (siehe z.B. Alahäivälä and Oinas-Kukkonen 2016; Koivisto and Hamari 2019). Diese Dissertation zeigt auf, dass die individuelle Motivation der Nutzer zu spezifischen Nutzungsmustern der Features (im Sinne von Opportunitäten wie z.B. Selbstüberwachung, Belohnung, Sozialer Vergleich) von Fitness Tracking Technologien führt und dass eine Passung zwischen individueller Motivation und genutzten Features zu einer höhen Wirksamkeit führen kann. Ferner zeigen die Ergebnisse den motivations-psychologischen Prozess auf, in dem die genutzten Features zur Unterstützung von Autonomie, Kompetenz, und Zugehörigkeit beitragen und so die antizipierte Wirksamkeit erzielen. Letztlich zeigt dieser Dissertation jedoch auch die „Schattenseiten“ von Fitness Tracking Technologien auf, bei den negativen Emotionen auftreten können oder Kompetenzbefriedigungen durch spezifische Features behindert werden können. Diese negativen Effekte beeinflussen im Umkehrschluss die Absicht Fitness Tracking Technologien weiterverwenden zu wollen, insbesondere bei Nutzern mit geringer Nutzungserfahrung und geringer Sportselbst-wirksamkeit. Für die Forschung tragen die Ergebnisse zu einem besseren Verständnis der motivationspsychologischen Charakteristika der Features von Fitness Tracking Technologien und zur Rolle individueller Motivationen in der Nutzung bei. Die Ergebnisse implizieren dabei, dass eine Nichtbeachtung dieser Faktoren andernfalls zu unschlüssigen Ergebnissen zur Effektivität von Fitness Tracking Technologien führen kann. Für die Praxis implizieren die Ergebnisse, dass Anbieter von Fitness Tracking Technologien Möglichkeiten zur Individualisierung der Features auf Basis individueller Ziele einführen sollten um bestmögliche Motivationsergebnisse zu erzielen. Gleichermaßen sollten Nutzer entsprechend auf Features zurückgreifen, die zu Ihren Zielen passen und auf Features, die demotivieren, eher verzichten.

Aus den Erkenntnissen dieser beiden Kontexte zur übergeordneten Rolle von Motivation, Fähigkeit und Opportunität leitet die vorliegende Dissertation ein Model zur effektiven Nutzung von Consumer Health IT ab. Dieses beschreibt in seinen Grundzügen, dass Motivationsfaktoren die spezifische Realisierung von Opportunitäten der Consumer Health IT (z.B. Features) steuern und diese spezifischen Opportunitäten dabei bestimmte Konsequenzen für gesundes Verhalten und Wohlbefinden verursachen können. Dabei ist ferner die Passung zwischen Motivation und Opportunität von Wichtigkeit um eine höhere Wirkung zu erzielen. IT- wie gesundheitsbezogene Fähigkeiten haben dabei eine unterstützende Rolle zur Realisierung der Opportunitäten und tragen zur Bewältigung ungewollter Effekte bei. Für die Forschung trägt das entstandene Modell zu einem übergeordneten Verständnis von Consumer Health IT bei und unterstützt zukünftige Forschung darin wesentliche Faktoren, die eine Nutzung determinieren, zu identifizieren, in Bezug zueinander zu stellen, und so die Wirksamkeit von Consumer Health IT zu analysieren.

Referenzen

Agarwal, R., Anderson, C., Crowley, K., and Kannan, P. 2011. "Understanding Development Methods From Other Industries to Improve the Design of Consumer Health IT: Background Report," Agency for Healthcare Research and Quality, Rockville, MD.

Alahäivälä, T. and Oinas-Kukkonen, H. 2016. "Understanding persuasion contexts in health gamification: A systematic analysis of gamified health behavior change support systems literature." *International Journal of Medical Informatics* (96:1), pp. 62-70.

Campbell, R. J. 2008. "Meeting seniors' information needs: Using computer technology." *Home Health Care Management & Practice* (20:4).

Gianchandani, E. P. 2011. "Toward smarter health and well-being: an implicit role for networking and information technology." *Journal of Information Technology* (26:2), pp. 120-128.

Kelley, H., Chiasson, M., Downey, A., and Pacaud, D. l. 2011. "The Clinical Impact of eHealth on the Self-Management of Diabetes: A Double Adoption Perspective." *Journal of the Association for Information Systems* (12:3), pp. 208-234.

Koivisto, J. and Hamari, J. 2019. "The rise of motivational information systems: A review of gamification research." *International Journal of Information Management* (45), pp. 191-210.

Statista. 2018. "eServices Report 2018 – Fitness." *Statista Digital Market Outlook*. Abgerufen am 23. Juli 2018 von: https://de.statista.com/statistik/studie/id/36673/dokument/fitness-outlook/

United Nations. 2015. "Transforming Our World: The 2030 Agenda for Sustainable Development." Abgerufen am 2. Juli 2019 von: https://sustainabledevelopment.un.org/post2015/transformingourworld

WHO. 2018. "Global action plan on physical activity 2018–2030: more active people for a healthier world." Abgerufen am 20. September 2018 von: http://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf

Yan, L. and Tan, Y. 2014. "Feeling Blue? Go Online: An Empirical Study of Social Support Among Patients." *Information Systems Research* (25:4), pp. 690-709.

Introductory Paper

Consumer Health Information Technology

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Consumer Health Information Technology

Motivation, Ability, and Opportunity in the Contexts of Older People and Fitness Tracking Technology

1 INTRODUCTION

"Goal 3. Ensure healthy lives and promote well-being for all at all ages."
– United Nations (2015a)

"Stressful lifestyles, poor diet habits, and aging populations are giving rise to chronic illnesses at unparalleled rates, and these are in turn dramatically altering the kinds of medical challenges we are facing as a society."
– Gianchandani (2011, p. 121)

"Digitization in the healthcare sector: Doctors to be allowed to prescribe apps"
– Tagesschau (2019)

The intersection of these three quotations strikingly illustrates the importance of society's health, the challenges confronting healthcare systems, and the pivotal role consumer health information technology is expected to play.

Maintaining and promoting the health and well-being of the world's population is a top priority of the United Nations' 2030 agenda for sustainable development, along with the goal of ending poverty and hunger (United Nations 2015a). Achieving health and well-being is complicated, as societies are undergoing profound changes in lifestyles and demographic structures. For example, every second German citizen is officially overweight or obese (Statistisches Bundesamt 2019) and only 43% of the German population currently meets the recommended minimum of physical activity – down startling from 60% in 2010 (Froböse et al. 2018). Moreover, as populations age steadily, the costs of caring for older people increase dramatically. In Germany, about half of public healthcare costs are caused by people aged 65 and above (Statistisches Bundesamt 2017). In partial response to these developments, healthcare systems are adapting, shifting from a disease- to a patient-centric care approach and from a treatment to a prevention focus, giving individuals more responsibility for their care and well-being (Gianchandani 2011).

Along with this, empowering individuals to manage their health through the use of information and communication technologies has become a top goal of the healthcare sector and government (The Office of the National Coordinator for Health Information Technology 2014; Waschinski 2019), the World Health Organization begins partnering with Google to find ways to promote healthy behaviors such as physical activity (WHO 2018b), and the German government is currently discussing legislation that would allow doctors to prescribe mobile health applications (apps) at the expense of health insurance companies (Waschinski 2019).

Clearly, consumer health IT, which Agarwal et al. (2011, p. 59) define as "tools and artifacts that use information systems to support an individual [consumer] in the management of his or her health-related needs", is expected to provide a broad variety of personal health and well-being benefits. Today, different tools and applications exist potentially supporting people in their self-care, such as online health information, mobile health technologies, virtual doctor offices, or fitness tracking technology (Demiris 2016). The information systems (IS) literature, however, has been comparatively slow in taking upon the consumer perspective on health IT despite early calls (Agarwal et al. 2010). The initial research available, though, lends initial support for positive impacts on, for example, people's health literacy (Chen et al. 2019), well-being (James et al. 2019b), or adoption of self-care activities (Kelley et al. 2011). However, because the tools and applications of consumer health IT are as diverse as the individuals using them, the literature currently lacks an overarching understanding of how individuals with different needs, goals, and abilities make use of consumer health IT and how the use of consumer health IT can support healthy behavior and well-being. This dissertation analyzes the determinants and consequences of consumer health IT use by following the central research question:

How can consumer health IT support healthy behavior and well-being?

To answer this question, this dissertation analyzes the state of knowledge on consumer health IT and identifies *motivation, ability, and opportunity* as constituent components of consumer health IT use: motivation refers to the different health-related needs and goals people have; ability involves both IT-related ability, such as IT self-efficacy, and health-related ability, such as health knowledge and health self-efficacy; opportunity reflects the type of consumer health IT and its features with which users can support their healthy behavior and well-being.

The twelve papers of this dissertation analyze the mutual interplay between these three components and their collective impact on health- and well-being-related outcomes. Each paper has a distinct focus on at least one of these three components, seeking to understand their nature, antecedents, and consequences. Thereby, the twelve papers of this dissertation take on two distinct contexts which are of high practical significance and come along with unique gaps in knowledge: 1) older people and 2) fitness tracking technology. By examining motivation, ability, and opportunity in these two contexts and synthesizing the research findings, this dissertation aims to develop a model of effective consumer health IT use (Figure 1).

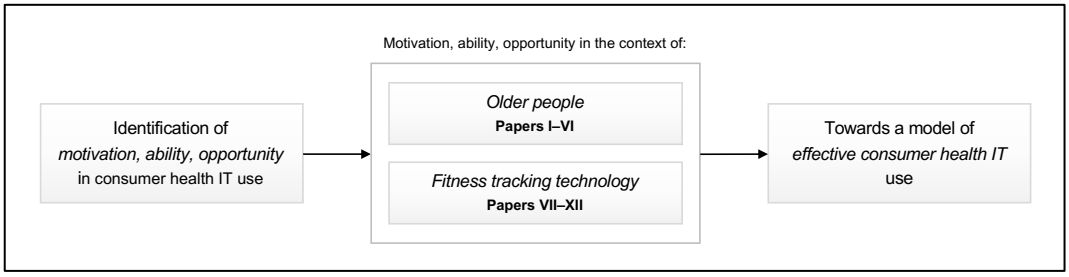


Figure 1. Structure of this dissertation

The research context of *older people* is concerned with the increasing proportion of older persons within the population due to declining fertility and increased longevity (United Nations 2015b; 2017). The number of people aged 60 years and above more than doubled from 1980 to 2017 and is expected to double again by 2050 with an estimated 2.1 billion people of higher age (United Nations 2017). As aging is associated with the emergence of chronic illnesses (Campbell 2008), the health of the older person is not only of significance for the self but also for many healthcare systems as a significant proportion of healthcare costs is spent on older people (Pew Research Center 2013; Statistisches Bundesamt 2017). Whilst the use of consumer health IT can be generally expected to be beneficial for older people's health and well-being, the predominant view in the literature is that older persons "lack either the ability or the willingness" to adopt and use IT (Fox and Connolly 2018, p. 997). While research stresses accordingly the importance of older people's IT-related ability for their adoption and use of IT (Fox and Connolly 2018; Niehaves and Plattfaut 2014; Tams et al. 2018), the sources of older people's IT-related ability are less well understood. Moreover, because older persons tend to stick with existing media practices (Nimrod 2017), they often underutilize their existing IT, such as that they are less likely to utilize the Internet to retrieve health information online (Fox and Duggan 2013). Because existing research mostly focuses on the adoption of new IT, their actual engagement with IT after adoption is less well understood (Tams et al. 2014) including mechanisms that potentially promote older people's utilization of existing IT for health-related purposes. To fill these gaps, Papers I-VI study the role of motivation, ability, and opportunity in the context of older people.

The research context of *fitness tracking technology* addresses the globally prevailing issue of insufficient regular physical activity which has become a leading factor of mortality (OECD 2017) and causes billions in healthcare costs and productivity losses (WHO 2018a). Fitness tracking technology, which includes both wearable devices (e.g., Fitbit) and software applications (e.g., Strava, Nike+ Running), is expected to enhance people's physical activity motivation and behavior (Hassan et al. 2019; James et al. 2019b) and currently attracts millions of individuals (Statista 2018), health insurance companies (BBC 2018; Best 2016), employers (Giddens et al. 2017), and even the World Health Organization (WHO 2018b). In research, however, the motivational impacts fitness tracking technology have are not well understood with studies reporting positive, neutral, and sometimes even adverse effects on motivation and physical activity (Alahäivälä and Oinas-Kukkonen 2016; Koivisto and Hamari 2019). Although fitness tracking technology offers a wide array of 'motivational features' that aim to support motivation and behavior, such as performance graphs, virtual rewards, challenges, or rankings, existing research mostly neglects the individual effects stemming from these features (Koivisto and Hamari 2019). Moreover, although individuals hold different motivations and pursue different goals when performing physical activity, existing research rarely considers the role of such interpersonal, motivational differences (Koivisto and Hamari 2019). In sum, the current literature lacks explanations as to how and why fitness tracking technology can promote the anticipated motivational benefits related to physical activity. To fill these gaps, Papers VII–XII examine motivation, ability, and opportunity in the context of fitness tracking technology.

The rest of this introductory paper unfolds as follows. The next section introduces the background on consumer health IT, reviews existing research, and derives motivation, ability, and opportunity as constituent components of consumer health IT use. Then, the two research contexts and the theoretical background are presented before research questions are derived. Subsequently, the research methods are outlined and the results of the twelve papers are presented and summarized in a model of effective consumer health IT use. Lastly, the main contributions and implications for research and practice of this dissertation are discussed.

2 THEORETICAL BACKGROUND

2.1 Consumer Health Information Technology

Ensuring the population's health and well-being is a top priority of nations (United Nations 2015a), and one which demands significant resources (Agarwal et al. 2010). To provide better care and to optimize resources, healthcare is currently undergoing a major transformation. Two key pillars of this transformation are patient-centered care and the digitization of healthcare.

Over the last years, a shift in the role of the patient in healthcare is propagated (Payton et al. 2011). Specifically, the patient-centered care model shifts the focus of care from the healthcare provider to the patient. In the traditional model, patients are passive recipients of health services, whereas in the patient-centered care model, patients' individual needs and preferences are central and patients are empowered to take an active role in staying and getting healthy (Payton et al. 2011). Thereby, the use of consumer health IT is seen as essential in effective, patient-centered care (Demiris 2016; Payton et al. 2011). As Agarwal et al. (2011, p. 1) put it:

> *"Central to the vision of a patient-centered health care system are information technologies and tools in the form of consumer health information technology (IT) applications that support a range of health management activities such as storing and retrieving health information, sharing health information with health care providers, and tracking health-related behaviors and actions."*

Consumer health IT, also called consumer health informatics (Eysenbach 2000; Gibbons et al. 2009, p. 13), can be broadly understood as "tools and artifacts that use information systems to support an individual [consumer] in the management of his or her health-related needs" (Agarwal et al. 2011, p. 59) or as "computer-based systems that are designed to facilitate information access and exchange, enhance decision making, provide social and emotional support, and help behavior changes that promote health and well-being" (Or and Karsh 2009). The broad vision of consumer health IT is that people can access information related to their health and thereby control their own healthcare and utilize healthcare resources more efficiently (Eysenbach 2000). As such consumer health IT serves as "personalized information source and decision aid to facilitate tailored monitoring of wellness, disease prevention, and treatment for informed and engaged consumers" (Demiris 2016, p. 46). In sum, consumer health IT focuses prevention, self-help, and self-care (Eysenbach 2000).

A broad variety of tools and applications exists, including online health information, telehealth, digital personal health records, mobile health, or, more recently, fitness tracking technology, that aim to facilitate people's self-help and self-care (Demiris 2016). The Internet, for example, has become a major source of health information (Agarwal et al. 2010) and is seen as means to empower individuals to become the 'source of control' in making their healthcare decisions (Prey et al. 2014). Indeed, about two-thirds of U.S. Internet users feel better informed about their health than they had five years earlier – thanks to the Internet (Pew Research Center 2014).

Understanding people's use of consumer health IT and resulting consequences warrants considerations about four distinct characteristics of this context. First, the healthcare context is distinct due to the high diversity of involved individuals with different physical traits, diverse medical issues and histories (Fichman et al. 2011). Consequently, people also have different motivations and goals which affect their health-related behavior (Lochbaum and Gottardy 2015; Ryan and Deci 2017). Taken physical activity as example, there are people who do sports for the

sake of pleasure and out of intrinsic motivation whereas others are much more extrinsically motivated such as by improving their physical appearance. Second, health is a highly sensitive matter and personal health issues, such as health conditions, are often emotion-laden such that health-related emotions can 'infuse' people's thoughts and decisions (Anderson and Agarwal 2011; Kordzadeh and Warren 2017). Third, though consumer health IT tools and applications, such as diabetes self-management applications (Kelley et al. 2011), often serve utilitarian purposes, they are not limited to this pragmatic characteristic; other tools and applications, such as those aiming to promote behavior change like fitness tracking technologies, also serve for hedonic purposes such as for the enjoyment, fun, and pleasure, which is relevant to sustained engagement (van der Heijden 2004; Wu and Lu 2013). Lastly, the consequences of personal health conditions determine people's overall quality of life and function within the society (Fichman et al. 2011) such that the outcomes of using consumer health IT are everything else than trivial. In essence, these aspects define the uniqueness of the consumer health IT context and provide opportunities for developing new or extending existing theories of IS use-related phenomena (Fichman et al. 2011).

2.1.1 General Research on Consumer Health IT

This section provides an overview of the current state of research on consumer health IT published in major journals of the IS domain (see also section 3.1). In line with the characteristics of this context just discussed, this review focuses on the following questions:

1. *What contexts, tools, and applications of consumer health IT have been examined?*
2. *What IT-related and health-related individual differences have been examined and what is their role?*
3. *What is known about the health- and well-being-related outcomes of consumer health IT use?*

With these questions in mind, the aim of the literature review is to get an initial understanding about how consumer health IT can facilitate healthy behavior and well-being, to identify the key factors determining consumer health IT use, and to identify gaps in research. Table 1 provides an overview of the twenty articles included in this review covering the last ten years of research (2008-2019). It can be generally noted that scholarly interest on consumer health IT grew particularly in the last few years and in parallel to this dissertation. Below, these articles are discussed according to the central questions concerning 1) the context, tools, and applications 2) the role of individual health- and IT-related differences, and 3) the health- and well-being-related outcomes of consumer health IT use.

Study	Contexts, tools, and applications	IT-related differences	Health-related differences	Health-related outcomes
Angst and Agarwal (2009)	Adoption of electronic health records	Control: Ability (computer skills, computer experience)		
Anderson and Agarwal (2011)	Disclosure of personal health information		Health status and emotions	
Kelley et al. (2011)	Use of diabetes self-management application for communication and learning	Computer self-efficacy, IT knowledge	Diabetes self-efficacy	Blood glucose values Diabetes self-care activities Change in HbA1c values
Yan and Tan (2014)	Social support in online mental health community		Health condition	Health condition changes
Yan et al. (2015)	Network formation in online mental health communities		Similarity in disease, symptoms, drugs, and treatments	
Venkatesh et al. (2016a)	Use of eHealth kiosk providing health information in rural area			Lowered infant mortality
Zahedi et al. (2016)	Design and evaluation of augmented virtual doctor office	Controls: personal innovativeness in IT, technological self-efficacy	Controls: medical flexibility (attitude), disease type, disease severity	
Kordzadeh and Warren (2017)	Disclosure of personal health information in virtual health communities			
Liang et al. (2017)	Online health information use by people with physical disabilities	Controls: Internet experience, eHealth literacy	Level of physical disability	
Prasopoulou (2017)	Memoir on experiential computing with an activity tracker			
Yan and Tan (2017)	Treatment review effectiveness in online mental health community		Pre-commitment (treatment experience)	Perceived treatment effectiveness
Fox and Connolly (2018)	Mobile health technology adoption intention by older persons	Mobile health self-efficacy Health information seeking experience		
Dadgar and Joshi (2018)	Value sensitive design of self-management application for diabetes			
Fan and Lederman (2018)	Trust development in online health communities and adoption of peer health information		Perceived similarity in medical status	
Zhang et al. (2019)	Patient-doctor relationship in online health-consultation platform		Disease severity	
Benbunan-Fich (2019)	User experience and usability of minimalist wearables			

Study	Contexts, tools, and applications	IT-related differences	Health-related differences	Health-related outcomes
Chen et al. (2019)	Social support in online health community		Context: users with chronic conditions	Health literacy Health attitude valence
James et al. (2019a)	Fitness tracking technology feature use	Controls: Fitness technology proficiency	Exercise goals (intrinsic, body-focused extrinsic, social extrinsic)	Subjective vitality
James et al. (2019b)	Fitness tracking technology feature use	Controls: Frequency of use, Proficiency	Exercise regulations (intrinsic, integrated, identified, introjected, external, nonregulation)	Subjective vitality
Hur et al. (2019)	Critical perspective on engagement in online health community			

Table 1. Research on consumer health IT in major IS journals

2.1.1.1 Contexts, Tools, and Applications

A variety of consumer health IT contexts, tools and applications have been examined so far, including online health communities (e.g., Yan and Tan 2014), fitness tracking technology (e.g., James et al. 2019b), mobile health technology (e.g., Fox and Connolly 2018), health self-management tools (e.g., Kelley et al. 2011), virtual doctor consultation platforms (e.g., Zhang et al. 2019), electronic health records (e.g., Angst and Agarwal 2009), and digitally provided health information (e.g., Liang et al. 2017).

Much of the available research so far focuses on **online health communities**. Here, research has shown that trust in community members increases an individual's adoption of peer-based health information such as health advice (Fan and Lederman 2018). Similarly, as such communities are also used to share medical treatment experiences, research revealed that a person's perceived treatment effectiveness is influenced by the community's consensus on treatment effectiveness (Yan and Tan 2017). Studies also centered on the role of social support in these communities revealing that exchanging social support positively impacts individuals' health conditions, particularly through emotional support, and particularly for patients with mental problems (Yan and Tan 2014). Furthermore, the social support provided and received also has been found to improve users' attitude towards health and their health literacy (Chen et al. 2019). Because these communities center on social relationships, research also examined the formation of social connections revealing that health status similarities between persons increase the likelihood of forming a social connection (Yan et al. 2015). In taking a critical view on online health communities, research recently investigated members' engagement and discourses in controversially discussed childhood immunization forums (Hur et al. 2019).

An emergent type of consumer health IT that recently received scholarly attention is **fitness tracking technology**, which includes devices such as fitness tracker wristbands and software applications that record physical activity. Because such devices are designed to be unobtrusive, the minimalist product design can create complex user experiences and usability issues (Benbunan-Fich 2019). As these devices interact with the body and are worn nearly constantly, they also create novel experiences of 'everyday computing' that scholars have studied by employing new research methods like memoirs (Prasopoulou 2017). Furthermore, since people have different exercise-related motivations and goals, recent research has shown that different

motivations can drive different uses of fitness tracking technology features which, in turn, can increase peoples' well-being (James et al. 2019a; James et al. 2019b).

For individuals with more severe health conditions, such as diabetes, **health self-management applications** can be beneficial. Here, research draws connections between the adoption and specific use of such applications and improvements in health (Kelley et al. 2011). Specifically, using a diabetes self-management application for communication and learning purposes facilitates the adoption of diabetes self-care activities (e.g., blood sugar testing, treatment of low blood sugar levels), particularly by enhancing self-care self-efficacy and knowledge. In consequence, adopting self-care activities results in improved HbA1c values (Kelley et al. 2011). In addition, research shows that value-sensitive design approaches, i.e. approaches considering the values important to people with chronic conditions, positively influence self-management activity levels and should inform the development of self-management applications and features (Dadgar and Joshi 2018).

Consumer health IT-related research also examined the use of **digitally provided health information,** showing that perceived benefits and risks are the main drivers and inhibitors of online health information use among people with disabilities (Liang et al. 2017). These benefits and risks, in turn, are determined by perceived information quality and system quality (Liang et al. 2017). Importantly, these relationships are influenced by people's level of disability, such that the impact of perceived benefits on online health information use is stronger among people with more severe disabilities (Liang et al. 2017). Initial research has also stressed the positive impacts of digitally provided health information, particularly in the case of developing countries challenged by high infant mortality (Venkatesh et al. 2016a). Here, special eHealth kiosks give mothers accurate medical information as a basis for deciding whether to seek professional medical care. It has been shown that eHealth kiosk use significantly lowers infant mortality rates and that the personal social network of the mother can be both a facilitator and hindrance of their eHealth kiosk use (Venkatesh et al. 2016a).

Another opportunity presented by consumer health IT is shifting doctor visits into the digital environment with specific **health consultation platforms**. In such platforms, people can post inquiries related to their health condition and doctors respond with professional health information (Zhang et al. 2019). In this case, information asymmetries and informational unfairness between the individual and the doctor determine their relationship quality, which is further influenced by the severity of the individual's disease (Zhang et al. 2019). Related research also examined the potential of virtual worlds for health consultation purposes (Zahedi et al. 2016). Individuals' acceptance of this format is driven by trust and perceived effectiveness whereby additional features, such as webcam inspections, increase people's trust in the virtual doctor's office (Zahedi et al. 2016).

In the realm of the digital divide, research examined the acceptance of **mobile health technologies by older people** (Fox and Connolly 2018). The results of a mixed method study stress the importance of older people's IT-related self-efficacy and level of Internet search experience as enabling factors of their willingness to adopt (Fox and Connolly 2018). The study also points at mistrust, risk perceptions, and privacy concerns as inhibiting factors of older people's mobile health acceptance (Fox and Connolly 2018).

In this vein, research also highlighted the role of individuals' privacy concerns in determining their willingness to adopt **electronic health records** and how positively framed messages can enhance individuals' positive attitudes to adopt (Angst and Agarwal 2009). Similarly, research into people's willingness to **disclose personal health information** reveals that

individuals' disclosure decisions vary by the type of health information, the purpose of information use, and the requesting institution (Anderson and Agarwal 2011). Furthermore, as people attach emotions to their current health status, this emotion makes individuals more willing to disclose their personal health information (Anderson and Agarwal 2011).

2.1.1.2 Health- and Well-Being-Related Outcomes of Consumer Health IT

While consumer health IT use is anticipated to bring about various benefits for the individuals, there has been little research into the health- and well-being-related outcomes of its use (Table 1). The seven exceptions noted, however, provide first insights into its potential effectiveness.

Hereto, research has shown that the social support exchanged, both informational and emotional, in online health communities has a positive impact on users' health conditions (Yan and Tan 2014). Receiving, but also particularly providing such social support can enhance peoples' health literacy and strengthens positive attitude towards health (Chen et al. 2019). An intriguing finding is also that people perceive a higher medical treatment effectiveness when other members in online health communities share a consensus on its effectiveness (Chen et al. 2019). Moreover, it has been found that using fitness tracking technology can enhance well-being, specifically subjective vitality (James et al. 2019a; James et al. 2019b). Likewise, using a diabetes self-management tool for communication and learning can contribute to improved diabetes self-efficacy, diabetes knowledge, diabetes self-care activities, and therefore to improved HbA1c results (Kelley et al. 2011). Perhaps most importantly, it has been shown that the use of consumer health IT can actually save lives, particularly in developing countries, where medical information provided by eHealth kiosks prompts mothers to consult professional medical care for their infants and can decrease infant mortality (Venkatesh et al. 2016a).

Taken together, these results provide an initial promising view of the beneficial health- and well-being-related impacts of consumer health IT. The results indicate that its use can impact health-related cognition (e.g., health literacy, diabetes self-efficacy), affect (e.g., health attitude), behavior (e.g., diabetes self-care activities, doctor consultation), well-being (e.g., subjective vitality), bodily outcomes (e.g., HbA1c improvement), and life outcomes (e.g., infant mortality).

2.1.1.3 Role of Health-Related Individual Differences

As discussed, an important characteristic of the healthcare context is the high level of diversity among individuals, especially with respect to health-related differences (Fichman et al. 2011). Consumer health IT research tends to echo this uniqueness and considers health-related individual differences both explicitly, such as by analyzing the influence of health severity, and implicitly in terms of the research context, such as members of online communities with mental problems (Table 1). Particularly in the former case, the explicit incorporation of individual health-related factors can provide key insights. Here, the factors examined so far can be classified as an individual's health needs (e.g., health status, disease severity), health goals (e.g., exercise motivations), and health abilities (e.g., diabetes self-efficacy, health literacy).

Health needs include, for instance, the level of physical disability (Liang et al. 2017), disease severity (Zhang et al. 2019), medical status (Fan and Lederman 2018), or health condition (Anderson and Agarwal 2011; Yan et al. 2015; Yan and Tan 2014). Such health needs significantly influence consumer health IT interactions. For example, health needs significantly influence patients' perceptions of the benefits of consumer health IT, such that the perceived benefits of online health information become a stronger driver for actual online health information use for people with a high degree of physical disability (Liang et al. 2017). Health

status also affects the impact of information quality and system quality on perceived risk of online health information. Specifically, it has been shown that people with greater disabilities have impaired sensitivity to risks and do not adhere to the objective signs of poor information and system quality in judging the perceived risks of online health information (Liang et al. 2017). Moreover, people attach emotions to their health status, and such health-related emotions increase peoples' willingness to disclose personal health information (Anderson and Agarwal 2011). In online health consultation platforms, people with more severe diseases invest more in the relationship with doctors and perceive a more urgent need to obtain information from them (Zhang et al. 2019). Additionally, people use their health status in evaluating health condition similarities with other persons which drives their development of new social connections (Yan et al. 2015) and trust (Fan and Lederman 2018) in online health communities. Finally, users with more severe health problems also benefit more from the social support received in online health communities, resulting in greater mental health improvements (Yan and Tan 2014).

Health goals can be understood as the motivational impetus stemming from a person's health needs. Health goals can include, for example, different exercise goals, such as becoming fitter, having more energy, or maintaining a desired weight (James et al. 2019a). Particularly in the physical activity and fitness tracking technology context, such health-related goals and motivations can drive distinct uses of the available features (James et al. 2019a; James et al. 2019b). For example, users who exercise with a socializing goal (i.e., meeting friends) are more inclined towards features that enable social interactions within these fitness tracking technologies (James et al. 2019a).

Health abilities can include disease-specific self-efficacy, such as diabetes self-efficacy (Kelley et al. 2011), disease-specific knowledge, such as diabetes knowledge (Kelley et al. 2011), general health literacy (Chen et al. 2019), or also medical treatment experiences (Yan and Tan 2017). Such health abilities have been considered in terms of the outcomes improved through using consumer health IT (Chen et al. 2019; Kelley et al. 2011), but also as a personal resource people draw upon in evaluating health information (Yan and Tan 2017). In the former case, for example, the use of self-management applications for the purpose of learning can improve users' disease-specific self-efficacy and knowledge (Kelley et al. 2011). Likewise, by receiving and particularly providing informational support in online health communities, users can also improve their health literacy (Chen et al. 2019). In the latter case, peoples' treatment experiences make them less likely to be influenced by others in evaluating the effectiveness of their medical treatments (Yan and Tan 2017).

In summary, as discussed detailed subsequently, health-related needs and goals appear to be critical factors influencing people's interactions with consumer health IT.

2.1.1.4 Role of IT-Related Individual Differences

Compared to the individual health-related differences just discussed, IT-related differences have received comparatively less attention in the literature and have been predominantly used as control variables. The IT-related differences that have significant influence can be categorized as IT-related experiences and IT-related skills.

IT-related experiences considered in the literature include Internet experience (Liang et al. 2017), computer experience (Angst and Agarwal 2009), health information seeking experience (Fox and Connolly 2018) or frequency of fitness tracking technology use (James et al. 2019b). **IT-related skills** include technological self-efficacy (Zahedi et al. 2016), computer self-efficacy (Kelley et al. 2011), mobile health self-efficacy (Fox and Connolly 2018), computer skills (Angst

and Agarwal 2009), fitness tracking technology proficiency (James et al. 2019a; James et al. 2019b) and eHealth literacy (Liang et al. 2017). Scholars have also examined the influence of personal innovativeness in IT (Zahedi et al. 2016). Regardless of whether these are considered as control or main variables, such IT-related individual experiences generally positively influence consumer health IT use. For example, fitness tracking technology proficiency increases the use of distinct features which support data management and social interaction (James et al. 2019a). Likewise, higher computer self-efficacy increases the use of health self-management tools for learning purposes (Kelley et al. 2011).

Both experiences and skills are usually understood as **IT-related abilities** that enable consumer health IT use (Fox and Connolly 2018; Kelley et al. 2011). In the context of older people, for instance, low IT-related abilities can significantly hinder mobile health IT adoption (Fox and Connolly 2018).

2.1.1.5 Summary and Guiding Research Framework

Consumer health IT refers to IT tools and artifacts used to support the personal management of one's health-related needs (Agarwal et al. 2011). An analysis of the literature reveals that diverse contexts, tools and applications of consumer health IT have been considered so far in research and that relatively few investigated the health- and well-being-related outcomes of consumer health IT. However, the results of the extant research indicate that the use of consumer health IT involves three distinct components: 1) people's health-related needs and goals (e.g., health status, exercise goals); 2) people's health-related and IT-related abilities (e.g., health self-efficacy, computer self-efficacy); and 3) the type and features of the specific consumer health IT.

These three components resonate with what is known about how motivation, ability and opportunity drive human behavior. Specifically, the so-called motivation-opportunities-abilities (MOA) framework is a well-established theoretical base of human behavior (Maclnnis et al. 1991; Ölander and Thøgersen 1995). As Figure 2 depicts, the MOA framework posits that individual characteristics (motivation and ability) and the external environment (opportunity) are determinants of specific behavior, which in turn, leads to certain behavioral outcomes (Maclnnis et al. 1991; Ölander and Thøgersen 1995; Rothschild 1999). As the MOA is a meta-theory providing a high level of generalization of human behavior (Hughes 2007), it has been applied in a variety of contexts such as in management of public health behaviors (Rothschild 1999), work performance (Blumberg and Pringle 1982), consumer behavior (Maclnnis et al. 1991; Ölander and Thøgersen 1995), healthy behavior (Brug 2008), and also in the IS literature in examining IT-facilitated organizational knowledge sharing (Kettinger et al. 2015).

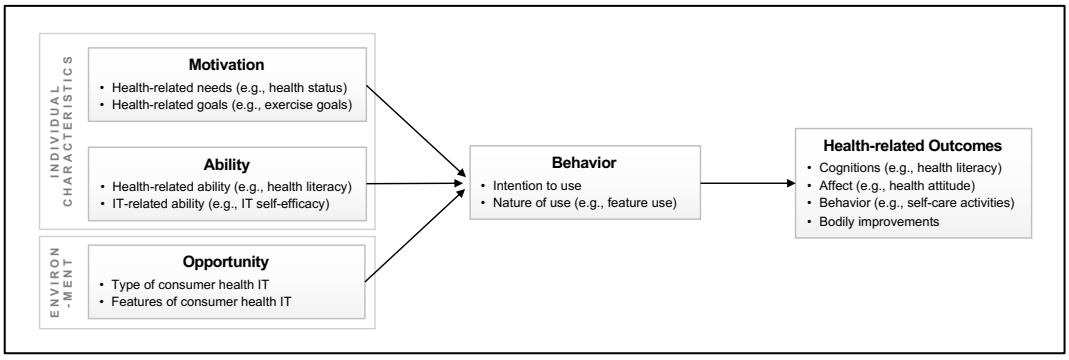


Figure 2. Derived research framework of the dissertation

The MOA framework posits **motivation** as the 'internal drivers' to perform a behavior (Parkinson et al. 2016; Siemsen et al. 2008). In the general consumer health context, motivation refers to goal-directed arousal to engage in healthy behaviors hence capturing a person's interest and willingness to perform the health-related behavior (Maclnnis et al. 1991; Moorman and Matulich 1993). Motivation is affected, among others, by personal relevance, needs, and goals (Hoyer et al. 2012). As such, the motivation component is echoed in the consumer health IT context by a person's health-related needs, such as health status, and health-related goals, such as exercise goals.

Ability refers to the person's knowledge, skills, and other proficiencies to perform a behavior (Siemsen et al. 2008). In the MOA literature, ability is related to past experiences, knowledge, and self-efficacy (Bandura 1997; Parkinson et al. 2016; Rothschild 1999). Noting parallel lines within the consumer health IT research context, abilities in this context involve both health-related and IT-related abilities. Health-related abilities refer to the ability to engage in healthy behavior and include, for instance, health knowledge, health literacy, or disease-specific self-efficacy (Kelley et al. 2011; Moorman and Matulich 1993). IT-related abilities, on the other hand, involve the experiences and skills, such as computer experience or computer self-efficacy, that are needed to adopt and use consumer health IT.

Opportunity reflects the extent to which external (i.e., environmental, situational) circumstances either facilitate or inhibit a specific behavior (Parkinson et al. 2016). An example of lack of opportunity is when someone desires to carry out a behavior but is prevented from doing so by environmental factors (Parkinson et al. 2016; Rothschild 1999). In general, several situational factors can be regarded as opportunities such as availability of time or resources, geographical location, social structures such as laws, or infrastructure (Parkinson et al. 2016). In the consumer health IT context, opportunity reflects the type of the consumer health IT tool or application of interest (e.g., online health community, fitness tracking technology) and particularly the features and functionalities it offers which is in line with IS research applying the MOA framework (Kettinger et al. 2015).

Despite the conceptual parsimony relating motivation, opportunity, and ability to behavioral outcomes, these three aspects are not necessarily independent but rather can be highly interrelated for certain behaviors (Parkinson et al. 2016). Scholars hence suggest considering the interactions between these components but also their implications for the 'nature of the behavior', i.e. the characteristics of the behavior (Kettinger et al. 2015; Lai et al. 2018; Ölander and Thøgersen 1995; Parkinson et al. 2016).

In summary, the MOA appears to be a viable organizing framework to examine the role of individual (health-related needs and goals, health-related abilities and IT-related abilities) and technological (type, features) factors in consumer health IT use and resulting health- and well-being-related outcomes. This dissertation hence adopts the MOA framework to examine the relationships between these three components as guiding framework to answer the research question how consumer health IT can facilitate healthy behavior and well-being. To this end, this dissertation draws upon two distinct research contexts which are ideally suited to examine motivation, ability, and opportunity in different constellations and their resulting consequences: 1) the context of older people's use of consumer health IT and 2) the context of fitness tracking technology facilitating people's physical activity. These two contexts are introduced next alongside their specific characteristics and gaps in research.

2.1.2 Research Context I: Older People

In most developed countries, people are living longer and longer, a trend known as "demographic change" (United Nations 2017; WHO 2015). However, ageing is often accompanied by the emergence of chronic illnesses (Campbell 2008), which is not only a burden for the individual oneself, but also a challenge for many healthcare systems as a significant proportion of healthcare costs is spent on older people (Pew Research Center 2013; Statistisches Bundesamt 2017). In Germany, for instance, about the half of the public healthcare costs are caused by citizens aged 65 and above and the per capita costs are 4.8 times high for people aged over 84 in comparison to the age cohort of 15-29 years (Statistisches Bundesamt 2017). Healthcare systems worldwide must therefore rise to the challenge of treating an increasingly older population at ever-greater cost (Chatterjee and Price 2009). Not surprisingly, the use of consumer health IT by older people is expected to benefit both the individual and also the society at large (Fox and Connolly 2018). In general, however, there is no agreed definition on the term 'older people': while most consider persons with a chronological age of 60-65 years and above as 'older people', others consider the threshold of 50 years and above (WHO 2012). As aging starts at around the age of 50 years, this dissertation considers persons aged 50 years and above as 'older people' which is in line with current IS research (Fox and Connolly 2018).

In terms of digital technology proficiency, older people are often considered "digital immigrants" because they learned computing technology during their adult life, unlike "digital natives" who grew up in a digital world (Vodanovich et al. 2010; Wang et al. 2013a). Older people's interactions with IT are also discussed in light of the "digital divide", which refers to the unequal access, use, and impact of IT across social groups (Dewan and Riggins 2005). Although adoption of certain technologies, such as the Internet and smartphones, increased considerably among older people in the last years (Anderson and Perrin 2017; ARD/ZDF 2019), older people often underutilize their existing IT and stick with traditional media practices, rather than making intense use of the digital environment (Nimrod 2017). For instance, older Internet users are less likely to use the Internet for banking, commerce, or social networks compared to younger people (DIVSI 2016; Statisches Bundesamt 2016). In the health context, despite general Internet use, only 58% of Internet users over 65 retrieve health information online, compared to 75% of adults under 65 (Fox and Duggan 2013).

The prevailing picture in the literature of older people's interactions with IT is that this group is less tech-savvy, has lower computer self-efficacy, possesses higher anxieties towards IT, has higher difficulties in using IT, and is generally perceived to be resistant towards modern IT (Czaja et al. 2006; Tams et al. 2014). Put differently, older persons "lack either the ability or the willingness" to adopt and use IT (Fox and Connolly 2018, p. 997). However, such stereotypical views on older people do not necessarily mirror reality. Older people are increasingly open to digitization. Many are curious and desire to become competent actors in this digital society (Weiß et al. 2017). Both practice and research increasingly recognize that older people are not a homogenous group in terms of IT and Internet use (DIVSI 2016; Niehaves and Plattfaut 2014).

However, the older people's use of IT in general, and consumer health IT in particular is an understudied area in the IS literature (Fox and Connolly 2018; Tams et al. 2014). As shown in Table 2, there is only little research in the major IS journals addressing the older population.

Existing research points at the importance of older people's computer self-efficacy and IT-related experiences in their decision to adopt technology such as the Internet (Niehaves and Plattfaut 2014) or mobile health technology (Fox and Connolly 2018). Moreover, older people's computer self-efficacy has also been found to be of relevance to cope with IT-related

interruptions and resulting workload stress at the workplace (Tams et al. 2018). These impacts are particularly relevant as that studies still reveal that older people have less IT-related experience and self-efficacy compared to younger people (Tams et al. 2018). As older people may lack the skills to use IT, literature suggests that these deficiencies can be overcome by older persons' social support network such that direct IT use among older people can be prevented and replaced by 'indirect' use instead (Spagnoletti et al. 2015).

Study	Topic	Relevant findings
Tams et al. (2014)	Research agenda on older people in the workforce	Discusses a research agenda on age-related IS research including the concept of age itself, the need to examine IS-related phenomena beyond initial IT adoption, and why ageing matters in IS use.
Niehaves and Plattfaut (2014)	Internet adoption by older people	Examines different models of Internet adoption in the context of older people and reveals computer self-efficacy as key determinant.
Spagnoletti et al. (2015)	Design for social media engagement: Insights from elderly care assistance	Discusses the design of elderly care assistance through social media and suggests that older people can also "indirectly" use IT, such as by having a support network who are the primary users.
Fox and Connolly (2018)	Mobile health adoption and 'age-related' digital divide	Mobile health adoption decisions are driven by older people's adoption abilities (IT-related self-efficacy and experience), trust, risk perceptions, and privacy
Tams et al. (2018)	Age, Technostress and Task Performance	Older people have less computer self-efficacy and computer experience, which are important factors in coping with technostress.
Ghasemaghaei et al. (2019)	Recommendation agents for older adults	Older people's evaluation of a recommendation agent's complexity and usefulness is influenced by their subjective age. Against common belief, older persons who perceive themselves as older find systems with high comprehensiveness as more useful.

Table 2. Research on older people in major IS journals

Because older people's cognitive abilities decline with higher chronological age, a common assertion in both practice and literature is that complex IT, such as online shopping recommendation agents, should be designed in most simple forms for this audience (Ghasemaghaei et al. 2019). However, a recent study employing an alternative measure of age – subjective age perception – provides the intriguing insight that older persons who perceive themselves as older than they really are evaluate systems with high complexity as more useful than those perceiving themselves as younger than they really are (Ghasemaghaei et al. 2019).

To summarize, to date, as also pointed out by Tams et al. (2014), only few age-related studies exist. Existing research, however, echoes the significance of computer self-efficacy and IT-related experiences for older people's IT adoption and use behavior (Fox and Connolly 2018; Niehaves and Plattfaut 2014; Tams et al. 2018). Despite its importance, however, surprisingly little is known how older people develop their computer self-efficacy. This has led to calls to examine the specific causes and sources of older people's computer self-efficacy (Fox and Connolly 2018; Tams et al. 2014). Moreover, as the review of Tams et al. (2014) also reveals, the majority of the age-related IS literature is restricted to initial technology adoption. Given that general technology adoption has increased amongst older people (Anderson and Perrin 2017; ARD/ZDF 2019), older people's actual engagement with IT after adoption (i.e., post-adoptive use) is less understood (Tams et al. 2014). Finally, initial research reveals that alternative conceptualizations of 'age' can shed new light on age-related IT phenomena (Ghasemaghaei et al. 2019; Hong et al. 2013) and calls have been made to examine alternative conceptualizations of age in examining older people's IT use (Tams et al. 2014).

In summary, despite its practical significance, older people's interactions with IT in general and with consumer health IT in particular has received scarce attention in the major IS literature. As such, and given the prevailing view that older people "lack either the ability or the willingness" (Fox and Connolly 2018, p. 997) to use IT, this context is particularly well-suited to elaborate upon the role of ability, motivation, and opportunity in consumer health IT use while simultaneously addressing the research gaps in the age-related IS literature.

2.1.3 Research Context II: Fitness Tracking Technology

Insufficient regular physical activity is a pertinent issue in most societies (WHO 2018a). Though 150 minutes of health-enhancing, moderately intense physical activity[1] a week is recommended (WHO 2018a), globally, every fourth person is considered physically inactive (Guthold et al. 2018). In high-income western countries, the prevalence is even higher (Guthold et al. 2018). For example, about 57% of the German population does not meet the recommended levels, up significantly from 40% in 2010 (Froböse et al. 2018). Globally, physical inactivity causes billions in healthcare costs and productivity losses (WHO 2018a) and has become a leading factor of mortality (OECD 2017). While physical activity is not only beneficial for the individual, but also for the society at large, its promotion has been a major challenge for decades (WHO 2010).

Aiming to counteract this issue by enhancing people's motivation to be physically active, fitness tracking technology currently attracts millions of individuals (Statista 2018), health insurance companies (BBC 2018; Best 2016), employers (Giddens et al. 2017), and even the World Health Organization (WHO 2018b). Fitness tracking[2] technology includes both wearable devices (e.g., Fitbit) and software applications (e.g., Strava) that aim to support physical activity by recording bodily functions and activity metrics such as movements, pulse, or calories burned (Lupton 2016). The most intriguing aspect of fitness tracking technology are, however, the additional 'motivational features' which augment the recorded data and aim to induce motivation and engagement (Koivisto and Hamari 2019; Lister et al. 2014). These motivational features include, amongst others, features to analyze the recorded activities such as performance graphs; feature that assist structuring exercises and facilitate goal attainment such as training feedback and schedules; features that provide virtual rewards such as points, badges, or trophies; and social network based features where users can connect with others to support (e.g., 'likes' on uploaded activities) or to compete with each other (e.g., challenges and rankings) (Hamari et al. 2018; James et al. 2019a; Stragier et al. 2018). As such, fitness tracking technology belongs to the broader class of motivational information systems[3]: systems designed and built for the purpose of inducing motivation, engagement, or behavior change (Koivisto and Hamari 2019).

Despite the optimistic views that fitness tracking technology facilitates motivation and physical activity, there are indications that these expectations are necessarily met. Coined as the 'dirty secret' of fitness tracking technology, every second user is no longer using it – and one-third

[1] Physical activity refers to "any bodily movement produced by skeletal muscle that requires energy expenditure" (WHO 2018a, p. 14) which can be undertaken in different ways (e.g., walking, cycling, sports).

[2] Related terms for 'fitness tracking' also used in this dissertation include: physical activity tracking, activity tracking, self-tracking, or self-quantification (Lupton 2016)

[3] Related concepts are: persuasive technology (Fogg 2003; Oinas-Kukkonen and Harjumaa 2009), gamification (Blohm and Leimeister 2013; Deterding et al. 2011) or positive computing (Peters et al. 2018; Zhang 2007)

stopped within the first six months (Ledger and McCaffrey 2014). Moreover, anecdotal user stories such as 'Why I Got Rid of My Fitbit' (Green 2015) or 'I quit Strava' (November Project 2017) indicate that fitness tracking technology use can also have adverse, demotivational effects.

In existing research, as several reviews point out, the motivational effectiveness of fitness tracking technology is not well understood (Alahäivälä and Oinas-Kukkonen 2016; Hamari et al. 2014a; Hamari et al. 2014b; Johnson et al. 2016; Koivisto and Hamari 2019; Orji and Moffatt 2016). While some studies report positive outcomes on users' motivation and behavior, there is also a considerable amount of studies reporting mixed, neutral, and otherwise inconclusive results (Hamari et al. 2014a; Johnson et al. 2016; Orji and Moffatt 2016). Although research considers the motivational features outlined above as the key to increasing user motivation, research has often examined the fitness tracking technology as a whole, neglecting the particular impacts stemming from these individual features (Hamari et al. 2014b; Koivisto and Hamari 2019). Despite ongoing calls to pay attention to the particular effects (e.g., Koivisto and Hamari 2019; Orji and Moffatt 2016), few scholars have responded; and these few exceptions provide somewhat inconclusive results where certain features have positive impacts in one, but neutral effects in other studies (Hassan et al. 2019; James et al. 2019a; James et al. 2019b; Suh 2018).

Accordingly, the current literature lacks explanations as to how and why fitness tracking technology can promote the anticipated motivational benefits related to physical activity. Hence, scholars call to consider the individual characteristics of the users, such as their motivations and goals, as well as the motivation-psychological processes underlying the use of the motivational features (Alahäivälä and Oinas-Kukkonen 2016; Hamari et al. 2014a; Johnson et al. 2016; Koivisto and Hamari 2019). Moreover, the literature also neglects the potential adverse motivational effects of using fitness tracking technology (Schmidt-Kraepelin et al. 2019) albeit indications exist that fitness tracking technology can undermine intrinsic motivation, induce peer pressure, or otherwise discourage users such as by prompting negative emotions or self-evaluation (Baumgart 2016; Schmidt-Kraepelin et al. 2019; Sjöklint et al. 2015).

In summary, the fitness tracking technology context of consumer health IT is of great practical and academic significance. In terms of its potential to counteract the trend of declining physical activity, the motivational impacts of fitness tracking technology are not well understood, raising questions about the effectiveness of the incorporated motivational features and the role individual motivation and goals play. As such, the fitness tracking technology context is particularly well suited to investigate the relationships between motivation (e.g., exercise goals), ability (e.g., exercise self-efficacy), and opportunity (i.e., fitness tracking technology features) in consumer health IT use while addressing the identified particular research gaps of this context.

2.1.4 Summary

Consumer health IT is an emergent field of the IS research discipline (see Table 1 for an overview). The few existing studies suggest an overall beneficial view as that use of consumer health IT can have positive impacts on health-related cognition (e.g., health literacy), affect (e.g., health attitude), behavior (e.g., self-care activities), and bodily outcomes (e.g., HbA1c improvement). Analysis of the literature indicates that supporting peoples' healthy behavior and well-being through consumer health IT appears to be a function of motivation (e.g., health needs), ability (e.g., health literacy, computer self-efficacy), and opportunity (e.g., type and features of the specific IT). This dissertation aims to get a better understanding about these three components of consumer health IT use in supporting healthy behavior and well-being. For this purpose, this dissertation takes on two research contexts that are of high practical

significance and also ideally suited to examine the three identified components of consumer health IT use while addressing the unique challenges and research gaps of each context: 1) older people and 2) fitness tracking technology. To this end, the twelve papers of this dissertation draw on different theoretical perspectives to examine the role and nature of motivation, ability and opportunity. These are presented next before the research gaps and questions are derived.

2.2 Technology Acceptance, Use, and Continuance Research

IS research uses various theories and models to explain how and why individuals adopt, use, or continue to use IT (Sorgenfrei et al. 2014). Generally, a person's adoption and use of IT occurs in three phases (Figure 3): the pre-adoption phase, the adoption phase and the post-adoption phase (Sorgenfrei et al. 2014). In the pre-adoption phase, a person might have heard about a technology and might acquire knowledge about it. In the adoption phase, a person forms the decision (i.e., intention) to adopt or buy a technology. After having decided to adopt the IT, individuals make initial use of it and transition into the post-adoption phase. In the post-adoption phase, individuals reconsider their adoption decision, explore the IT, or routinize their use, but also make decisions whether to continue or stop using it (Sorgenfrei et al. 2014).

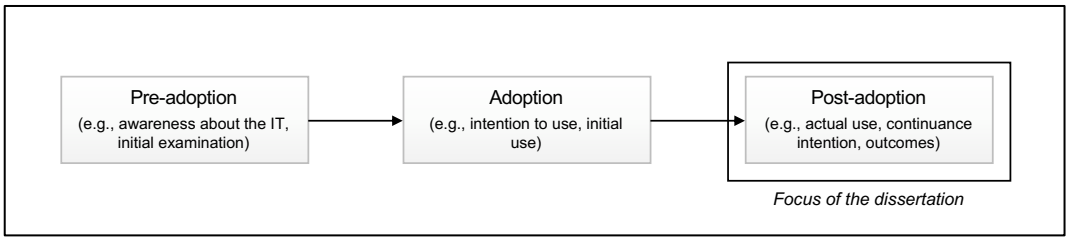


Figure 3. Adoption stages in technology adoption and use

As it is the post-adoption stage where users derive the potential benefits from using the IT (Sorgenfrei et al. 2014), this dissertation focuses on the post-adoption stage and individuals' actual uses of consumer health IT. Next, relevant theories and models are introduced.

2.2.1 Technology Acceptance Model

The well-established Technology Acceptance Model (TAM) (Davis 1989; Davis et al. 1989) explains IT adoption decisions and its initial use. Theoretically based on the Theory of Reasoned Action (Fishbein and Ajzen 1975), the TAM specifies that two core beliefs, perceived usefulness and perceived ease-of-use, influence individuals' behavioral intention to use a technology, which, in turn, leads to actual usage (Figure 4).

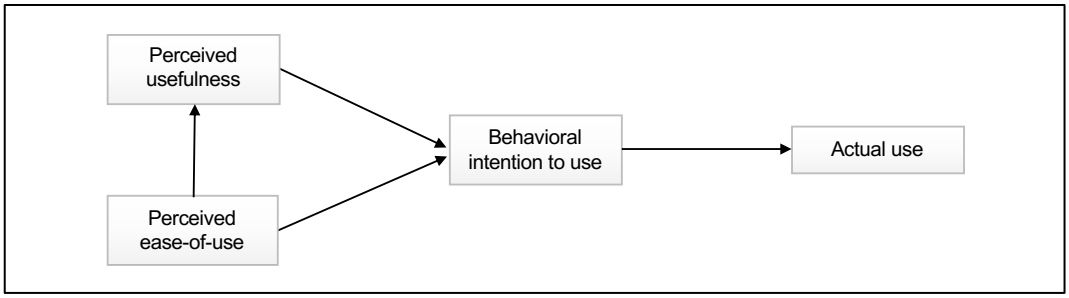


Figure 4. Technology Acceptance Model (Davis 1989)

In its originating organizational context, perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989, p. 320) and perceived ease-of-use as "the degree to which a person believes that using a particular system would be free of effort" (Davis 1989, p. 320). The TAM further posits that usefulness perceptions are also determined by perceived ease-of-use and that all other external factors, such as technology or user characteristics, impact technology adoption only indirectly by influencing these two key beliefs (Davis 1989; Davis et al. 1989).

The core logic of the TAM has been applied in numerous studies and many extensions and modifications of the TAM have been developed in the literature, almost all of which include perceived usefulness and perceived ease-of-use as core drivers of technology adoption (Venkatesh and Bala 2008; Venkatesh and Davis 2000; Venkatesh et al. 2003; Venkatesh et al. 2012; Venkatesh et al. 2016b). Particularly in the context of older people, it has been demonstrated that these two beliefs constitute the key drivers of their technology adoption and use, particularly as older people often perceive themselves as not sufficiently skilled to use IT or do not see the benefits of using IT (Chen and Chan 2011).

2.2.2 Social Cognitive Theory and Technology Use

Social Cognitive Theory (SCT; Bandura 1986) is a theory of human behavior frequently applied in the IS literature to explain various phenomena related to IT use (e.g., Compeau and Higgins 1995b; Wei et al. 2011). SCT centers on the premise that personal factors (e.g., cognitions, personality), environmental factors (e.g., social pressures, situational characteristics), and behavior reciprocally interact and influence each other (Bandura 1986). That is, persons choose the environments in which they want to engage but are also influenced by those environments; personal factors, such as cognitions, determine behavior yet behavior also influences these personal factors; behavior is influenced by the environment and the environment, in turn, is influenced by individuals' behavior (Figure 5) (Compeau and Higgins 1995b).

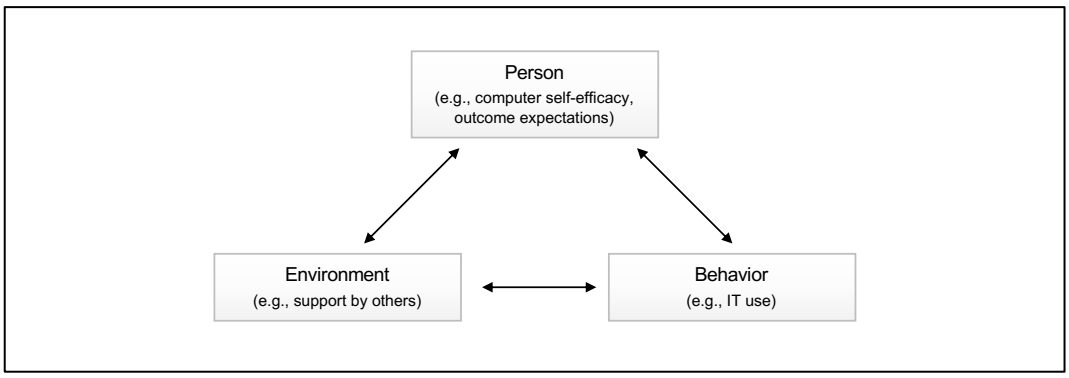


Figure 5. Social Cognitive Theory

A central personal factor in SCT is self-efficacy, defined as the "the belief in one's capability to organize and execute the courses of action required to manage prospective situations" (Bandura 1997, p. 2). A person's self-efficacy is informed by four sources: (1) enactive attainment – the experience of mastery, (2) vicarious experience – the observation of others performing the target behavior, (3) social persuasion – encouragement from others, and (4) physiological states – such as emotional arousal including anxiety (Bandura 1977; 1982).

Adapted to the IS context, computer self-efficacy, defined as the "judgment of one's capability to use a computer" (Compeau and Higgins 1995b, p. 192), has evolved as a core construct in the IS literature, often utilized alongside the key tenets of SCT to examine phenomena such as IT use (e.g., Compeau et al. 1999), computer training (Compeau and Higgins 1995a; Johnson and Marakas 2000; Lam and Lee 2006), and the digital divide (Wei et al. 2011).

Computer self-efficacy impacts a wide range of IS-relevant cognition, affects, and behaviors, including usefulness beliefs (i.e. outcome expectations; Compeau et al. 1999), ease-of-use beliefs (e.g., Venkatesh 2000), computer anxiety (e.g., Thatcher and Perrewe 2002), as well as actual IT use (Davis and Mun 2012; Wang et al. 2013b). As discussed, computer self-efficacy is of particular significance for older people's IT adoption and use (e.g., Niehaves and Plattfaut 2014).

2.2.3 Integrative Framework of Technology Use

After individuals decided to adopt a technology, they gradually transition into the post-adoption phase in which they gain actual experiences in using the technology and also decide whether they continue or stop using it (Sorgenfrei et al. 2014). Persons' evaluations of the focal technology (e.g., usefulness, ease-of-use, enjoyment) are still of relevance in informing their decisions to continue using the technology (Lowry et al. 2015; Venkatesh et al. 2011). Given their central role, it is also important to understand how these evaluations evolve over time.

The Integrative Framework of Technology Use (IFTU) is two-wave panel model of IS continuance behavior which centers on how users' evaluations and usage behaviors evolve as they gain experience with the focal IT (Kim and Malhotra 2005). To this end, the IFTU builds upon four mechanisms (Figure 6): 1) the TAM processes, 2) sequential updating mechanisms, 3) feedback mechanisms, and 4) repeated behavioral patterns (Kim and Malhotra 2005).

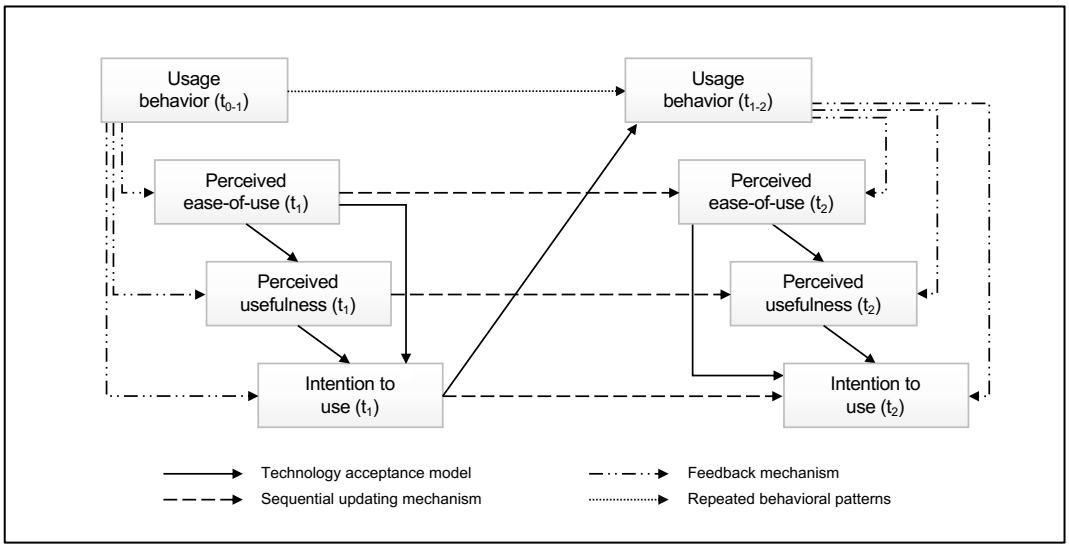


Figure 6. The Integrative Framework of Technology Use (Kim and Malhotra 2005)

The *TAM processes* serve as the theoretical backbone of IFTU, positing that usage intentions determine actual usage behavior. As illustrated in Figure 6, the intention to use of the first wave in t_1 determines the actual usage behavior assessed at the second wave in t_2. Moreover, as per the original formulation of the TAM (Davis et al. 1989), usage intentions, at both points of time t_1 and t_2, are formed by the two beliefs perceived usefulness and perceived ease-of-use.

The *sequential updating mechanism* is used to understand how central beliefs (e.g., perceived usefulness and perceived ease-of-use) evolve and are updated over time. This mechanism is based on Belief Update Theory (Hogarth and Einhorn 1992) which posits that beliefs and intentions are not formed from scratch, but rather develop from prior beliefs and intentions. The prior beliefs and intentions made serve as anchors and any new information serves as an adjustment for these anchors. In IFTU, the beliefs and intentions at t_2 are thus (in part) informed by the beliefs and intentions of t_1 (Kim and Malhotra 2005).

The *feedback mechanism* in IFTU posits that beliefs and intentions are also (in part) determined by the actual usage behavior. The feedback mechanism is informed by Self-perception Theory (Bem 1967) which suggests that individuals do not form specific evaluations until they are asked to do so. Moreover, individuals develop their beliefs by inferring them from their actual behavior such as "I use this software tool every day – thus, I think I like it" (Kim and Malhotra 2005). As such, beliefs and intentions are based on instant evaluations based on past behavior. Kim and Malhotra (2005) hence posit that novice users rather rely on the sequential updating mechanism whereas experienced users more likely rely on the feedback mechanism in their formations of beliefs and intentions.

Finally, *repeated behavioral patterns* posit that past behavior predicts future behavior. Thereby, IFTU draws upon Habit Theory (Triandis 1977) in theorizing the automatic processes underlying the past-future behavior relationship that coexist besides the conscious processes discussed above (Kim and Malhotra 2005).

2.2.4 Exploratory IT Behavior

IT is often equipped with several functionalities and features that aim to support people in their tasks and activities. As such, realization of the anticipated benefits of the focal IT often depends upon the depth of use and the features employed (Burton-Jones and Straub 2006; Jasperson et al. 2005; Sorgenfrei et al. 2014). Research on post-adoption behavior hence seeks to understand how people use and extend their use of the features built into the IT (Jasperson et al. 2005). A key mechanism promoting extended uses is users' exploratory IT behavior.

Exploratory IT behavior, or 'system exploration', refers to the extent to which a user seeks and experiments with new features and explores new ways of using a focal IT (Liang et al. 2015; Peng and Guo 2019). Relatedly, the concept 'Trying to innovate with IT' describes "an individual's goal of finding novel uses of information technologies" (Ahuja and Thatcher 2005, p. 435). The literature posits that users' exploratory IT behavior is a predecessor of enhanced, effective or meaningful uses of the focal IT (Liang et al. 2015; Peng and Guo 2019). This is because by exploring the IT, users discover meaningful features and applications that can be assistive to attain their goals (Liang et al. 2015), which results in higher system utilization so that users use more of the available features (Liang et al. 2015; Maruping and Magni 2012).

Research on exploratory IT behavior particularly takes place in organizational settings examining the impacts of users' exploratory IT behavior on the use of organizational IT such as collaboration technology (Maruping and Magni 2012; 2015) or enterprise resource planning systems (Liang et al. 2015; Peng and Guo 2019). Antecedents of users' exploratory IT behavior discovered so far fall into the categories of technology, user, task, and environment. The technological antecedents reported include the IT's complexity (Liang et al. 2015), modularity (Peng and Guo 2019), and perceived ease-of-use (Peng and Guo 2019). User-related antecedents involve gender (Ahuja and Thatcher 2005; Maruping and Magni 2012), age (Ahuja and Thatcher 2005), IT experience (Ahuja and Thatcher 2005; Peng and Guo 2019), and IT-related self-

efficacy (Liang et al. 2015; Peng and Guo 2019). Associated to the organizational context, task-related antecedents involve, for instance, job autonomy (Ahuja and Thatcher 2005; Liang et al. 2015), task variety (Liang et al. 2015; Peng and Guo 2019), and work overload (Ahuja and Thatcher 2005). Lastly, environmental antecedents include the innovation and team climate (Liang et al. 2015; Maruping and Magni 2012; 2015) or management's commitment to the system (Peng and Guo 2019). Despite the literature's focus on the organizational context, however, exploratory IT behavior holds promises to be applicable in the private context alike.

2.3 Affordance Theory

Understanding the outcomes of IT use is a central issue in the IS literature (Al-Natour and Benbasat 2009). Oftentimes, however, the anticipated benefits of using a focal IT do not unfold for all users to the same extent (Gable et al. 2008; Sabherwal et al. 2006). As just discussed, scholars agree that a holistic perspective on the focal IT may lend misleading conclusions of the observed effects as the causes are not always identifiable hence necessitating examination of the technology's properties and features (e.g., Akhlaghpour et al. 2013; Benbasat and Zmud 2003; Jasperson et al. 2005). At the same time, though, users' choices and goals in employing the IT and its features can differ alike and need to be considered (Al-Natour and Benbasat 2009). By taking both, the IT and the user into perspective, affordance theory receives growing interest amongst IS scholars (Cheikh-Ammar 2018; Markus and Silver 2008; Strong et al. 2014).

Rooted in ecological psychology, affordance theory maintains that actors directly perceive the actionable attributes of an object – what the object allows them to do (Gibson 1986; Stoffregen 2003). Rather than initially perceiving the properties of an object (e.g., a chair's height), actors directly perceive what the object affords (e.g., a chair affords sitting) (Gibson 1986; Seidel et al. 2013). Thereby, affordances are relative to the actor's properties: a chair, for example, affords sitting to adults given their sufficient leg height but not necessarily for toddlers with small legs. A chair affords sitting for an actor with the goal to rest, but a chair also affords standing on for an actor with the goal for reaching something high up (Gibson 1986; Seidel et al. 2013). As such, scholars consider affordances as relations between the environment (objects) and actor rather than only the qualities of the object alone (Chemero 2003; Seidel et al. 2013). Affordances are thus essentially understood as action potentials and reflect the complementarity between an actor and an object (Davern et al. 2012; Gibson 1986).

In the IS context, **affordances** can be referred to as the "possibilities for goal-oriented action afforded to specified user groups by technical objects" (Markus and Silver 2008, p. 622) or "the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an artifact and a goal-oriented actor or actors" (Strong et al. 2014, p. 69). The affordance lens thereby provides the means to examine how users interpret the focal IT including its features in light of their goals (Chan et al. 2019; Seidel et al. 2018). Thus, users' goals shape their perception of what actions an IT affords (Chan et al. 2019; Leonardi 2013; Markus and Silver 2008). However, while most IS scholars focus on the relational view on affordances (i.e., affordances are relationships between the IT and the user), some also consider affordances as dispositional properties of the IT which are intentionally designed into the IT (Norman 1999; Seidel et al. 2018).

IS scholars applying the affordance lens have identified various affordances across a variety of contexts such as organizations' use of big data analytics (Lehrer et al. 2018), blockchain (Du et al. 2019), or social media (Majchrzak et al. 2013); service robots in hospitals (Mettler et al.

2017); unintended uses and effects of social media (Chan et al. 2019); and recently also for fitness tracking technology (James et al. 2019b). Particularly in the latter case, scholars also employ the term **motivational affordance** which transfers the affordance concept to questions of human motivation (Deterding 2011) and is formally defined as "the properties of an object that determine whether and how it can support one's motivational needs" (Zhang 2008, p. 145). Despite the different affordances identified so far, it is important to note that no single set of affordances is applicable to every technology (Markus and Silver 2008); rather, each context requires identification of the salient affordances (Mettler et al. 2017).

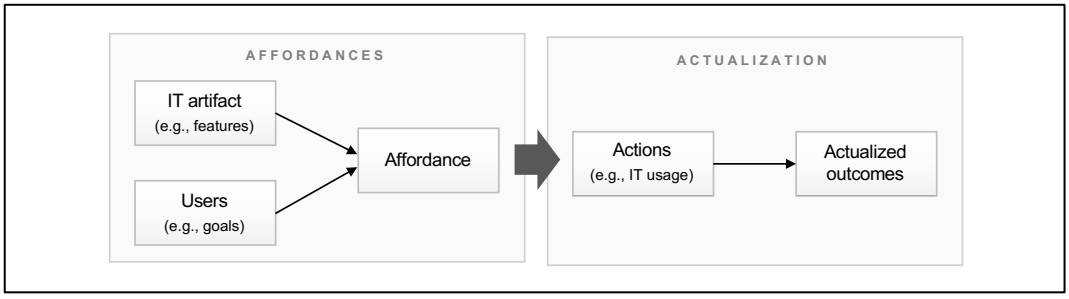


Figure 7. Affordances and affordance actualization in IS research (Du et al. 2019; Strong et al. 2014)

Because affordances reflect opportunities or potentials for action (Hutchby 2001; Stoffregen 2003), affordances should be "understood as potentially necessary (but not necessary and sufficient) conditions for 'appropriation moves' (IT uses) and the consequences of IT use" (Markus and Silver 2008, p. 625). That is, to realize the anticipated benefits and to transform the potential into the actual, affordances must be enacted or 'actualized' (Lehrer et al. 2018; Strong et al. 2014). **Affordance actualization** generally refers to the process with which an actor takes goal-oriented actions to use the technology to achieve an outcome (Du et al. 2019; Strong et al. 2014).

In summary, the affordance lens goes beyond studying the mere features uses of IT but to concentrate on the "digitally enabled actions and their outcomes" (Tim et al. 2018, p. 49). Affordances are thus propagated to provide a concrete understanding about the uses of a focal IT (Tim et al. 2018) and hence to study 'effective uses', i.e. that type of IT use that helps its users to attain the desired goals (Burton-Jones and Volkoff 2017).

2.4 Theories of Human Motivation

Human motivation concerns the processes that give behavior its energy and direction (Reeve 2005). Motivation scholars hence seek to understand the sources of human motivation and their resulting behavior and suggest that both the person and her environment are influential (Reeve 2005). Two well-known and established theories of human motivation that consider these dual sources are Achievement Goal Theory (Ames 1992; Nicholls 1989) and Self-determination Theory (Deci and Ryan 2012; Ryan and Deci 2017) with particularly strong support in the physical activity context (Duda and Appleton 2016; Ntoumanis 2001).

2.4.1 Achievement Goal Theory

Achievement Goal Theory (AGT; Ames 1992; Nicholls 1989) is a social-cognitive framework of human motivation with strong empirical support in the education and physical activity context

(Roberts et al. 2007). AGT posits that persons are goal-directed beings and that, accordingly, their motivation and behaviors are directed by so-called achievement goals (Roberts et al. 2007). In AGT, achievement refers to the attainment of a goal with personal or social value such as skill acquisition or demonstration of superior skills (Roberts et al. 2007). In its traditional sense, AGT distinguishes between two types[4] of achievement goals: *mastery goals* focus on competence development, emphasizing improvement and effort in a self-referential manner; *performance goal*s are normative-referenced definitions of competence emphasizing interpersonal comparisons, evaluations and demonstration of ability to others (Harackiewicz and Elliot 1993). Noteworthy, these two achievement goals can be salient within the individual – referred to as goal orientations – and be stressed within one's social environment, called goal structures (Ames 1984; Dweck and Leggett 1988).

Goal orientations are the mastery and/or performance goals emphasized by the individual and can be situational or dispositional (Nicholls 1989). Individuals with a high mastery goal orientation thrive for competence development, believing that competence and mastery is the result of hard work and effort (Maehr and Zusho 2009). Mastery-oriented persons value the process of learning rather than the outcome and are interested in the progress they make in self-referenced manner (Ames 1992; Elliot and McGregor 2001). Individuals with a high performance goal orientation, on the other hand, define achievement on normative bases, strive to demonstrate competence, show superior ability, outperform others, and gain favorable judgments from others (Maehr and Zusho 2009).

Goal structures, also referred to as the 'motivational climate' (Ames 1992), are the achievement-relevant and goal-related emphases within the social environment of the individual (Ames 1984; Dweck and Leggett 1988). They are based on environmental practices such as specific messages sent by social actors like teachers, sports coaches, teammates or peers (Ames 1992; Murayama and Elliot 2009). Goal structures alike can have an emphasis on mastery and performance goals. A mastery goal structure emphasizes improvement and understanding. Here, sports coaches, for example, orient their athletes toward improvement emphasizing working hard and doing their best (Duda 2013). A performance goal structure stresses relative ability, social comparison, and interpersonal competition (Ames 1992; Murayama and Elliot 2009). A performance goal structure is created, for example, when sports coaches judge individual's abilities in comparison with other athletes and emphasize outperforming teammates (Duda 2013).

As both, goal orientations and goal structures, are influential for motivation and its outcomes (e.g., behavior, performance), scholars consider different relationships between these concepts as well as their combinatory effects (Figure 8) (Murayama and Elliot 2009; Roberts et al. 2007).

[4] The two achievement goals can be further distinguished along the dimension of approach, which considers promotion and pursuit, and avoidance, which considers loss prevention (Maehr and Zusho 2009). In this dissertation, achievement goals refer to the approach dimension.

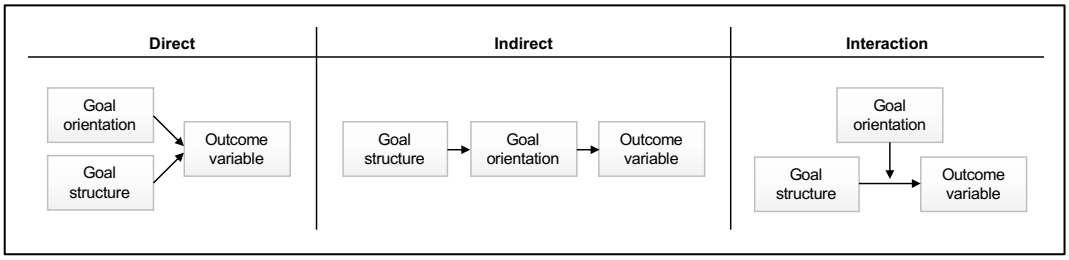


Figure 8. Relationships of goal structures and goal orientations (based on Murayama and Elliot 2009)

According to the direct effect model, goal orientations and goal structures directly and independently influence motivation-relevant outcomes (Murayama and Elliot 2009). The indirect effect model posits that goal structures indirectly impact motivation-relevant outcomes by prompting individuals to adopt an achievement goal orientation, such that a performance goal structure, for instance, promotes performance goal orientation adoption (Murayama and Elliot 2009). Lastly, the interaction effect model posits that goal orientation moderates the impact of goal structures such that both components have interactive effects on the outcome of interest (Murayama and Elliot 2009). Though only few examined this relationship (e.g., Lau and Nie 2008; Linnenbrink 2005), their interaction can be generally thought of 'matching' effects (Jagacinski et al. 2001; Murayama and Elliot 2009). That is, most positive outcomes are expected when goal orientations and goal structures are congruent ('match') concerning their emphasis on mastery and performance goals: individuals with a strong mastery goal orientation are expected to achieve higher motivational outcomes when acting within a mastery goal structure whereas individuals high in a performance goal orientation are best situated within a performance goal structure (Jagacinski et al. 2001; Murayama and Elliot 2009).

2.4.2 Self-Determination theory

Self-determination Theory (SDT; Deci and Ryan 2012; Ryan and Deci 2017) is fundamentally concerned with human motivation, behavior, and well-being. A key contention of SDT is that all human beings have three innate, basic psychological needs which need to be satisfied for optimal human functioning: autonomy, competence, and relatedness (Deci and Ryan 2012). Autonomy is the need for the self-regulation of one's actions and experiences – acting volitionally and congruently with one's true interests and values; competence is the need to feel able to operate effectively in life contexts, to feel effectance and mastery; relatedness is the need to feel socially connected, to feel cared for by others and to be a member of a social group (Ryan and Deci 2017). Greater satisfaction of these three needs is linked to optimal motivational outcomes and well-being (Ryan and Deci 2017), including motivation, engagement, and persistence in physical activity (see e.g., Ng et al. 2012; Teixeira et al. 2012). Albeit SDT posits that all three needs are essential for optimal human functioning, their salience can vary according to the context (Ntoumanis et al. 2009).

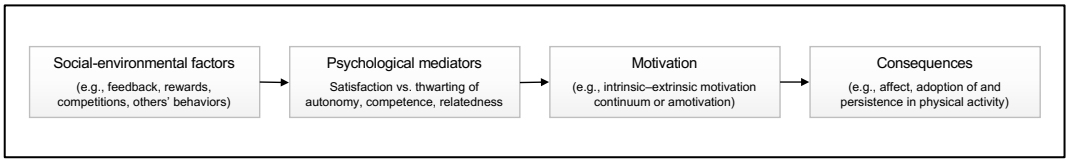


Figure 9. Motivational sequence of Self-determination Theory (based on Vallerand and Losier 1999)

Social-environmental factors, such as feedback, rewards, or competitions, are highly influential as these can either satisfy or thwart (i.e., actively suppress) one's basic psychological needs and thereby cause various psychological and behavioral reactions (Bartholomew et al. 2011; Gunnell et al. 2013; Ryan and Deci 2017; Vallerand and Losier 1999). SDT thus distinguishes between need-supportive environments and need-thwarting environments. In terms of sports, a need-supportive environment which satisfies an athlete's need for autonomy is when a sports coach acknowledges the individual preferences of the athlete and gives her choice; the need for competence is satisfied by providing optimal challenges and constructive feedback; and the need for relatedness is satisfied, for instance, through the encouragement of teammates (Jõesaar et al. 2011; Ng et al. 2012; Ryan and Deci 2017). Need-thwarting environments, in contrast, are characterized as overly challenging, discouraging, critical, negative, impersonal and rejecting, and control individuals' behaviors through surveillance, task-contingent rewards, negative feedback, and external pressures (Ng et al. 2012; Ntoumanis et al. 2009; Ryan and Deci 2017). While need-supportive environments lead to human thriving and well-being, need-thwarting environments cause motivational depletion, exhaustion, and ill-being (Bartholomew et al. 2011; Ryan and Deci 2017). In essence, SDT specifies the processes underlying the motivational impacts of social-environmental factors (Figure 9).

2.5 Research Questions

This dissertation seeks to develop an understanding of how consumer health IT can support people's healthy behavior and well-being. The review of the literature on consumer health IT provides indications that supporting healthy behavior and well-being involves people's motivation (e.g., health needs) and ability (e.g., health literacy, computer self-efficacy) as well as the opportunity provided by consumer health IT (e.g., type and features of the specific IT). To examine the role and relationships of these three components and their joint impacts on healthy behavior and well-being, this dissertation takes on two research contexts, older people and fitness tracking technology, while addressing their unique research gaps. Therefore, this section is structured according to these two contexts, recalls their research gaps, and derives according research questions that contribute to the overall objective of this dissertation.

2.5.1 Research Questions on Older People's Use of Consumer Health IT

The first research context of this dissertation centers on older people's use of consumer health IT. As discussed in section 2.1.2, literature on older people's adoption and use of IT in general (Niehaves and Plattfaut 2014; Tams et al. 2014; Tams et al. 2018) and of consumer health IT in particular (Fox and Connolly 2018), points at the influential role of older people's IT-related self-efficacy. Despite these observations, however, older people's development of IT-related self-efficacy is less well understood calling for specific causes and sources of their IT-related self-efficacy (Fox and Connolly 2018; Tams et al. 2014).

Social Cognitive Theory, the theoretical origin of IT-related self-efficacy, posits that self-efficacy is informed by actual experiences, observation of others, encouragement from others, and emotional arousal such as anxiety (Bandura 1977; 1982). A potential context providing these sources is older people's past workplace in which they could have made actual experiences using IT and also received social and formal support in using IT such as through coworkers' support and mutual help in using computers as well through formal computer training. In the realm of the digital divide, which also entails older people, an identical yet still unanswered question raised by Dewan and Riggins (2005, p. 313) is: "if employees are provided access [to IT] within the workplace, to what extent does the support, training, and socialized context of the workplace

promote home use and skill development?". Transferring this question into the context of older people and their use of consumer health IT, the first research question is:

> ***RQ 1:*** *How does the past workplace influence older people's IT-related self-efficacy and their use of consumer health IT in consequence?*

In recent times, older people's adoption of mainstream technologies, such as the Internet and smartphones, has increased considerably (Anderson and Perrin 2017; ARD/ZDF 2019). Despite having access to IT by now, older people often underutilize their IT and instead continue with their traditional media practices (Nimrod 2017). This is particularly observable in the consumer health IT context as older Internet users are less likely to utilize the Internet to retrieve health information online compared to younger people (Fox and Duggan 2013). Post-adoption IS research indicates that exploratory IT behavior – the extent to which a user seeks out and experiments with available features to find novel uses of IT (Ahuja and Thatcher 2005; Peng and Guo 2019) – can promote higher utilization of a given IT (Liang et al. 2015; Maruping and Magni 2012). As this mechanism, however, has been examined mainly in the organizational context of IT use, research misses an understanding of the antecedents and consequences of exploratory IT behavior in the private context. Accordingly, the second research question is:

> ***RQ 2:*** *How does older people's exploratory IT behavior promote consumer health IT use?*

By addressing these two research questions, this dissertation aims to contribute to the understudied area of older people in the IS literature and to extend existing research on older people, which focuses mostly on initial IT adoption, by a post-adoption perspective which have been both called for by Tams et al. (2014) in their strategic research agenda on older people.

2.5.2 Research Questions on Fitness Tracking Technology

The second research context of this dissertation focuses on fitness tracking technology which gains increasing public (Statista 2018; WHO 2018b) and scholarly interest (Hamari and Koivisto 2015; James et al. 2019b) for its potentials to enhance people's physical activity motivation and behavior. As discussed in section 2.1.3 above, fitness tracking technology offers a variety of 'motivational features' users can draw upon to motivate themselves including features to analyze exercise performance, to facilitate goal setting and attainment, to earn virtual rewards, or to connect with other users to support and compete with each other (Hamari et al. 2018; James et al. 2019a; Stragier et al. 2018). Although these features are considered as the core aspects of fitness tracking technology, their actual 'motivational effectiveness' is not well understood (Koivisto and Hamari 2019). The nascent research available so far often examined the fitness tracking technology as a 'whole' hence neglecting the individual features incorporated so that the actual impacts of the features are mostly unknown (e.g., Koivisto and Hamari 2019).

To better understand the role of these features and their potentials to enhance motivation and physical activity, Affordance Theory (Gibson 1986) can be potentially assistive. In the IS context, the concept of affordances describes the possibilities for goal-oriented action afforded technical objects (Markus and Silver 2008). The affordance lens is advocated to provide a "concrete understanding of the uses of the technological artifact and the related implications for individuals' behaviors" (Tim et al. 2018, p. 4) and hence to study effective IT use, i.e. "that type of use that helps attain desired goals" (Burton-Jones and Volkoff 2017, p. 468). Affordances go beyond a mere focus on features of technology as affordances consider the potential ways of using them as perceived by an individual (Grgecic et al. 2015). Thus, this dissertation asks:

> ***RQ 3:*** *What are the affordances of fitness tracking technology?*

As affordances reflect potentials for action (Hutchby 2001; Stoffregen 2003), Affordance Theory further posits that in order to realize the anticipated benefits, affordances must be enacted (Lehrer et al. 2018; Strong et al. 2014). The anticipated benefits of fitness tracking technology can be generally referred to as enhancements of people's physical activity motivation and behavior. As discussed, however, the actual motivational impacts stemming from the use of features are not well understood (Hamari et al. 2014b; Koivisto and Hamari 2019). Specifically, the few studies assessing the impacts of the used features tend to provide mixed and inconclusive results. As example, the use of features providing means for social interaction is found to enhance users' subjective vitality (e.g., James et al. 2019b), but others found no effects on users' reported benefits for motivation and physical activity (Hassan et al. 2019).

Scholars call into considering the motivational processes underlying the feature use (i.e., affordance enactment) to explain the motivational impacts and to resolve the inconsistencies in prior research (Hamari et al. 2014a; Koivisto and Hamari 2019; Orji and Moffatt 2016). Hereto, Self-determination Theory posits that the influence of social-environmental factors, such as feedback, rewards, or competitions, on a person's motivation and behavior takes place through the extent these factors satisfy the person's basic psychological needs for autonomy, competence, and relatedness (Ryan and Deci 2017; Vallerand and Losier 1999). The notion of basic psychological need satisfaction can potentially provide explanations about the underlying motivational processes and the impacts on people's physical activity motivation and behavior resulting from fitness tracking technology feature use. Hence, the fourth research question is:

> ***RQ 4:*** *How does enactment of the fitness tracking technology affordances affect users' needs for autonomy, competence, and relatedness and their physical activity motivation and behavior in consequence?*

A second potential explanation for these inconsistencies might be the different goals people strive for when conducting physical activity. Scholars call into attention that because people are differently motivated, an application of the features might not suit a 'one-size-fits-all' approach (Hamari et al. 2014b; Seaborn and Fels 2015). However, despite the awareness about interpersonal differences, the role of these individual users characteristics, such as their motivations and goals, has been rarely examined (Alahäivälä and Oinas-Kukkonen 2016; Koivisto and Hamari 2019; Orji and Moffatt 2016; Sardi et al. 2017). The notion of users' goals is central to Affordance Theory as users' goals shape their perception of what actions an IT and its features afford (Chan et al. 2019; Leonardi 2013; Markus and Silver 2008). In the context of motivation, Achievement Goal Theory suggests two central goals, namely mastery goals and performance goals, to guide persons' motivation and behaviors but also their reactions to environmental factors (Ames 1992; Nicholls 1989; Roberts et al. 2007). Particularly in the latter case, Achievement Goal Theory posits that optimal motivational outcomes emerge when the achievement goals pursued by the individual 'fit' or 'match' those achievement goals facilitated by environmental factors (Murayama and Elliot 2009). Accordingly, Achievement Goal Theory holds potentials to better understand the relationship between users' goals and the affordances of fitness tracking technology as well as their resulting impacts on physical activity motivation and behavior. Accordingly, this dissertation asks:

> ***RQ 5:*** *How do achievement goals influence the enactment of the affordances and the outcomes – in terms of increased motivation and physical activity – of fitness tracking technology use?*

While both practice and literature hold generally optimistic views that using fitness tracking technology supports people's motivation and physical activity, two indications dampen these

expectations. First, many fitness tracking technology users stop their use within the first months (Ledger and McCaffrey 2014). Second, anecdotal user stories indicate that using fitness tracking technology can also have adverse, demotivating impacts on the users which might cause the lowered fitness tracking technology continuance (Barratt 2017; Foss 2014; Hargrave 2013; November Project 2017), such as negative emotional reactions about one's physical activity behavior (Baumgart 2016; Sjöklint et al. 2015) or negative evaluations of one's ability (Hargrave 2013). Research on fitness tracking technology, however, neglects so far these unintended and adverse impacts and calls for their examination (Koivisto and Hamari 2019; Schmidt-Kraepelin et al. 2019). Accordingly, the research question is:

> ***RQ 6:*** *How do adverse consequences of fitness tracking technology use emerge and, in consequence, influence continued fitness tracking technology use decisions?*

2.6 Summary

This section discussed the characteristics of the consumer health IT context highlighting the diversity of individuals and their health-related conditions, the personal and sensitive nature of health, and the significance of people's health for their overall quality of life and function within the society (Fichman et al. 2011). To understand how consumer health IT can potentially support healthy behavior and well-being, analysis of the literature revealed three components: people's motivation (i.e., health-related needs and goals) and ability (i.e., IT-related and health-related abilities) and the opportunities provided by the different consumer health IT tools and applications (i.e., type of consumer health IT and its features).

To better understand the nature, role, and relationships of motivation, ability, and opportunity in affecting people's healthy behavior and well-being, two distinct research contexts were discussed: older people and fitness tracking technology. Based on the unique challenges of both contexts and the theoretical perspectives presented, research gaps and according research questions were derived, which this dissertation aims to answer. To this end, different research approaches and methods are used as presented in the next section.

3 METHODOLOGY

This dissertation employs different research approaches and methods to answer the research questions developed above. Figure 10 provides an overview of the research methods employed, the research approach these methods follow and the papers that use these methods.

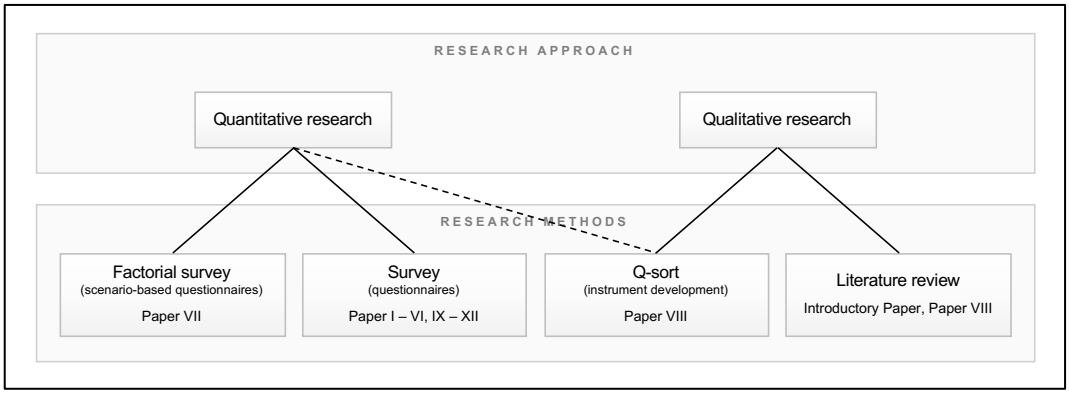


Figure 10. Overview of research methods in this dissertation

Generally, research approaches can be categorized according to *empirical vs. non-empirical* and *qualitative vs. quantitative* (Chen and Hirschheim 2004). While empirical studies are based on observations and data, non-empirical approaches center on ideas and concepts (Chen and Hirschheim 2004). Non-empirical approaches facilitate concept and theory development and empirical approaches provide concrete evidence (Chen and Hirschheim 2004). This distinction between qualitative and quantitative research can be understood as follows.

Qualitative research approaches center on "the description and understanding of the situation behind the factors" (Chen and Hirschheim 2004, p. 205). Generally, qualitative approaches are beneficial for exploratory stages of research, when the phenomenon of interest is emerging, not well examined, and hence not fully understood (Recker 2013). Thus, non-empirical approaches fall into the qualitative dimension of research as they center on concept and theory development (Chen and Hirschheim 2004). The literature review and the conceptual framework development presented in section 2.1.1 of this Introductory Paper adopts a qualitative approach. Moreover, Paper VII employs a qualitative research approach to identify salient affordances in fitness tracking technology as well as to develop corresponding measurement instruments (see also section 3.4).

Quantitative research approaches, in contrast, analyze quantitative data to answer research questions (Recker 2013). Specifically, quantitative approaches rely on numbers to represent the values of theoretical constructs and the interpretation of these values is used to provide evidence about a phenomenon (Recker 2013). Accordingly, measurement is the focus of quantitative research approaches (Recker 2013). Moreover, quantitative research employs statistical approaches which usually follow the "effects-of-causes" approach seeking to answer questions like "what is the effect of A on B" (Mahoney and Goertz 2006). That is, researchers seek to examine the average effect of one or more causes across a broader population so that outcomes of individual cases are not of concern (Mahoney and Goertz 2006). Quantitative approaches are most appropriate when the state of prior related theory and research is intermediate to mature, so that the theoretical contributions are validations and/or extensions

through new constructs, contexts, or boundaries (Edmondson and McManus 2007). In general, quantitative research approaches are most popular in IS research, particularly surveys (Chen and Hirschheim 2004). Papers I-VI and VIII-XII adopt a quantitative research approach.

Table 3 provides an overview of the empirical studies of this dissertation that are explained in detail in section 3.2 (Study I, II, V), section 3.3 (Study III), and section 3.4 (Study IV).

Study	Type	Context	Participants	Reported in
Study I	Survey	Older people's Internet use	165	Paper I, Paper II
Study II	Survey	Older people's use of consumer health IT	234	Paper III, Paper IV, Paper V, Paper VI
Study III	Factorial survey	Emotions and fitness tracking technology continuance	345	Paper XII
Study IV	Q-sort	Affordances of fitness tracking technology	7 and 55	Paper VII
Study V	Survey	Strava use	514	Paper VIII, Paper IX, Paper XI, Paper X

Table 3. Overview of empirical studies and methods

3.1 Literature Review

The main literature review on consumer health IT is presented in the theoretical background (section 2.1) in this Introductory Paper. This literature review examines the current state of existing research on consumer health IT in the IS literature centering on the research contexts as well as tools and applications of consumer health IT, the health-related outcomes of using consumer health IT, and the role of health-related and IT-related individual differences. This central literature review serves as the foundation to seek answers on the overall research question concerning *how consumer health IT can support healthy behavior and well-being* and to identify research gaps.

This dissertation takes a common approach to conducting a literature review (Webster and Watson 2002). First, the search scope and the timeframe are specified. The definition of the search scope involves the selection of the journals in which relevant research is published. As the eight journals in the so-called 'AIS Senior Basket' (i.e., ISR, MISQ, JMIS, EJIS, ISJ, JAIS, JIT, and JSIS) are of high significance for IS research (Lowry et al. 2013), research published in these journals in the last ten years was reviewed (2008–2019). Because consumer health IT is an umbrella term including a broad variety of technologies, a manual search through these journals was conducted and the thematic relevance of the articles was assessed based on title, abstract, and keywords. In the second step, the resulting articles were structured in a concept-centric approach to synthesize the current state of literature (Webster and Watson 2002). Here, the key concepts reviewed include the *health IT context including its tools and applications*, the *health-related outcomes*, as well as the role of *health-related individual differences* and *IT-related individual differences* in consumer health IT. This concept matrix is shown in Table 1 and discussed in section 2.1 of this Introductory Paper.

In addition, Paper VII includes a literature analysis to identify the affordances in fitness tracking technology and reviews related concepts from neighboring fields, including gamification (e.g., Blohm and Leimeister 2013), persuasive system design (e.g., Oinas-Kukkonen and Harjumaa 2009), motivational affordances (e.g., Zhang 2008), social media affordances (e.g., Karahanna et al. 2018), and behavior change (e.g., Michie et al. 2011).

3.2 Survey Research

Survey research is the dominant research method of quantitative research approaches employed in the IS literature (Chen and Hirschheim 2004). A survey is a means to obtain information about the characteristics, perceptions, beliefs, attitudes, or opinions of a larger group of individuals, groups, or organizations (Recker 2013). Surveys are suitable for answering research questions such as "what is happening", "how and why is it happening" or "is it happening at all" (Recker 2013). As such, survey research is particularly suitable to understand how and why people perceive, react to, and make use of consumer health IT.

Surveys can be conducted with different techniques including printed questionnaires, online questionnaires, or live/telephone interviews (Recker 2013). The data collected in surveys is usually analyzed statistically such as by using structural equation modeling (see section 3.5).

As shown in Table 3, most of the studies and papers comprising the body of this dissertation are based on traditional survey research. Specifically, **Study I** is a survey on older people's use of the Internet that informed Papers I–II. Specifically, Study I assesses older people's IT-related traits (e.g., computer self-efficacy, personal innovativeness in IT), their current Internet use, and their past Internet use at work. This study targets elderly individuals who are difficult to reach (e.g., Guo et al. 2013; Heart and Kalderon 2013; Srivastava and Panigrahi 2019), particularly as online surveys attract the technology-savvy segment of this population. The study was conducted using printed questionnaires and respondents were recruited randomly from public locations in southern Germany (e.g., train stations, libraries, gyms, adult schools, or senior citizen centers). To encourage participation, respondents were incentivized with the chance to win a tablet computer. The questionnaire was pre-validated with 18 respondents from the target group to ensure readability, comprehensibility and proper wording and hence the executability of the survey (Recker 2013). In total, a total of 165 responses were collected and in accordance of the papers' sampling strategies corresponding subsets of the responses analyzed (n=135 in Paper I and n=146 in Paper II).

Study II is a survey on older people's use of consumer health IT that assesses the beliefs and use of consumer health IT alongside personal health-related factors (e.g., health status, health literacy), IT-related traits (e.g., computer self-efficacy), but also general past IT use at the workplace. This study is used in Papers III–VI. As was the case with Study I, this survey targeted elderly individuals and was carried out using printed questionnaires and participants recruited at public spaces (e.g., pedestrian zones, adult schools, senior citizen centers) in the United States. A total of 234 responses were collected from which subsets have been analyzed according to each paper's sampling strategy (n=132 in Paper III; n=156 in Paper IV, n=180 in Paper V; n=219 in Paper VI).

Study V is a survey on individuals' use of a popular fitness tracking application called 'Strava' (www.strava.com). The questionnaire focused on the use of the fitness tracking app (i.e., features used, continuance intentions, experience, beliefs and perceptions), individuals' physical activity (e.g., exercise self-efficacy, achievement goals), as well as motivational effects and outcomes gained from using this application (e.g., psychological need satisfaction, increased motivation towards physical activity). This study informed Papers VIII–XI. The study was targeted at users of the Strava fitness tracking app and carried out as an online survey. Participants were recruited using an online panel provided by Amazon Mechanical Turk (MTurk). MTurk is widely recognized as a viable and reliable source for empirical IS research (e.g., Jia et al. 2017; Lowry et al. 2016; Steelman et al. 2014) and IS research on fitness tracking

technology in particular (e.g., James et al. 2019a; James et al. 2019b). Following IS-oriented guidelines on MTurk (Jia et al. 2017), responses were restricted to the United States as such responses provide reliable results similar to regular consumer panels (Steelman et al. 2014). Only participants who reported that they currently use Strava were permitted to participate in the survey. To safeguard response quality, IP addresses were recorded and checked for non-unique occurrence in the data and several 'attention traps' (e.g., "if you read this carefully, please respond with 'rather disagree'") were incorporated (Lowry et al. 2016). Respondents were incentivized with one USD. In total, 514 responses of Strava users were obtained and response subsets were analyzed based on the safeguarding means and sample requirements of the papers (n=417 in Paper VIII; n=283 in Paper IX and Paper XI; n=286 in Paper X).

In all studies, participants were assured of the confidentiality, anonymity, and academic purpose of the study, and that there are no wrong or right answers, which served to mitigate the potential influence of common method bias (see section 3.5.3) (Podsakoff et al. 2003).

Each paper reports the corresponding sample profile (e.g., respondents' characteristics such as demographics), the items of the questionnaire, as well as their validity and reliability (see section 3.5.1) (Recker 2013). A conventional survey research, as described here, is, however, a non-experimental research method such that this method does not involve controlling or manipulating certain variables (Recker 2013). To overcome this limitation, Paper XII employs a particular derivate of survey research, called 'factorial survey design' as outlined next.

3.3 Factorial Survey Research

Factorial survey design (Lauder 2002; Rossi and Nock 1982) – also called vignette methodology (Aguinis and Bradley 2014) – combines surveys with experimental methods and is thus a suitable way of collecting larger number of participants while allowing for control and manipulation of variables (Lauder 2002). As such, factorial survey research has the benefits of experimental methods, especially internal validity, as it provides the means to isolate, control, and assess specific variables (causes) and to examine the consequences on other variables (effect) (Recker 2013).

The factorial survey design method employs short vignettes to examine how people understand and react to particular situations (Lauder 2002). A vignette is "a short, carefully constructed description of a person, object, or situation, representing a systematic combination of characteristics" (Atzmüller and Steiner 2010, p. 128). Vignettes are typically in written format, but can be utilized through images, videos, or other media (Aguinis and Bradley 2014). In factorial survey design studies, vignettes are presented to study participants and participants are then requested to make explicit decisions, judgments, or choices, or to express their behavioral reactions (Aguinis and Bradley 2014). As such, vignettes can be used to elicit individuals' beliefs, attitude, judgments, or intended behavior (Atzmüller and Steiner 2010) which are central to most theories and models of IS-related behaviors. The strength of factorial survey designs and vignettes lies in the ability to simulate real world events and to manipulate variables (Gould 1996; Lauder 2002).

Study III employs a factorial survey design using vignettes to examine how emotions influence individuals' decisions to continue using fitness tracking technology (see Paper XII). This is because specific emotions arise out of specific real world events and their emergence is bound to specific event characteristics (Lazarus 1991). The emergence of happiness, pride, or sadness, for example, require the event to have goal-relevance for the person (Lazarus 1991). For

example, a person might seek to achieve a certain physical activity goal like running for a longer time or distance; the feedback provided by a fitness tracking device or app therefore has goal relevance for the user. Moreover, the occurrence of happiness and pride requires goal-congruence of the event: if the goal is met, then happiness is likely to occur and if the goal is even surpassed, then pride is likely to occur (Lazarus 1991). Sadness, in contrary, emerges only under the condition of goal-incongruence (Lazarus 1991). Thus, if the performance result presented by an activity tracker displays that a person met her goal of running for a longer time or distance, the person is likely happy; if the performance results exceeds the person's goal, then the person is likely proud; and if the person failed to meet her goal, then the person is likely sad.

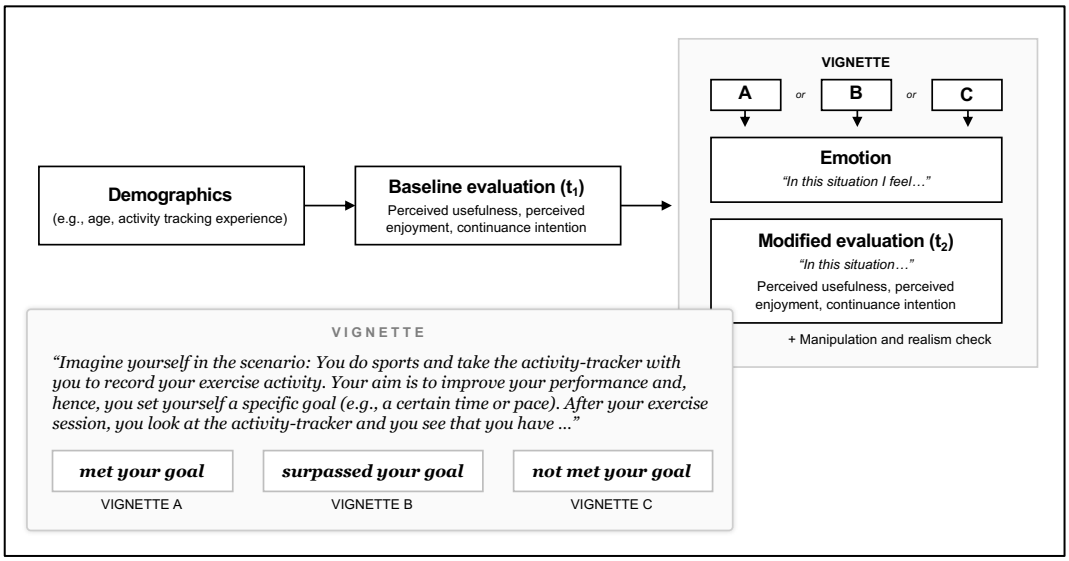


Figure 11. Factorial survey design of Paper XII

Hence, a vignette-based factorial survey can provide the necessary means to simulate these real-world events that specify the emergence of certain emotions. Figure 11 depicts the survey structure of Study III. Study participants were first asked to provide demographic information, followed by an evaluation of their general beliefs and continuance decisions. Then participants were requested to imagine themselves in a situation of doing sports using an activity tracker and having the goal to improve their performance. Each participant was randomly assigned to one of the three scenarios in which their performance 1) met the goal, 2) surpassed the goal, or 3) did not meet the goal. Participants were then requested to evaluate their beliefs and activity tracking continuance decisions in this situation. Furthermore, realism and manipulation check questions were incorporated to ensure that the vignettes were perceived as realistic and that the intended manipulations were actually perceived by the participants (Dennis et al. 2012; Johnston et al. 2016).

Furthermore, to ensure sufficient randomization, participants' demographics across the different groups were statistically compared. Likewise, to evaluate whether the manipulation evoked the intended change (i.e., type of emotional reaction), the manipulated variables were also statistically compared across the groups (Robert et al. 2009). After manipulation validity was established, the data was further analysed.

3.4 Q-Sort and Instrument Development

All papers except Paper VII rely on quantitative survey methods that assess people's perceptions, beliefs, attitudes, or uses of consumer health IT. Because quantitative research focuses on measurement, researchers must ensure that the employed measurement instrument (e.g., questionnaire) measures what they intend it to measure, i.e. the contents of theoretical constructs of interest (Haynes et al. 1995; Recker 2013). That is, researchers must establish content validity of the measurement instrument to ensure that items correctly represent the targeted construct and do not have similar meanings as other constructs (Haynes et al. 1995).

Formally, content validity refers to "the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose" (Haynes et al. 1995, p. 238). Researchers usually rely on available instruments of prior research to assess existing constructs. However, when new constructs are developed and/or according measurement instrument are not available, such as when new affordances are identified (Paper VII), new instruments need to be developed. Here, establishment of content validity is the first and crucial step in the development of new items (MacKenzie et al. 2011).

The practice of content validation is a "multimethod, quantitative and qualitative process" and is applied to increase "the probability of obtaining supportive construct validity indices in later studies" (Haynes et al. 1995, p. 244). For the systematic and rigorous development and evaluation of new measurements, a two-step procedure is recommended: 1) develop a pool of candidate items, and 2) assess their content validity using q-sort methodology (Moore and Benbasat 1991; Nahm et al. 2002).

The first step is to generate a pool of items that represent the conceptual domain of a construct (MacKenzie et al. 2011). These items should be written with simple, specific, and concise words to avoid ambiguity (Podsakoff et al. 2012). The contents of these items can be informed by variety of sources, such as literature and empirical studies relevant to the construct, existing and related measurement instruments, rational deductions, as well as by suggestions from experts and target populations (Haynes et al. 1995).

In the second step, the resultant initial pool of candidate items is then evaluated using q-sort methodology (also called 'card-sorting') (Moore and Benbasat 1991; Nahm et al. 2002). Here, individuals such as experts and candidates from the target population sort the items by assigning them to one of the different constructs which they think best reflect the item. Each construct is named and defined, and an 'ambiguous' category is additionally included to prevent forcing respondents to assign problematic or ambiguous items. If an item is consistently assigned to one construct, it demonstrates 'convergent validity' with that construct and 'discriminant validity' with all other constructs (Moore and Benbasat 1991). To assess the reliability of the sorting, two metrics are evaluated: 1) levels of agreement between the raters (raw agreement and Kappa) and 2) a 'hit-ratio' reflecting the frequency of correct assignments (Moore and Benbasat 1991; Nahm et al. 2002). To evaluate the level of agreement (Kappa values), the following interpretations have been proposed: < 0.00 (poor), < 0.20 (slight), < 0.40 (fair), < 0.60 (moderate), < 0.80 (substantial), and < 1.0 (almost perfect) (Landis and Koch 1977). Items with less than 0.61 agreement should be removed (Landis and Koch 1977). The hit-ratio (item placement ratio) serves as an indicator of how many items were assigned to the intended construct by the raters (Moore and Benbasat 1991). Albeit no evaluation guidelines for this ratio exist, it helps to identify any problematic areas (Moore and Benbasat 1991). This procedure (i.e., item optimization, reduction, and sorting) is repeated until satisfactorily results

are achieved. After content validity has been established, researchers continue evaluating the psychometric properties of the newly developed instruments (i.e., construct reliability and validity, cf. section 3.5.1) using larger quantitative studies (MacKenzie et al. 2011).

Study IV employs q-sort method for the evaluation of content validity of newly developed measurement instruments for the affordances of fitness tracking technology (reported in Paper VII). After a pool of initial items was developed from corresponding definitions and related literature, these items were evaluated using q-sort. The q-sort procedure was administered using an online tool ('OptimalSort') and conducted in two rounds (n=7 and n=55). Results of the first round – conducted with seven colleagues and friends – indicated overall moderating agreement and pointed at some areas for improvement. After revision, a second round was conducted where participants were recruited using an online panel (MTurk; see also section 3.2). Response quality was safeguarded with attention traps and participants were paid 0.7 USD. Final results of 55 participants with sufficient background expertise of fitness tracking technology provided an overall 'substantial agreement' between respondents and an overall hit-ratio of 90%, such that adequate content validity was achieved. The measurement instrument is utilized in Study V and Papers VIII–XI, which provide evaluation of the instrument's psychometric properties.

3.5 Structural Equation Modeling

Papers I–VI and VIII–XII use quantitative research approaches with structural equation modeling (SEM) to analyze the data and to test the hypotheses. SEM belongs to the class of multivariate statistical tools and so-called second-generation statistical methods that are often applied in the behavioral, managerial, health, and social sciences (Bagozzi and Yi 2012). Precisely, SEM are "statistical procedures for testing measurement, functional, predictive, and causal hypotheses" (Bagozzi and Yi 2012, p. 8). The primary advantage of SEM lies in its combination of aspects of factor analysis and regression which enables the simultaneous examination of the relationships between the measured and latent variables (the so-called measurement model) as well as the relationships between the variables (the so-called structural model) as depicted in Figure 12 (Gefen et al. 2011; Hair et al. 2014).

In SEM, the central variables of a theory and the focal research model are usually called 'latent variables' or 'constructs', and are depicted by the ellipses Y_1-Y_4 and Z_1 in Figure 12[5] (Bagozzi and Yi 2012). The connections between the latent variables are represented by arrows (e.g., $Y_1 \rightarrow Y_4$), called 'paths', which are causal relationships used to test a hypothesis (Bagozzi and Yi 2012). For example, Y_1 depicts 'perceived usefulness' of a system and Y_4 depicts 'intention to use' the system, so that the arrow connecting them means that 'intention to use' is a function of 'perceived usefulness' (Bagozzi and Yi 2012; Venkatesh et al. 2003). Each of the latent variables is connected to designated measurements, also called 'manifest variables', 'empirical variables', 'observations', 'indicators' or 'items' (X_1-X_{12} in Figure 12) (Bagozzi and Yi 2012). The arrows connecting the measurements with the latent variables can differ in direction (i.e., outbound or inbound), which is a matter of whether the latent variable is measured 'reflective' or 'formative'.

[5] Note: the latent variable Z_1 is a special kind of construct, a so-called 'second-order construct' which is explained in more detail in section 3.5.5

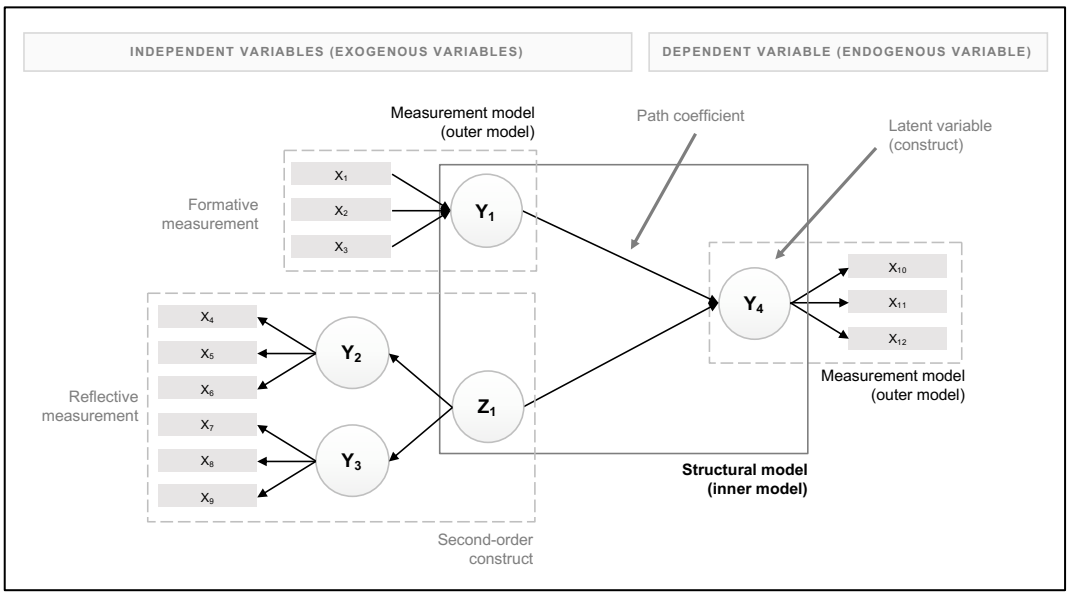


Figure 12. PLS path model (Hair et al. 2014)

Measurement is fundamental to empirical research in social sciences, particularly in quantitative approaches (Hair et al. 2014). Several things can be directly 'measured' as a variable for analysis, such as height using a ruler, body weight using a scale, temperature using a thermometer, or vehicle speed using the speedometer of the car (Hair et al. 2014). However, variables such as satisfaction, trust, or usefulness perceptions are abstract, complex, and not directly observable. In such cases, one speaks about latent (i.e., unobservable) variables or constructs (Hair et al. 2014). Albeit these latent variables cannot be directly measured like body weight, one can draw upon indirect measures by using a set of indications that serve as proxy variables (Gefen et al. 2011; Hair et al. 2014). Each indicator then represents a certain aspect of the larger concept (i.e., the intended latent variable). For instance, the rather abstract construct 'perceived usefulness' of a spreadsheet software can be measured via an employee's agreement to statements like "Using the spreadsheet software improves my productivity" or "Using the spreadsheet software enables me to accomplish tasks more quickly" (Davis 1989). As mentioned before, these indicators can be utilized to measure a latent variables in either reflective or formative ways (Hair et al. 2014).

In **reflective measurement models** (e.g., constructs Y_2 and Y_3 in Figure 12), as the name implies, the indicators' contents reflect the meaning of the construct. Because they reflect the meaning of the construct, the indicators should be highly correlated (Hair et al. 2014). Moreover, the indicators should be interchangeable and single indicators can be removed without altering the meaning of the construct (Hair et al. 2014). The aforementioned 'perceived usefulness' construct is measured in a reflective manner with cited indicators (Davis 1989). The logic behind using several indicators reflecting the construct's meaning is to increase measurement accuracy and validity (Hair et al. 2014).

In contrast, in **formative measurement models** (e.g., construct Y_1 in Figure 12), the indicators are not interchangeable (Hair et al. 2014). Rather, each indicator captures a particular aspect of the construct's meaning such that, jointly, all items define the constructs' meaning (Hair et al. 2014). In consequence, omitting an indicator potentially changes the

meaning of the construct and researchers must be careful to ensure that the meaning of the construct is captured by all corresponding indicators (Hair et al. 2014).

Constructs can also be conceptualized as first-order constructs (e.g., constructs Y_1-Y_3 in Figure 12) or as second-order constructs (e.g., construct Z_i in Figure 12). A second-order construct, also called 'higher-order construct, is itself a composite of first-order constructs which assess specific dimensions and is applied when capturing latent variables at a higher abstraction (Hair et al. 2014). A detailed explanation is given in section 3.5.5.

The two most common approaches to SEM in the IS literature are covariance-based SEM (CB-SEM) and variance-based partial least squares SEM (PLS-SEM) (Gefen et al. 2011; Hair et al. 2014). These approaches differ in their underlying philosophy, assumptions of data distributions, and estimation objectives (Gefen et al. 2011). CB-SEM is preferable when the research objective is to test or confirm a theory or compare a theory with alternative theories, with the objective of confirming structural relationships (Hair et al. 2011). Because PLS-SEM is prediction-oriented and aims to maximize the explained variance in the dependent constructs, PLS-SEM is favored for theory development such as exploration or extending existing structural theories (Hair et al. 2011). Because this dissertation seeks to develop understanding of phenomena that has not been the focus of extensive prior IS research (e.g., older people, fitness tracking technology), this dissertation employs the PLS-SEM approach to analyze quantitative empirical data. Further advantages associated with PLS-SEM are its ability to work with wider ranges of samples sizes, less restrictive data requirements (such as normal distributions), and its ability to deal with model complexity (many constructs and measurements) (Hair et al. 2011).

In applying PLS-SEM, the papers in this dissertation use the software SmartPLS in its version 3 (Ringle et al. 2015). Data analysis using PLS-SEM usually proceeds in two steps: evaluation of the measurement model, followed by evaluation of the structural model (Chin 1998). These two steps and corresponding evaluation criteria are explained next.

3.5.1 Measurement Model Assessment

Before assessing the structural model and testing corresponding hypotheses, the measurement model needs to be evaluated. For reflective measurements, as consistently used in all papers using PLS-SEM, evaluation centers on validity and reliability. The rationale for this first step is that without establishing confidence in the measurements applied, there is little reason to observe the structural relationships and hence to pursue hypotheses testing (Hair et al. 2011).

Validity is concerned with whether measurement variables indeed measures what researchers want to measure – the construct's content (Recker 2013). Reliability, on the other hand, focuses on whether the measurement variables measure the construct consistently and precisely (Recker 2013). Validity and reliability are also referred to as the 'the psychometric properties of measurement variables' (Recker 2013).

As graphically depicted in Figure 13, validity and reliability can be understood using the analogy of a dartboard where the darts are understood as the measurement variables and the construct's validity is the centre of the board (Hair et al. 2011; Recker 2013). Thus, the closer the darts and hence measurement variables are to the centre, the higher their validity is (Hair et al. 2011). Reliability is the distance between the single darts fired – the closer they are to each other, the higher the reliability (Hair et al. 2011). Confidence in the adequacy of the measurements is established when all the measurement variables are very close to the center of the board and very close to each other, as depicted on last dartboard to the right in Figure 13 (Recker 2013).

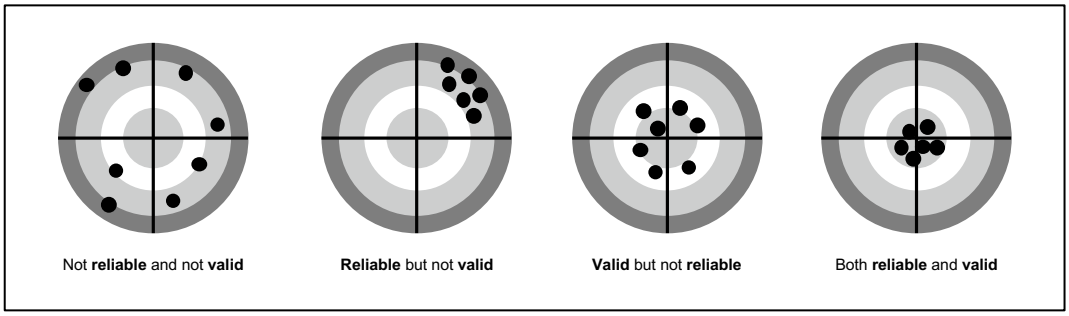


Figure 13. Reliability and validity (Recker 2013)

Table 4 provides an overview of specific evaluation criteria for validity and reliability that are explained next.

Content validity ensures that measurement items correctly represent the targeted construct and do not have similar meanings as items of other constructs (Haynes et al. 1995). Content validity is usually ensured by relying on established measurement instruments of prior research. If measurement instruments need to be newly developed, such as in the case of newly identified affordances (Paper VII), then content validity needs to be evaluated accordingly (see section 3.4). Bearing in mind that evaluation of content validity is a more qualitative concern than a strictly statistical matter, inter-rater agreements and hit ratios can serve as indications of content validity though.

Criterion	Measure	Evaluation guideline
Content validity	(Interrater Agreement, Hit-Ratio)	Evaluation is more a qualitative than quantitative approach
Discriminant validity	Indicator's cross-loadings	Indicator's loading on designated construct > loading on other constructs
	Fornell-Larcker criterion	Construct's AVE > its highest correlation with other constructs
	Heterotrait-monotrait ratio (HTMT)	< 0.85 or 0.90 (acceptable)
Convergent validity	Average variance extracted (AVE)	> 0.50
Construct reliability	Cronbach's Alpha	> 0.70 (> 0.60 in exploratory stages)
	Composite reliability	
Indicator reliability	Indicator outer loadings	> 0.707 and significant

Table 4. Evaluation criteria of reflective measurement models (Hair et al. 2014)

Discriminant validity refers to "the extent to which a construct is truly distinct from other constructs by empirical standards" (Hair et al. 2014, p. 104). Hence, discriminant validity ensures that the construct captures phenomena not represented by other constructs (Hair et al. 2014). Three measures of discriminant validity are applied. First, by examining the indicators' cross-loadings, discriminant validity is supported when each indicator loads highest on its designated construct (Hair et al. 2014). Second, the Fornell-Larcker criterion specifies that discriminant validity is supported when the square root of each construct's AVE is greater than its highest correlation with other constructs (Fornell and Larcker 1981; Hair et al. 2014). That is, a construct shares more variance with its designated indicators than with other constructs (Hair et al. 2014). Third, the hetero-monotrait ratio (HTMT) should be lower than 0.85 albeit values below 0.90 are deemed acceptable (Henseler et al. 2015).

Convergent validity is understood as extent to which a construct's indicator correlates positively with alternative indicators of the same construct (Hair et al. 2014). Establishment of convergent validity involves evaluation of each construct's average variance extracted (AVE) which needs to be at least 0.50 in order to ensure that the construct is able to explain on average at least half of its indicators' variance (Hair et al. 2011; Hair et al. 2014).

Construct reliability refers to a construct's internal consistency (Hair et al. 2011). Estimates of construct reliability are Cronbach's Alpha and Composite Reliability (Hair et al. 2011). For both criteria, values should be at least 0.70 in advanced stages of research and at least 0.60 for exploratory stages to provide confidence in construct reliability (Hair et al. 2011; Nunnally and Bernstein 1994)**.**

Indicator reliability is represented by an indicator's outer loading and its significance, which should be at least 0.70 and significant respectively (Hair et al. 2011; Hair et al. 2014).

3.5.2 Structural Model Assessment

After establishment of confidence in the measurement models' adequacy, analysis proceeds with an assessment of the structural model (Chin 1998). Primary evaluation criteria for the structural model are the significance and magnitude of the path coefficients, the coefficient of determination (R^2), and effect sizes (Hair et al. 2011; Hair et al. 2014). A summary of these criteria is presented in Table 5 and explained next.

Criterion	Evaluation guideline
Significance of path coefficients	t-values for two-tailed test: 1.65 = 10% significance level 1.96 = 5% significance level 2.57 = 1% significance level
Sign of path coefficients	According to its assumed direction
Magnitude of path coefficients	The closer to 0, the weaker the relationship
Coefficient of determination (R^2)	Depending on subject matter, rule-of-thumb: > 19% = weak > 33% = moderate > 67% = substantial
Effect size (f^2)	> 0.02 = small effect > 0.15 = medium effect > 0.35 = large effect

Table 5. Evaluation criteria of structural models (Hair et al. 2014)

The **path coefficients** in the structural model represent the hypothesized relationships between the constructs (Hair et al. 2014). Path coefficients have standardized values ranging between -1 to +1 indicating the strength of negative or positive relationships respectively (Hair et al. 2014). The significance of path coefficients is determined with a bootstrapping procedure (Hair et al. 2011). Whereas significant paths in the proposed direction support a proposed hypothesis, insignificant path and/or directions contrary to assumptions do not lend support (Hair et al. 2011). In addition to significance and direction, researchers assess the magnitude: the closer the path coefficient is to 0, the weaker the relationship is (Hair et al. 2014).

The **coefficient of determination (R^2)** is a measure of the model's predictive accuracy and represents the combined effects the independent variables have on the according dependent variable (Hair et al. 2014). R^2 values range from 0 to 1 with higher numbers representing higher

explanatory power (Hair et al. 2011). However, what values of R^2 can be regarded as high depends on the research discipline and study's subject (Hair et al. 2011). Nonetheless, as a rule-of-thumb, Chin (1998) suggest that R^2 values of 0.67, 0.33, or 0.19 can be interpreted as substantial, moderate, or weak, respectively.

In addition to the overall explanatory power of the model, the actual effect of each independent variable on the dependent variable can be identified by its **effect size (f^2)** (Hair et al. 2014). The effect size can be assessed by the change in the R^2 when omitting the construct of interest compared to its inclusion (Hair et al. 2014). Effect sizes of 0.02, 0.15, and 0.35 can be interpreted as small, moderate, and large effects respectively (Cohen 1988).

3.5.3 Common Method Bias

Common method bias (CMB; also "common method variance") refers to "variance that is attributable to the measurement method rather than to the construct of interest" (Bagozzi and Yi 1991, p. 426). The term "method", in this context, is more broadly concerned with the form of measurement such as the content of items, response format, scale types, general instructions, or the general context (Bagozzi and Yi 1991). In quantitative empirical behavioral research, including the IS discipline, agreement appears amongst scholars that CMB is a potential problem (Aguirre-Urreta and Hu 2019). There are at least two major detrimental effects caused by common method biases (MacKenzie and Podsakoff 2012). First, the presence of CMB can lead to biased estimates of construct validity and reliability and hence incorrect conclusions drawn about the adequacy of the employed scales (detailed explanations in section 3.5.1). Second, CMB can lead to biased estimates of the relationships between the constructs and, in consequence, can affect hypotheses testing (e.g., Type I or Type II errors) or lead to incorrect conclusions about the explained variance (MacKenzie and Podsakoff 2012).

CMB is likely to be caused by a variety of sources including a common rater (e.g., consistency motif, illusory correlations, social desirability, mood), item characteristics (e.g., ambiguity, common scales or anchors), item context (e.g., priming), or measurement context (e.g., independent and dependent variables assessed at the same time, location, or same medium) (Podsakoff et al. 2003). Accordingly, researchers should apply techniques to prevent the influence of CMB during data collection but should also apply detective techniques to assess the presence of the CMB in the data (Aguirre-Urreta and Hu 2019).

Preventive techniques – or "procedural remedies" – are applied to minimize or to altogether avoid the emergence of CMB during data collection, mostly through optimization of the data collection instrument (Podsakoff et al. 2003). Whenever possible, it is recommended to a) obtain responses for independent and dependent variables from different sources (e.g., employee and supervisor), b) to have a temporal, proximal, psychological, or methodological separation of the measurements, c) to protect respondents' anonymity and threat of evaluation, and d) to counterbalance the question order (Podsakoff et al. 2003).

Detective approaches – or "statistical remedies" – are statistical approaches to control for CMB and to generally inform about its presence within the data collected (Aguirre-Urreta and Hu 2019). Amongst others, the following approaches have been proposed.

Harman's single-factor test is one of the most widely applied techniques for the detection of CMB (Aguirre-Urreta and Hu 2019; Podsakoff et al. 2003). Using this technique, all items/variables are entered into an exploratory factor analysis. Then, the unrotated factor solution is examined in order to define the numbers of factors needed to account for the

variable's variance. According to this test, a substantial amount of CMB is present when only one factor emerges or when one general factor accounts for more than 50% of the variable's variance (Podsakoff et al. 2003). Despite its widespread application among scholars, however, concerns about the suitability to reliably detect CMB have been raised (Malhotra et al. 2006; Podsakoff et al. 2003). Most recently, scholars provided evidence using real world data where biases have been experimentally induced (Schwarz et al. 2017) as well as simulations (Aguirre-Urreta and Hu 2019) that this test is unsuitable to reliably detect the presence of CMB.

Examination of the correlation matrix, as proposed by Pavlou et al. (2007), involves an assessment of the correlation matrix of the variables. The assumption of this approach is that extremely high correlations ($r > 0.9$) are an indicator of CMB.

Collinearity assessment of the variables is another technique proposed by Kock (2017). In this test, the variance inflation factors (VIF) for all latent variables are observed and VIF values above 3.3 are an indication of CMB.

The *Unmeasured Latent Method Construct (ULMC) technique* involves the creation of a latent variable that represents a "method effect" (Liang et al. 2007; Richardson et al. 2009; Schwarz et al. 2017; Williams et al. 2003). This method effect construct consists of all indicators (i.e., assessed items) of the study (Schwarz et al. 2017). Moreover, all indicators are additionally transformed into single-item constructs. Then, the respective influence of the theoretical construct is compared to the influence of the method effect factor. The ULMC test has been applied in more recent IS studies (Laumer et al. 2016; Liang et al. 2007; Maier et al. 2015). Nonetheless, concerns of the test's suitability to detect CMB have been raised (Chin et al. 2012), even though Schwarz et al. (2017) recently demonstrated that the ULMC is generally able to detect and estimate CMB.

Accordingly, all empirical studies of this dissertation employed preventive techniques to mitigate the potential influence of CMB during data collection. Moreover, most papers also applied preventive techniques.

3.5.4 Meditation and Moderation

The analytical approaches explained so far centre mostly on direct relationships between two variables without considerations of any other variables (i.e. direct model in Figure 14). In many cases, however, two variables may only be indirectly associated with each other such that relationships only exist when considering additional variables (called 'mediation') or the relationships between two variables vary because of additional variables, so-called 'moderation' (Hair et al. 2014). Figure 14 below illustrates the differences between the direct, the mediation and the moderation model.

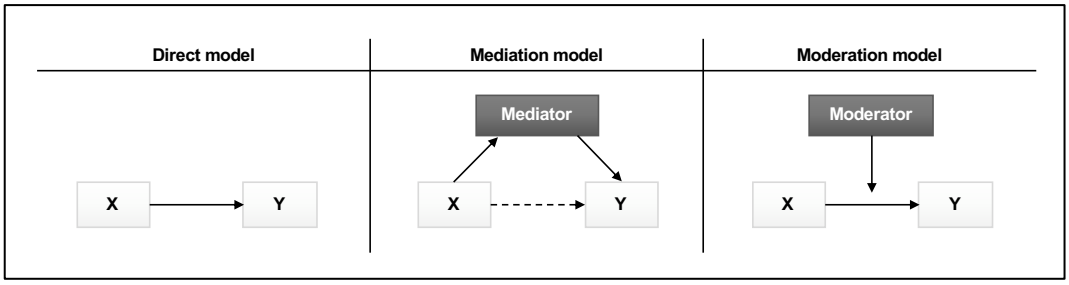


Figure 14. Mediation and moderation

3.5.4.1 Mediation

Mediation helps the researcher to "understand the process by which X affects Y" (Iacobucci 2008, p. 1) and, in particular, whether a relationship between two variables exists because of an intermediate third variable. Mediation can be understood as the "mechanism through which an independent variable might affect a dependent variable—not directly, but rather through an intervening process, captured by the mediator variable" (Iacobucci 2008, p. 1). Mediators serve to illuminate how or why certain effects occur – that is the underlying 'process' or 'mechanism' (Baron and Kenny 1986; Preacher and Hayes 2004). As such, mediation is of interest in theory building for many social scientists (Iacobucci 2008). Formally, a variable is considered to be a 'mediator' by "the extent that it accounts for the relation between the predictor and the criterion" (Baron and Kenny 1986, p. 1176). Hair et al. (2014) illustrate mediation with the example of seawater temperature as a cause of swimming incidents. It might be assumed that the lower the water temperature, the higher the number of incidents because cold water leads to a quicker exhaustion and many swimmers might misjudge their abilities. Statistical results, however, indicate a positive relationship meaning that with higher temperature the number of incidents increases. However, when taking the 'number of swimmers' in the water into the model, it turns out that with higher water temperature, the more swimmers are in the water, which, in turn, leads to a higher number of incidents. Hence, the variable 'number of swimmers' serves as a mediator to explain the relationship between water temperature and number of incidents (Hair et al. 2014). Within the IS literature, a well-known example of mediation is found in the technology acceptance model (Davis 1989) that postulates that all external variables (e.g., user training) influence a user's system usage decisions through influencing the user's beliefs about using the system, in particular via beliefs about the usefulness and ease-of-use of the system (see section 2.2.1).

The most common methodological approaches to test mediation formally are Baron and Kenny (1986) and Preacher and Hayes (2004). According to Baron and Kenny (1986), mediations occurs when: 1) the independent variable X significantly influences the dependent variable Y, 2) the independent variable X significantly influences the mediator variable, and 3) the mediator variable exerts a significant influence on the dependent variable Y while controlling for the impact of X on Y. However, as the procedure of Baron and Kenny (1986) is not without criticism (e.g., Zhao et al. 2010), an alternative approach is the bootstrapping procedure of Preacher and Hayes (2004).

Moreover, mediation can be either full or partial. Full mediation occurs when the prior significant relationship between X and Y becomes insignificant when entering the mediation relationship. Partial mediation occurs when both, the direct and the mediated relationship, are significant. Paper III and Paper X employ a formal mediation test.

3.5.4.2 Moderation

Moderation occurs when the strength or even direction between two variables X and Y are altered by a third 'moderating' variable (Hair et al. 2014). Because people often differ in their perceptions and evaluations of variables, including technology-related variables like usefulness or ease-of-use perceptions, relationships between variables may also yield differences across different respondents (Hair et al. 2014). In IS research, individual differences, including variables such as gender, age, or technology experience, regularly serve as such moderating variables (Venkatesh et al. 2003). For example, the relationship between usefulness perceptions of a focal technology and an individual's intention to use it is stronger for younger individuals

and for men whereas ease-of-use beliefs have a stronger influence on use intentions for women or older individuals (Venkatesh et al. 2003).

Figure 14 shows such a moderation model where the relationship between X and Y is influenced by a third moderator variable. Because effect sizes (f^2) in moderation-relationships are usually smaller compared to direct-relationships (Aguinis et al. 2005; Kenny 2015), a more 'realistic' effect size interpretation is suggested to be 0.005, 0.01, and 0.025 for small, medium, and large effect sizes respectively (Kenny 2015).

Moreover, there are two types of moderating relationships: continuous and categorial (Hair et al. 2014). A *continuous moderating effect* exists for metrically measured variables such as age, whereas a *categorial moderating effect* refers to categorial data such as gender (Hair et al. 2014). The latter is often also of interest when comparing the same model across subsamples of a population, for example high- and low-experienced users, to examine whether there are differences between the two groups. Such tests are often conducted by *multigroup analyses* which allow to examine whether the relationships between variables (i.e., path coefficients) differ between groups (Hair et al. 2014).

In this dissertation, Papers III–V and IX-XI employ moderation analyses with categorial (e.g., gender) and/or continuous (e.g., age, goals, health need, self-efficacy) variables. Paper VI and Paper XII employ a multigroup analysis using PLS to understand differences for entire models between two groups (i.e., retired vs. non-retired people and novice vs. experienced users).

3.5.5 Hierarchical Component Models

The constructs (or 'latent variables') discussed so far can be characterized as having a single layer – so-called 'first-order' constructs (Hair et al. 2014). In certain instances, however, constructs are operationalized at a higher level of abstraction (Hair et al. 2014). For instance, one might conceptualize the construct 'service satisfaction' with subdimensions such as service quality, personnel satisfaction, or price satisfaction (Hair et al. 2014). As such, 'service satisfaction' serves as a multidimensional higher-order (or 'second-order') construct consisting of lower-order (or 'first-order') constructs (see also construct Z_1 in Figure 12 for a graphical representation). Although this process can be extended in infinite ways, most higher-order constructs consist of two layers (Hair et al. 2014). In general, such higher-order models are called 'hierarchical component models' (HCM) in the PLS-SEM context (Hair et al. 2014).

There are at least two main reasons for HCM promoted in the literature (Hair et al. 2014; Wetzels et al. 2009). First, HCM facilitates theoretical parsimony as with the reduction of constructs (via abstraction), the number of relationships within the model are reduced and the model is easier to comprehend (Edwards 2001; Wetzels et al. 2009). Second, HCMs are useful when the constructs are highly correlated resulting in otherwise collinearity and discriminant validity issues (Hair et al. 2014).

Conceptually, HCM can be distinguished by the relationship between the higher-order construct and its dimensions (i.e. lower-order constructs). A *superordinate construct* is technically equivalent to a reflective measurement – a general concept represented by its specific dimensions (Edwards 2001; Wright et al. 2012). A superordinate construct has been also called a "molecular model" (Wetzels et al. 2009). An *aggregate construct* is the technical equivalent to a formative measurement model so that the higher-order construct is created with formative subdimensions – the specific subdimensions combine to produce the construct (Edwards 2001). Synonyms include "molar model" (Wetzels et al. 2009).

Operationally, the development of higher-order constructs and implementation into the structural model follows a two-step approach (Hair et al. 2014). In the first stage, the latent variable scores for each lower-order construct are obtained which, in the second stage, serve as the indicators for the corresponding higher-order construct. Evaluation of the psychometric properties of the higher-order construct follows according to its conceptualization (i.e., reflective vs. formative) (Hair et al. 2014; Wright et al. 2012).

HCM is applied in Paper X, where the affordances of the fitness tracking technology are conceptualized at a higher level of abstraction. For example, the higher-order construct 'self-quantification' is represented by the lower-order constructs 'self-monitoring' and 'performance analysis'. In this case, HCM facilitates model parsimony and reduction of complexity at the conceptual level and prevents collinearity and discriminant validity issues at the empirical level.

3.5.6 Path Comparison Analysis

Whereas moderation, particularly multigroup analysis, seeks to understand differences for path relationships between groups, researchers are also often interested which of the independent variables exhibits the strongest relationship with and impact on a dependent variable. In this case, researchers are more interested in comparing the path coefficients between several independent on a dependent variable.

When seeking to understand the influences of many independent variables (e.g., perceived usefulness, satisfaction) on a dependent variable (e.g., IS continuance intention), scholars often find that the independent variables exert relationships with differing strength (magnitude) with the dependent variable and may draw conclusions such as "satisfaction was the stronger predictor of continuance intention in this study than perceived usefulness" (Bhattacherjee 2001, p. 364) and provide corresponding practical implications.

To provide confidence in the interpretation of path comparisons, statistical tests of path differences are advocated (Chin et al. 2013). Paper VIII employs a formal path comparison test with a bootstrapping approach in PLS-SEM to compare the influences of two different exercise goals on corresponding affordances.

3.6 Summary

In summary, this dissertation employs qualitative, non-empirical and quantitative, empirical research methods to respond to the specific research questions. The qualitative, non-empirical methods serve for conceptual developments including the general research framework of this dissertation (section 2.1.1), to identify salient affordances of consumer health IT and to develop measurement instruments (section 3.4). The quantitative, empirical research methods – mainly survey-based studies – are used to examine the relationships between the different factors and variables, i.e., the different relationships between motivation, ability, opportunity, and outcomes of consumer health IT use. The results are presented in the next section.

4 MAIN RESEARCH RESULTS

The results of the twelve papers are structured according to the two research contexts. The first six papers focus on older people's use of IT in general and consumer health IT. The second six papers focus on fitness tracking technology. Each paper provides answers to the specific research questions (section 2.5) and thereby examines different facets of motivation, ability, and opportunity of consumer health IT (section 2.1.1.5). Table 6 provides an overview of the factors examined regarding motivation, ability, and opportunity alongside the results and implications.

Paper	Motivation	Ability	Opportunity	Result
Context: Older people				
Paper I		Computer/ Internet self-efficacy		Older people's IT-related self-efficacy predicts most strongly the intensity of their Internet use (i.e., advanced IT uses). *» IT-related ability necessary for advanced IT uses.*
Paper II		Computer/ Internet self-efficacy		Past Internet use at work is an antecedent of older people's IT-related self-efficacy, which, in turn, predicts their private Internet use. *» IT-related ability determined by prior experiences.*
Paper III		Computer self-efficacy		Older people's computer self-efficacy influences consumer health IT use by enhancing their associated usefulness beliefs but not directly. *» IT-related ability accounts only indirectly for consumer health IT use.*
Paper IV	Health need	• Computer self-efficacy • Health knowledge	• Health decision support • Health management	Older people's different uses of consumer health IT are differently determined: use for health decision support predicted directly by perc. usefulness and health knowledge; use for health management predicted by perc. usefulness and perc. ease-of-use. Computer self-efficacy only indirectly predicts these uses; health needs strengthen the influence of perc. usefulness. *» Realization of opportunities differently determined; motivation enhances the impact of usefulness perceptions on consumer health IT use; health-related ability influences ease-of-use perceptions.*
Paper V	Health need	Health knowledge	Online health information	Older people's exploratory IT behavior predicts alongside perceived usefulness and health knowledge their online health information use. The influence of exploratory IT behavior gets stronger with increasing age. Exploratory IT behavior and perc. usefulness are determined by health need and health knowledge. *» Realization of opportunities is differently caused; motivation strengthens the impact of usefulness perceptions on consumer health IT use; health-related ability influences ease-of-use perceptions; IT-related ability indirectly influences consumer health IT use.*
Paper VI		• Computer self-efficacy • Health knowledge	Online health information	Older people's health knowledge increases through the use of online health information. This use is predicted by exploratory IT behavior, which, in turn, is predicted by their computer self-efficacy and determined by past work IT intensity. All relationships and effects are stronger for retired people than non-retired people. *» Realization of opportunities provided by consumer health IT contributes to health-related, cognitive outcomes. IT-related ability indirectly influences consumer health IT use.*

Paper	Motivation	Ability	Opportunity	Result
Context: Fitness tracking technology				
Paper VII			Eight affordances	Identifies salient affordances in fitness tracking technology: Self-monitoring, Performance analysis, Exercise guidance, Rewards, Social comparison, Watching others, Social recognition, Self-presentation. Moreover, corresponding measurement instruments are developed and evaluated for content validity. *» Different opportunities provided by fitness tracking technology that potentially motivate users.*
Paper VIII	• Mastery goal orientation • Performance goal orientation		• Self-monitoring • Exercise guidance • Rewards • Social comparison	Users' mastery and performance goal orientations drive distinct fitness tracking technology feature uses (i.e., specific affordance enactments): Mastery goals mainly determine self-monitoring and exercise guidance affordance enactments; performance goals primarily determine social comparison, rewards, and exercise guidance affordance enactments. *» Different motivations drive distinct patterns of realized opportunities provided by the IT.*
Paper IX	• Mastery goal orientation • Performance goal orientation		• Self-monitoring • Rewards • Social comparison	Enactment of fitness tracking affordances determines the motivational benefits gained (i.e., increased motivation and physical activity), and these achieved benefits vary with users' motivation-relevant goals. *» Engagement with provided opportunities results in anticipated outcomes; yet realized opportunities and motivations need to 'fit' for optimal outcomes.*
Paper X	• Mastery goal orientation • Performance goal orientation	Controls: • Fitness tracking experience • Exercise self-efficacy	• Self-quantification • Exercise control • Social interaction	The motivational benefits gained from the enacted affordances takes place through the satisfaction of psychological needs for autonomy, competence, and relatedness. The influence on need satisfaction varies with users' goals. *» Engagement with provided opportunities satisfies users' motivational needs and thereby leads to realization of health-related outcomes; satisfaction of needs varies by the motivations.*
Paper XI		Exercise self-efficacy	• Self-monitoring • Rewards • Social recognition	Specific affordances can cause both satisfaction and thwarting of competence needs (positive and negative effects) and, in turn, influence decisions to continue using the fitness tracking technology. Users' with low exercise self-efficacy react more strongly to need satisfaction and thwarting. *» Provided opportunities can also have adverse impacts on users' motivational need; health-related ability serves as a coping resource for adverse effects.*
Paper XII	Improvement goal	Fitness tracking technology experience	Performance feedback	Performance feedback from fitness tracking technology causes positive and negative emotional reactions that 'infuse' users' decisions to continue using the fitness tracking technology, particularly their associations of usefulness and enjoyment. Novice users are more sensitive to their emotions in these evaluations. *» Provided opportunities can cause positive and negative emotional reactions infusing the evaluation of consumer health IT, particularly in early stages.*

Table 6. Overview of research results and main findings for motivation, ability, and opportunity in consumer health IT use

4.1 Paper I: IT-Related Traits and Older People's Internet Use[6]

The first paper of this dissertation (Paper I) focuses on the role of the ability component and examines its influence on older people's IT use, specifically their Internet use. Thereby, this paper aims to examine the role of older people's IT-related differences, specifically IT-related traits (Maier 2012), in predicting their Internet use behavior (i.e. frequency and intensity). Given that older people are not a homogenous group in terms of IT use and that prior literature suggests that older people often lack the willingness or ability to use IT (Fox and Connolly 2018), the paper conceptualizes older people's IT-related traits as curiosity-related (i.e. Personal innovativeness in IT, Computer playfulness) and control-related (Computer self-efficacy, Computer anxiety) differences. The paper then comparatively examines how variations in these two types of older people's IT-related differences account for different measures of Internet use: 1) duration of Internet use in terms of the average amount of time spent using the Internet per week (Venkatesh et al. 2008) and 2) intensity of Internet use, i.e. the amount of 'features' used such as seeking information seeking, news reading, commerce, online banking, communication, entertainment, or general browsing (Limayem et al. 2007). With this approach, the paper aims to get a better understanding about for which type of IT use older people's IT-related ability is of highest influence.

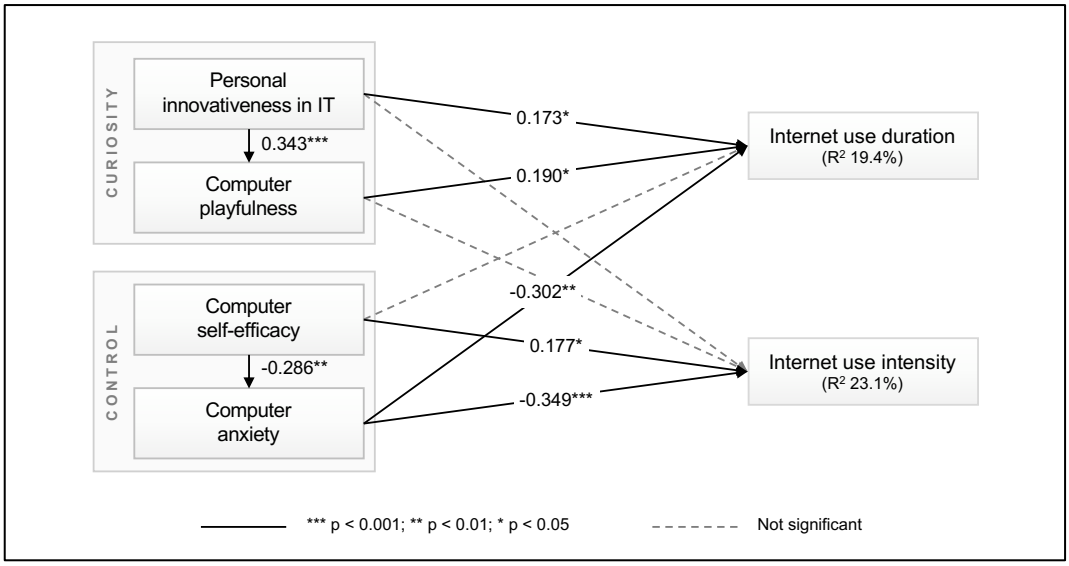


Figure 15. Results of Paper I (n=135)

As illustrated in Figure 15, an analysis of empirical data from Study I reveals that curiosity- and control-related IT differences account for different types of older people's Internet use. In a comparative assessment, the curiosity-related differences (Personal innovativeness in IT, Computer playfulness) are significant predictors of older people's Internet use duration and not of their Internet use intensity, meaning that the more curious older persons are towards the

[6] Rockmann, R. and Gewald, H. 2018. "How Do IT-related Traits Drive the Internet Use of Mature Adults? The Interplay of Curiosity and Control." In: *Proceedings of the Hawaii International Conference on Systems Sciences*, Waikoloa, Hawaii.

Internet, the more time they spent online. In contrast, the control-related differences (Computer self-efficacy, Computer anxiety) are significant predictors of older people's Internet use intensity such that the more they feel to have the necessary 'control' in using the Internet, as echoed by high self-efficacy and low anxiety, the more features they use and the more advanced their Internet use becomes. Above and beyond, older people's computer anxiety is a general inhibitor of their Internet use.

In summary, Paper I examines potential distinguishing factors (IT-related traits) to unravel heterogeneity among older people, which are inaccurately often considered a homogenous group. This paper offers an alternative conceptualization of IT-related traits in the context of older people (i.e. curiosity and control) and provides empirical evidence that these traits account for different Internet use conceptualizations. Notably, older people's computer self-efficacy and anxiety, which are often considered as key factors of this target group (Fox and Connolly 2018; Niehaves and Plattfaut 2014; Tams et al. 2014), have the greatest effect with regard to comparatively advanced interactions and feature uses. As such, the results indicate that the 'ability' component is more relevant in more sophisticated IT uses.

4.2 Paper II: The Role of the Past Workplace in Older People's Internet Use[7]

Noting the significance of older people's computer self-efficacy as an enabling factor of their IT adoption and use, research has called for the specific sources and developments of older people's computer self-efficacy (Fox and Connolly 2018; Tams et al. 2014). For older persons, past work experience might constitute a unique source of their computer self-efficacy. Since many firms adopted IT and the Internet before their widespread diffusion in households, some older persons might have accessed the Internet at work before they retired. Paper II accordingly examines the effect of the past workplace as an antecedent of older people's computer self-efficacy, computer anxiety, and hence their current Internet use.

Based on the key tenets of Social Cognitive Theory (Bandura 1986; Compeau et al. 1999), the model shown in Figure 16 posits that 1) past behavior (i.e. Internet use at the workplace) positively impacts computer self-efficacy and negatively impacts computer anxiety, 2) computer self-efficacy is negatively related to computer anxiety, and that 3) computer anxiety and self-efficacy determine actual behavior (i.e. private Internet use). In this study, computer self-efficacy and anxiety are contextualized (i.e. Internet self-efficacy and anxiety).

Empirical validation using data from Study I (see Figure 16) shows that computer self-efficacy and computer anxiety account for older people's current Internet use. Confirming prior studies, higher computer self-efficacy among older persons leads to lower computer anxiety. An intriguing finding is that while previous Internet use at the workplace indeed significantly and positively contributes to older people's computer self-efficacy, it does not impact their computer anxiety. This may be attributable to Internet-related threats, such as identity theft, fraud, scams,

[7] Gewald, H. and Rockmann, R. 2016. "Digital Services for the Aging Society: The Impact of Previous Workplace Privileges on Mature Adults' Use of the Internet." In: *Proceedings of the International Conference on Digital Society and eGovernments*, Venice, Italy.

or phishing, which are continuously emerging and changing, such that anxiety towards the Internet changes more dynamically than self-efficacy.

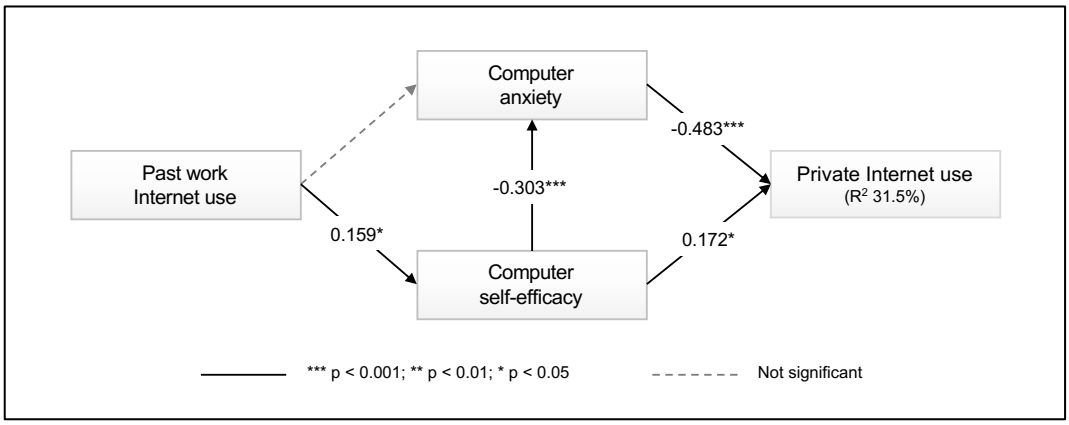


Figure 16. Results of Paper II (n=146)

In summary, Paper II provides initial evidence about the existence of the past workplace as source of older people's computer self-efficacy, particularly in the case of Internet use. As such, Paper II provides initial indications about the potential sources of the ability component in the context of consumer health IT.

4.3 Paper III: The Role of the Past Workplace in Older People's Use of Consumer Health IT[8]

The third paper of this dissertation (Paper III) examines the role of the past workplace in the context of older people's consumer health IT use. The objective of Paper III is two-fold: first, to confirm the impact of past workplace beyond the Internet context; and second, to examine its consequences for the use of consumer health IT. As with Paper II, the model shown in Figure 17 is grounded in Social Cognitive Theory and further posits that computer self-efficacy not only directly influences older people's consumer health IT use, but also indirectly in terms of enhancing the positive outcome expectations older people associate with using consumer health IT, such as supporting aspects of their healthcare, their health, and well-being. Moreover, it is assumed that the impact of past work IT intensity on computer self-efficacy and computer anxiety weakens the longer the person is retired (i.e., retirement duration as moderator).

[8] Gewald, H. and Rockmann, R. 2016. "Mature Adults' Use of Digital Health Services - The Role of Prior Computer Experience on eHealth Adoption." In: *Proceedings of the International Conference on Information Resources Management*, Cape Town, South Africa.

A prior version of this paper was presented in: Rockmann, R., Weeger, A., and Gewald, H. 2015. "Elderly People in eHealth: Investigating Internet Self-Efficacy and the Role of Occupational Internet Usage." In: *Proceedings of the Americas Conference on Information Systems*, Puerto Rico.

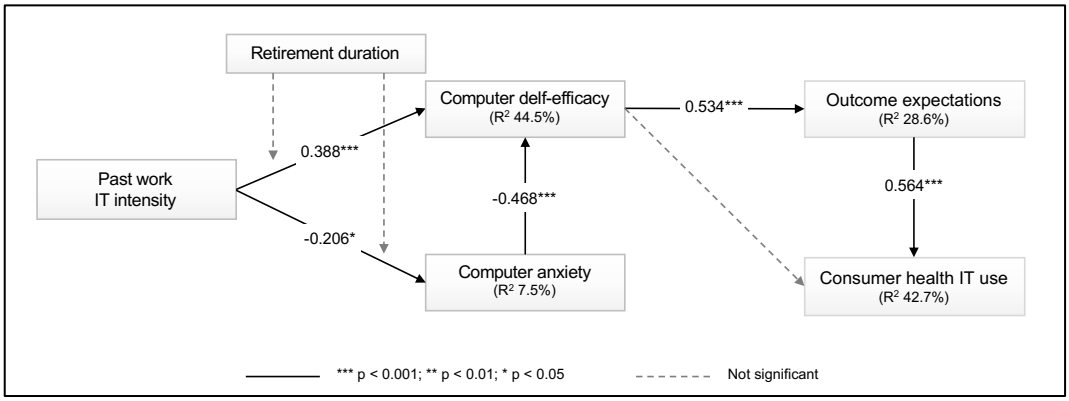


Figure 17. Results of Paper III (n=132)

Based on an analysis of the empirical data collected in Study II, the results shown in Figure 17 support that past work IT intensity increases older persons' computer self-efficacy and decreases their computer anxiety which extends the findings of Paper II beyond the Internet context. However, the expected moderating effect of retirement duration is not supported, meaning that the impact of the past workplace does not decrease the longer a person is in retirement. Moreover, consumer health IT use is directly determined by outcome expectations, meaning that older people's beneficial beliefs about the potential positive health-related impacts of using consumer health IT drive their use. Computer self-efficacy, as supported by additional mediation analysis, only indirectly affects their consumer health IT use.

In summary, by focusing the 'ability' component of consumer health IT use, Paper III reveals that ability, as reflected by computer self-efficacy, rather indirectly contributes to the use of consumer health IT. Moreover, Paper III confirms and generalizes the role of the past workplace as antecedent of older people's computer self-efficacy and anxiety.

4.4 Paper IV: The Role of IT-Related and Health-Related Individual Differences for Different Types of Older People's Consumer Health IT Use[9]

In its most general form, consumer health IT aims to serve as information source and decision aid for consumers (Demiris 2016, p. 46). Hence, consumer health IT can be used for different purposes, such as supporting health decisions by looking up for health information online or researching healthcare providers before seeking medical care, or supporting people's health management, such as managing a healthcare regimen or collecting and storing health data such as personal health records. Put differently, there are at least two general, yet different

[9] Rockmann, R. and Gewald, H. 2016. "Technology-Mediated Health Activities: An Exploratory Study on Older Adults." In: *Proceedings of the Americas Conference on Information Systems*, San Diego.

This paper received the AIS SIG Health Best Paper Meritorious Mention Award under the Junior Scholar category in 2017.

'opportunities' with which individuals can support their health and well-being: 1) health decision support and 3) health management.

Accordingly, and in line with the research framework of dissertation, the aim of Paper IV is to examine whether, and if so how, these two types of consumer health IT uses (opportunity) are differently predicted by older people's IT-related and health-related differences (i.e., ability and motivation). Moreover, with this approach, this paper aims to extend Paper I regarding the different predictions of 'use' into the context of consumer health IT.

The corresponding model shown in Figure 18 is based on the central tenets of the Technology Acceptance Model (Davis 1989) meaning that perceived usefulness and perceived ease-of-use are expected to drive these two types of uses. The model further posits that older people's computer self-efficacy (IT-related ability), personal innovativeness in IT as well as their health knowledge (health-related ability) positively impact these two beliefs in addition to having a direct influence on the uses. Moreover, it is assumed that for older persons with higher health needs (i.e., motivation), as reflected by a higher number of physician visits and presence of chronic disease (Wilson and Lankton 2004), perceived usefulness becomes a stronger driver of these two uses than for persons with lower health needs.

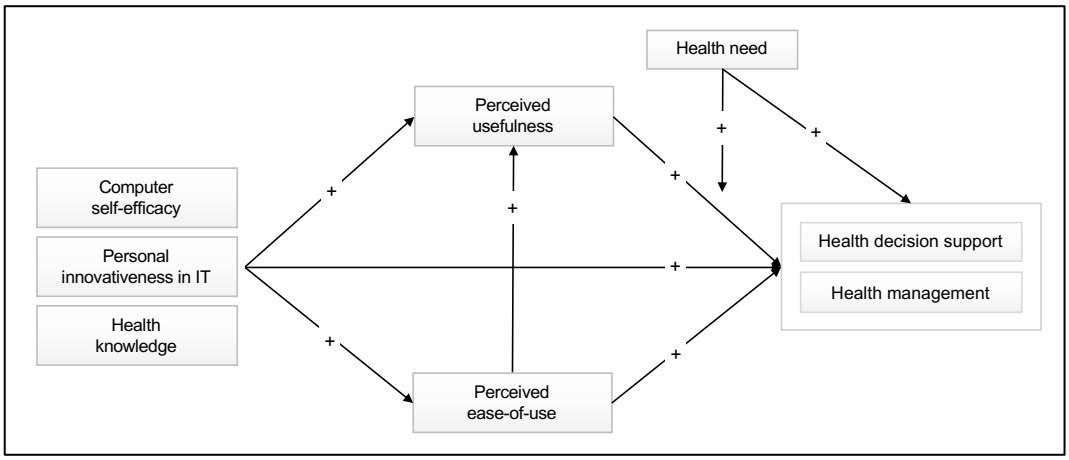


Figure 18. Research model of Paper IV

The model was evaluated in a study of 156 persons (average age 72 years) based on the empirical survey data from Study II. The results shown in Table 7 reveal that IT use for health decision support use and health management are differently determined.

Older people's IT use for health decision support is mainly driven by their usefulness beliefs and their health knowledge; interestingly, commonly assumed factors for older people such as their ease-of-use beliefs or computer self-efficacy (Chen and Chan 2011; Fox and Connolly 2018) do not impact this kind of use. This is rather the case of using IT for the purpose of health management which is driven by perceived usefulness and ease-of-use perceptions and also their personal innovativeness in IT. In both cases, the impact of perceived usefulness on IT use increases with higher health needs. Another finding of Paper IV is that perceived ease-of-use of consumer health IT is not only predicted by computer self-efficacy and personal innovativeness in IT, but also by health knowledge. This means that older people's perceptions of ease-of-use of consumer health IT is grounded not only in technological aspects, but also in their health knowledge. Because consumer health IT, such as online health information, involves

understanding of health terminology, a lack of health knowledge makes consumer health IT seem more difficult to use for older people.

	Perc. ease-of-use (R^2 38.9%)	Perc. usefulness (R^2 57.2%)	Health decision support (R^2 41.1%)	Health management (R^2 44.3%)
CSE	**0.321****	0.091 (n/s)	0.011 (n/s)	0.142 (n/s)
PIIT	**0.262***	0.022 (n/s)	0.175 (n/s)	**0.251****
HKnow	**0.195****	0.084 (n/s)	**0.187***	-0.011 (n/s)
PEOU		**0.653*****	0.175 (n/s)	**0.338*****
PU			**0.355****	**0.267****
HNeed			0.119 (n/s)	0.133 (n/s)
HNeed × PU			**0.148***	**0.194****

**** p < 0.001; ** p < 0.01; * p < 0.05; n/s not significant*

CSE = Computer Self-efficacy; PIIT = Personal Innovativeness in IT; HKnow = Health Knowledge; PEOU = Perceived Ease-of-Use; PU = Perceived Usefulness; HNeed = Health Need

Table 7. Results of Paper IV (n=156)

In summary, Paper IV makes a first effort to examine the relationships between motivation (i.e., health need), ability (i.e., computer self-efficacy, health knowledge), and opportunities (i.e., health decision support and health management). This paper proposes two conceptualizations of consumer health IT use that focus on the health-related activities the IT supports and different sets of corresponding antecedents. Retrospectively interpreted, Paper IV identified two general affordances of consumer health IT.

4.5 Paper V: The Role of Exploratory IT Behavior in Older People's Online Health Information Use[10]

The Internet has become a major source of health information (Agarwal et al. 2010; Fox and Duggan 2013) and many Internet users feel better informed about their health because of the Internet (Pew Research Center 2014). Yet, older people are less likely to utilize the Internet for health information than younger people – even those who generally use the Internet (Fox and Duggan 2013). As the results of Paper IV reveal, however, computer self-efficacy and perceived ease-of-use are, somewhat counterintuitively, not the main reasons underlying older people's online health information use. Post-adoption research points at users' exploratory IT behavior as a mechanism promoting enhanced utilization of a focal IT (see section 2.2.4). Paper V therefore aims to adapt the notion of exploratory IT behavior to the context of older people's use of consumer health IT and, thereby, to identify the antecedents and consequences relevant for older people's online health information use.

[10] Rockmann, R. and Gewald, H. 2017. "Older Adults' Use of Online Health Information – Do They Even Try?" In: *Proceedings of the Hawaii International Conference on Systems Sciences*, Waikoloa, Hawaii.

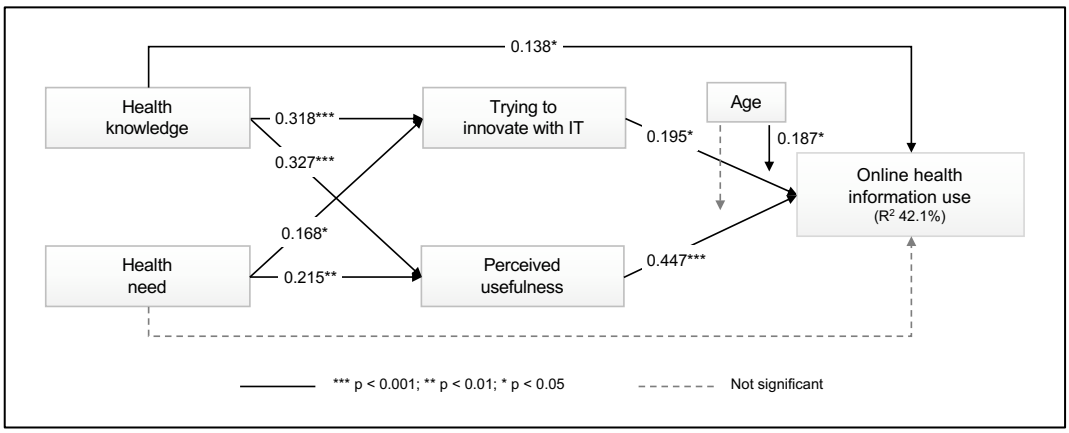


Figure 19. Results of Paper V (n=180)

Specifically, as shown in Figure 19, Paper V uses the concept 'Trying to innovate with IT' – "an individual's goal of finding novel uses of information technologies" (Ahuja and Thatcher 2005, p. 435) – to describe exploratory IT behavior alongside perceived usefulness as main determinants of older people's online health information use. Moreover, the model posits that these two determinants exert stronger influences on online health information use with higher age. This is assumed because older people often stick with familiar media practices (Nimrod 2017) so that using the Internet to obtain health information is rather 'innovative' or 'novel' and more likely the result of exploratory IT behavior the older the person is. Likewise as their age increases, older persons are less likely to trust the Internet as a health information source (Hesse et al. 2005), weakening the influence of perceived usefulness. Additionally, the model posits that older people's health need and health knowledge influence these two main determinants and also online health information directly. A person's health need is assumed to serve as trigger for exploratory IT behavior because persons with higher health needs are more interested in health information (Fox 2011), and may thus engage more strongly in exploratory IT behavior in pursuit of obtaining health information to better manage their health needs. Furthermore, health knowledge should prompt exploratory IT behavior because persons with greater health knowledge should be more interested in obtaining further health information, which motivates exploratory IT behavior. Moreover, with higher health needs and higher health knowledge, older people should perceive more benefits in using IT to support their health. As shown in Figure 19, empirical evaluation of data collected from 180 persons (average age 73 years) in Study II supports most arguments.

In summary, Paper V focuses on the role of motivation (health need) and ability (health knowledge) for the specific opportunity of obtaining health information online. The results suggest that motivation and ability motivate stronger engagement in finding new purposes for existing IT and also enhance beneficial perceptions towards consumer health IT. This, in turn, leads to higher use of online health information. Moreover, Paper V extends exploratory IT behavior into the context of older people and consumer health IT, identifies two contextual (i.e. health-related) antecedents, the moderating role of age, and confirms its role in enhancing users' utilization of a given IT.

4.6 Paper VI: The Digital Divide in Older People's Online Health Information Use[11]

Older people's adoption and use of IT, including consumer health IT, is often discussed with relation to the digital dive – the unequal access, use, and impact of IT across social groups (Dewan and Riggins 2005). In light of the previously discussed findings, the objective of Paper VI is an examination of the constituent parts of the digital divide among older people – a so-called 'digital divide cascade' – in the context of online health information use (see Figure 20). Based on Social Cognitive Theory (Bandura 1986; Compeau et al. 1999; Wei et al. 2011) and post-adoption research (Ahuja and Thatcher 2005; Jasperson et al. 2005), the proposed cascade implies that disparities in prior access to IT lead to unequal outcomes for the well-being of older people through a chain of effects (Wei et al. 2011). The second objective of Paper VI is to examine retirement as a qualitative segmentation criterion for older people. Literature indicates that chronological age is not always a meaningful indicator of ageing (WHO 2012) and alternative conceptualizations can potentially shed new light on the age-related associations with IT use (Ghasemaghaei et al. 2019; Hong et al. 2013; Tams et al. 2014). The transition into retirement comes along with greater changes in one's life including changes in the social network and institutional support. Though IT brings opportunities to be less isolated and to stay informed, retired persons are more strongly confronted with the IT issues on their own.

The developed cascade posits that the digital divide among older people begins with the access divide in terms of the unequal access to and use of IT at the past workplace which, in turn, is a predecessor of the capability divide (i.e. skill divide) among older people as reflected in the control-related IT-differences computer self-efficacy and computer anxiety (see Papers I–III). The intensity of IT exposure in past work is expected improve older people's digital capabilities particularly due to the actual experiences made using IT and the social and formal support received at the workplace (e.g., observation of coworkers' use of IT, coworkers helping each other to resolve IT issues, and formal IT training). However, as discussed earlier, older people's use of online health information is not necessarily solely a matter of digital abilities, but also a matter of interest to utilize the existing IT (see Papers IV–V). Hence, the cascade proposes an engagement divide which precedes the use of online health information (use divide) but this engagement divide is partly caused by an antecedent capability divide. Lastly, the model posits that by obtaining health information online, older persons increase their health knowledge. Put differently, the use divide accounts for an outcome divide.

[11] Rockmann, R., Gewald, H., and Haug, M. 2018. "Equal Access for Everyone? A Digital Divide Cascade for Retired Senior Citizens." In: *Proceedings of the European Conference on Information Systems,* Portsmouth, United Kingdom.

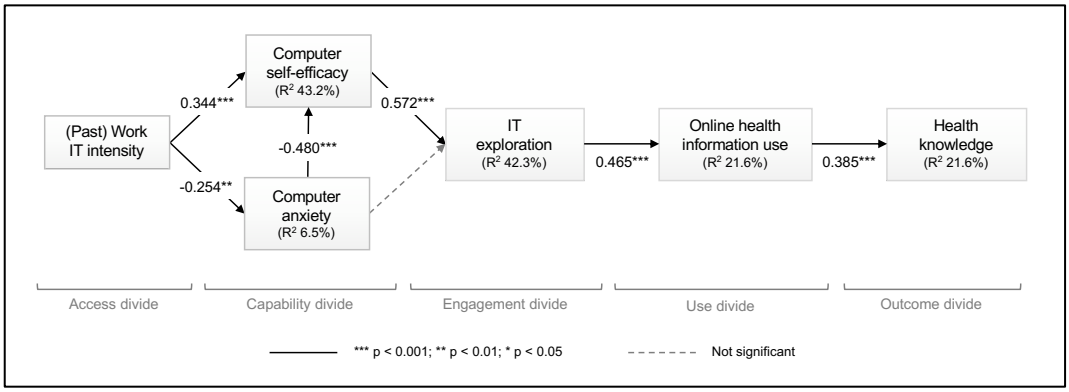


Figure 20. Results of Paper VI (retired people; n=157)

The proposed cascade was tested empirically based on data collected on 157 retired persons (average age 72 years) drawn from Study II. Furthermore, to lend support that the cascade is of higher explanatory power for retired persons, the model was also tested with non-retired persons (n=62; average age 56 years).

The results of this group-wise comparison (Table 8) provide support that the entire divide sequence of Access → Capability → Engagement → Use→ Outcome exhibits higher explanatory power, stronger relationships and higher effect sizes for retired persons than for non-retired persons. The only exception is found within Access divide → Capability divide where the impact of the (past) workplace on persons' computer anxiety is stronger for non-retired persons than for retired persons. As discussed earlier, computer anxiety appears to be more much more dynamic and malleable and less influenced by prior experiences (see also Papers II and III).

	Retired persons (n=157)		**Non-retired persons** (n=62)	
	Path	*Effect*	*Path*	*Effect*
Outcome: Health knowledge (R^2)	**14.9%**		**6.4%**	
Online health information use	0.385 ***	0.174 (M)	0.254 (n/s)	0.069 (S)
Use: Online health information use (R^2)	**21.6%**		**12.3%**	
IT exploration	0.465 ***	0.275 (M)	0.351 **	0.140 (S)
Engagement: IT exploration (R^2)	**42.3%**		**31.5%**	
Computer self-efficacy	0.572 ***	0.384 (L)	0.253 (n/s)	0.055 (S)
Computer anxiety	-0.124 (n/s)	0.018	-0.363**	0.113 (S)
Capability: Computer self-efficacy (R^2)	**43.2%**		**46.5%**	
Computer anxiety	-0.480 ***	0.379 (L)	-0.519 ***	0.385 (L)
(Past) Work IT intensity	0.344 ***	0.194 (M)	0.257 *	0.094 (S)
Capability: Computer anxiety (R^2)	**6.5%**		**23.6%**	
(Past) Work IT intensity	-0.254 **	0.069 (S)	-0.486 ***	0.308 (M)
*** p < 0.001; ** p < 0.01; * p < 0.05; n/s not significant Effect sizes: 0.02 (S; small), 0.15 (M; medium), and 0.35 (L; large) (Cohen 1988)				

Table 8. Results of Paper VI (comparison of retired and non-retired people)

In summary, Paper VI provides a first examination of the outcomes of consumer health IT use in this dissertation suggesting that specific outcomes (e.g., increased health knowledge) are gained by realizing specific opportunities provided by consumer health IT (i.e., online health information). Moreover, in examining the ability component (i.e., computer self-efficacy) of consumer health IT use, results imply that ability has a stronger impact for retired persons than for non-retired persons. As such, ability appears to be a facilitating condition for consumer health IT use, relevant mostly for older people. In addition, Paper VI adds computer self-efficacy as antecedent of exploratory IT behavior and reveals 'retirement' as meaningful qualitative segmentation criteria for older people.

4.7 Paper VII: Affordances of Fitness Tracking Technology[12]

Fitness tracking technology – particularly software applications such as Strava – offers a range of features designed to motivate users to be physically active, such as visual performance graphs, virtual scores and trophies, performance rankings, or social network features that allow following, commenting, or 'liking' other users' physical activities (Lister et al. 2014). As such, fitness tracking technology provides a multitude of 'opportunities' from which users can draw on to motivate themselves. To identify these different opportunities provided by fitness tracking technology, Paper VII draws on the notion of affordances (i.e., possibilities for goal-oriented action) and develops measurements instruments to assess these affordances empirically.

Affordance	Definition	Feature examples
Self-monitoring	Possibility to systematically document and observe one's sport behavior	Recording of GPS and steps taken; training log and diaries, reports about of step rates, pulse frequency, speed, distance, or calories burned
Performance analysis	Possibility to systematically analyze and evaluate performance indicators	Statistics on recorded parameters, side by side comparison of records from the logged activities
Exercise guidance	Possibility to get instructed in physical activity	Textual or audio-visual media with exercise tips, alerts for pulse zones or interval training, live performance feedback
Rewards	Possibility to obtain rewards for physical activity	Points, badges, trophies
Social comparison	Possibility to compare your performance against others	Leaderboards, rankings, competitions, activity reports of others, other's profile pages
Watching others	Possibility to observe other people's sport activities	Newsfeed, activity reports of others, other's profile pages
Social recognition	Possibility to receive social feedback and respect from others	Leaderboards, rankings, "likes" or "kudos", comments on uploaded activities
Self-presentation	Possibility to create and communicate unique self-identity and image	Profile page, sharing/posting activities

Table 9. Results of Paper VII (identified affordances)

[12] Rockmann, R. and Gewald, H. 2018. "Activity Tracking Affordances: Identification and Instrument Development." In: *Proceedings of the Pacific Asia Conference on Information Systems*, Yokohama, Japan.

The identification of affordances was informed by a variety of sources, including prior literature, anecdotal user stories, vendor's marketing and by nine interviews with actual fitness tracking users. As a result, eight salient affordances in fitness tracking technology were identified for which according definitions, descriptions and feature examples are derived (see Table 9).

Having identified the salient affordances, this paper further developed a corresponding measurement instrument to assess the affordances in survey research. A q-sort method was applied across two rounds (n=7; n=55) to evaluate the content validity of the developed items (Study IV; see also section 3.4). Table 10 provides examples for the final, content-valid items.

Affordance	**Example item**: *The fitness tracking app offers me the possibility to …*
Self-monitoring	monitor my sport behavior.
Performance analysis	perform statistical analysis of performance metrics.
Exercise guidance	get supervised to reach my physical activity goals.
Rewards	earn virtual rewards as a token for my efforts in physical activity.
Social comparison	find out how I am doing in exercise compared to what others have done.
Watching others	follow the sport activities of other people.
Social recognition	earn compliments from others for my physical activity.
Self-presentation	present myself as physically active person.

Table 10. Results of Paper VII (measurement items)

In summary, Paper VII focuses on the possibility component of consumer health IT use and, using the affordance lens, identified such possibilities in terms of eight affordances salient in fitness tracking technology. Moreover, this paper provides content-validated measurement instruments to empirically assess these affordances in survey research. Thereby, Paper VII provides the conceptual and empirical underpinnings for the subsequent Papers VIII–XI.

4.8 Paper VIII: The Role of Achievement Goals in Predicting Fitness Tracking Technology Feature Use[13]

As just discussed, fitness tracking technology offers a variety of features designed to motivate people to be physically active. Since people's physical activity motivations and goals differ, fitness tracking technology users might choose to use different features available to motivate them individually. To better understand the relationship between peoples' motivations and fitness tracking technology features, Paper VIII examines how different motivations, in terms of goals, drive fitness tracking feature use. Thereby, this paper further elaborates on motivation and ability of consumer health IT use.

Paper VIII builds on four archetypical affordances of fitness tracking technology identified in Paper VII (i.e., self-monitoring, exercise guidance, rewards, and social comparison) as well as

[13] Rockmann, R. and Gewald, H. 2019. "Individual Fitness App Use: The Role of Goal Orientations and Motivational Affordances." Forthcoming in: *Proceedings of the Americas Conference on Information Systems*, Cancún, México.

on Achievement Goal Theory's key tenets concerning people's goal orientations, environment's goal structures and their emphases on mastery goals (competence development) and performance goals (competence demonstration) (Ames 1992; Nicholls 1989). The main argument of Paper VIII is that fitness tracking technology users' goal orientations distinctively drive the affordances enacted. Because people generally seek out environments that best fit their personality (Diener et al. 1984; Emmons et al. 1986; Ickes et al. 1997), the paper theorizes that the affordances can be interpreted as providing goal structures which potentially facilitate an individual's goal accomplishment. Serving as goal structures, the affordances specifically facilitate accomplishment of mastery and/or performance goals. With this, it is assumed that users enact those affordances they believe will help them in accomplishing their goals (Emmons et al. 1986; Ickes et al. 1997).

Paper VIII posits that the self-monitoring and exercise guidance affordances predominately serve as a mastery goal structure due to their emphasis on self-improvement and development of physical abilities. The rewards affordance can serve as both mastery and/or performance goal structure due to rewarding self-improvements, such as running a personal best time, but also due to rewarding physical performance in relation to other users, such as through leaderboards. Lastly, the social comparison serves as performance goal structure as it emphasizes interpersonal comparison and competition. Consequently, Paper VIII posits that users' mastery and performance goal orientations exert their strongest influence on those affordances that provide the corresponding goal structure. An empirical evaluation of data collected from 417 users of a fitness tracking application called Strava (www.strava.com) obtained in Study V largely supports these assumptions (Figure 21).

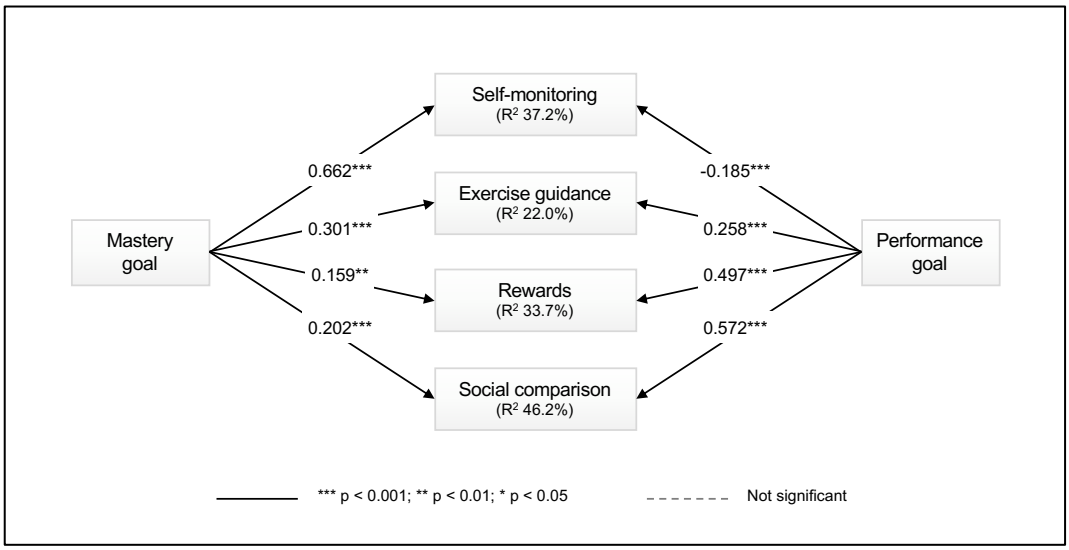


Figure 21. Results of Paper VIII (n=417)

In summary, Paper VIII nurtures on the relationship between motivation (i.e., goal orientations) and opportunities (i.e., affordances) of consumer health IT. The paper provides a parsimonious, theory-driven account how motivations drive enactment of the opportunities provided by consumer health IT: the different features incorporated provide distinct affordances to the user which – from a motivation-theoretical perspective – serve as goal structures. Because these affordances hence potentially facilitate attainment of specific goals, users seek out those features that will most likely support them in accomplishing their individual goals, such as mastery and

performance goals. Thereby, Paper VIII contributes to fitness tracking technology research by providing an explanation and empirical evidence as to how and why users with different motivations employ different fitness tracking technology features.

4.9 Paper IX: The Role of Achievement Goals in Accounting for Different Benefits Gained from Fitness Tracking Technology Feature Use[14]

Although the many 'motivational features' incorporated into fitness tracking technology are expected to enhance motivation and physical activity, several scholars conclude from the mixed and inconclusive results reported in prior research that the actual 'motivational effectiveness' of these features is not well understood (Alahäivälä and Oinas-Kukkonen 2016; Hamari et al. 2014a; Hamari et al. 2014b; Johnson et al. 2016; Koivisto and Hamari 2019; Orji and Moffatt 2016). As discussed above, people's motivations and goals differ, which may affect the motivational impacts of these features. The aim of Paper IX is accordingly to examine the interplay between fitness tracking technology features and users' goals concerning the motivational benefits gained from fitness tracking technology use (i.e., increased motivation and physical activity; net benefits).

As in Paper VIII above, this paper applies the affordance lens to examine archetypical affordances in fitness tracking technology identified in Paper VII (i.e., self-monitoring, rewards, and social comparison) and the key tenets of Achievement Goal Theory (Ames 1992; Nicholls 1989). Also, as in Paper VIII, a key premise of Paper IX is that the affordances serve as goal structures with varying emphasis on mastery and/or performance goal structures. However, whereas Paper VIII argues that goal orientations drive distinct affordance enactments, this paper theorizes that users' goal orientations and their enacted affordances interact with each other, such that the better the fit between enacted affordance and goal orientation (i.e., when they share the same goal emphasis), the greater the motivational net benefits (Jagacinski et al. 2001; Murayama and Elliot 2009). For instance, users with a strong performance goal orientation are motivated by demonstrating their abilities to others and outperforming others, so using features affording social comparison (e.g., leaderboards) should result in higher motivational benefits than for users with a low performance goal orientation.

This assumption was evaluated empirically using data collected from 283 users of the fitness tracking application 'Strava' in Study V. The results, as shown in Figure 22, first of all reveal that each of the three focal affordances uniquely contributes to the motivational benefits in terms of enhanced motivation and physical activity.

[14] Rockmann, R. and Maier, C. 2019. "On the Fit in Fitness Apps: Studying the Interaction of Motivational Affordances and Users' Goal Orientations in Affecting the Benefits Gained." In: *Proceedings of the International Conference on Wirtschaftsinformatik*, Siegen, Germany.

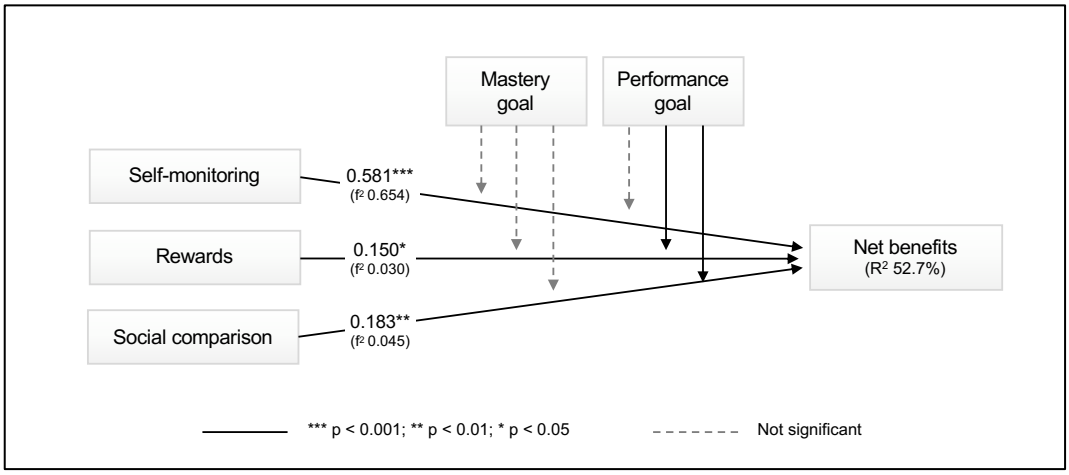


Figure 22. Results of Paper IX (main effects; n=283)

Furthermore, the results support two significant interaction effects: users' performance goal orientations with enactment of the rewards affordance and of the social comparison affordance (Figure 23). As assumed, these interactions imply that users with a high performance goal orientation – a focus on competence demonstration – gain higher motivational benefits from using features that afford rewards and social comparison than users with a low performance goal orientation.

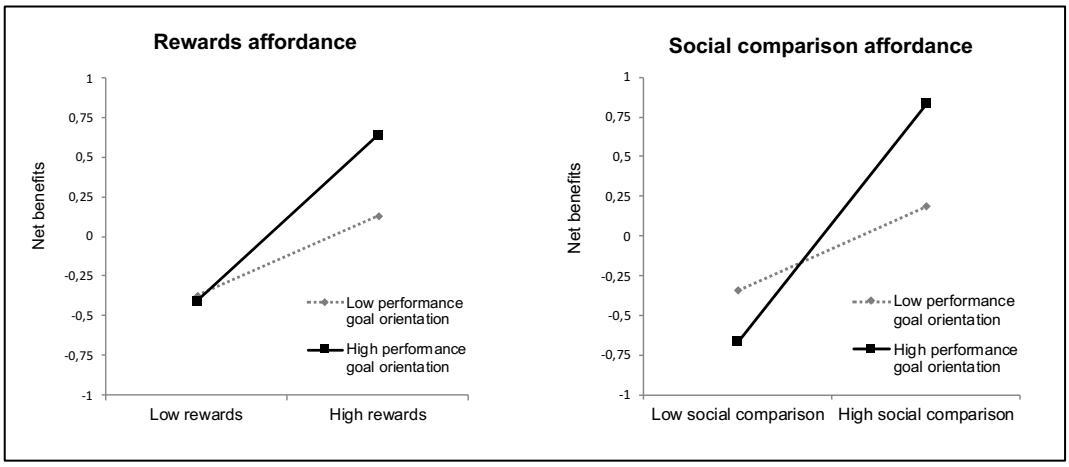


Figure 23. Results of Paper IX (interaction effects)

In summary, Paper IX focuses on the relationship between motivation (i.e., goal orientations) and opportunities (i.e., affordances) to explain the outcomes of consumer health IT use. Specifically, Paper IX implies that in certain circumstances, a strong fit between the opportunities provided by consumer health IT and users' motivation yields more beneficial, health-related outcomes. This is because users striving to accomplish their goals are more successful if they have the supporting conditions they need to do so, i.e. features that facilitate their goal attainment. In the fitness tracking technology context, this paper addresses the call to better understand the motivational effectiveness of incorporated features and to consider the characteristics of the users (i.e., their motivations) (e.g., Alahäivälä and Oinas-Kukkonen 2016; Johnson et al. 2016; Koivisto and Hamari 2019; Orji and Moffatt 2016). Essentially, Paper IX

provides a theory-driven and parsimonious explanation of why the 'motivational effectiveness' of these features varies among users.

4.10 Paper X: Motivating Individually: Needs, Goals, and Affordances in Fitness Tracking Technology[15]

Paper IX discussed above addressed the role of interpersonal differences (i.e., achievement goals) to explain the motivational effectiveness of the different fitness tracking features, providing insights into who gains motivational benefits from these features. Less understood so far, however, is *how* these features provide motivational benefits, i.e. the motivational processes underlying fitness tracking technology feature use (Koivisto and Hamari 2019). To provide a more complete explanation about the motivational effectiveness of fitness tracking technology feature use, Paper X takes both the person and the process into account.

Hereto, Paper X utilizes the previously identified affordances (Paper VII) in combination with interactional perspective of Achievement Goal Theory to examine the role of the person (Murayama and Elliot 2009), as well as the key tenets of Self-determination Theory (Ryan and Deci 2017) to examine the underlying motivational process. Self-determination theory posits that the motivational impact of external factors, such as rewards or competition, depends on the extent to which they satisfy a persons' need for autonomy and competence (i.e., growth needs) and relatedness (Ryan and Deci 2017). Extending the notion that the affordances act as goal structures (Papers VIII–IX), this paper further posits that through enactment, each affordance satisfies distinct needs. For instance, while self-monitoring and performance analysis can be expected to support and satisfy users' growth needs (autonomy and competence), social comparison and social recognition affordance are also uniquely addressing users' relatedness need. Need satisfactions are also expected to be contingent upon the users' achievement goals, such that a fit between goal orientations and affordances will result in greater need satisfaction.

The model of Paper X is empirically evaluated using data collected from 286 users of the fitness tracking application 'Strava' in Study V. The results, as shown in Figure 24, confirm that the motivational impact of the enacted affordances takes place through the satisfaction of users' growth and relatedness needs. For example, self-monitoring and performance analysis (self-quantification) as well as exercise guidance and rewards (exercise control) satisfy mostly users' growth needs and social comparison and social recognition (social interaction) mostly satisfy users' relatedness needs. As need satisfaction levels rise, users report higher benefits from their fitness tracking technology use in terms of enhanced physical activity motivation and behavior.

[15] A previous version of this paper has been published in: Rockmann, R. and Gewald, H. 2017. "Is IT What You Make out of IT? On Affordances, Goals, and Positive and Negative Consequences in Activity Tracking." In: *Proceedings of the International Conference on Information Systems*, Seoul, South Korea.

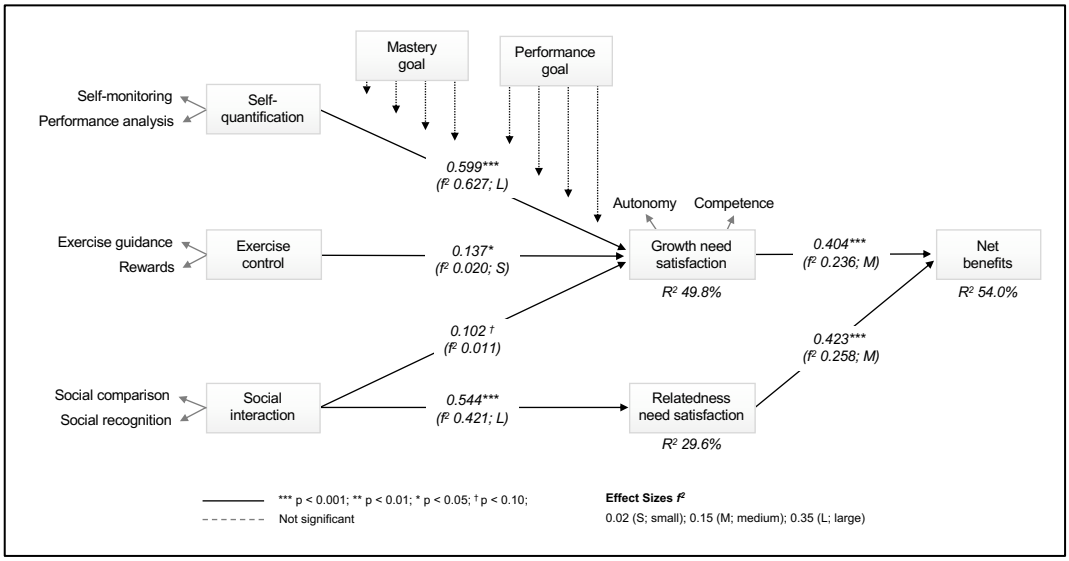


Figure 24. Results of Paper X (main effects; n=286)

In addition, the results also reveal significant interactions between enacted affordances, users' goal orientations, and need satisfaction levels (see Figure 25). For example, users with a strong performance goal orientation have higher growth need and relatedness need satisfaction levels through the exercise control and social interaction affordances. Users with a strong mastery goal orientation, in contrast, achieve higher growth need satisfaction levels from enacting the social interaction affordances.

In summary, Paper X further elaborates the relationships between opportunities (i.e., affordances), motivations (i.e., goal orientations), and the outcomes of consumer health IT use in the fitness tracking technology context. Paper X particularly explains how the opportunities provided by fitness tracking technology features support the health and well-being of its users, i.e., through the satisfaction of people's basic psychological needs for autonomy, competence, and relatedness (Ryan and Deci 2017). The results indicate that the satisfaction of these three basic psychological needs results in heightened motivation and increases in physical activity with additional variations through users' goal orientations. Paper X hence extends the interaction between affordances and goals identified in Paper IX to include the satisfaction of basic psychological needs. In essence, this paper provides a rich explanation of the motivational impacts of fitness tracking technology features.

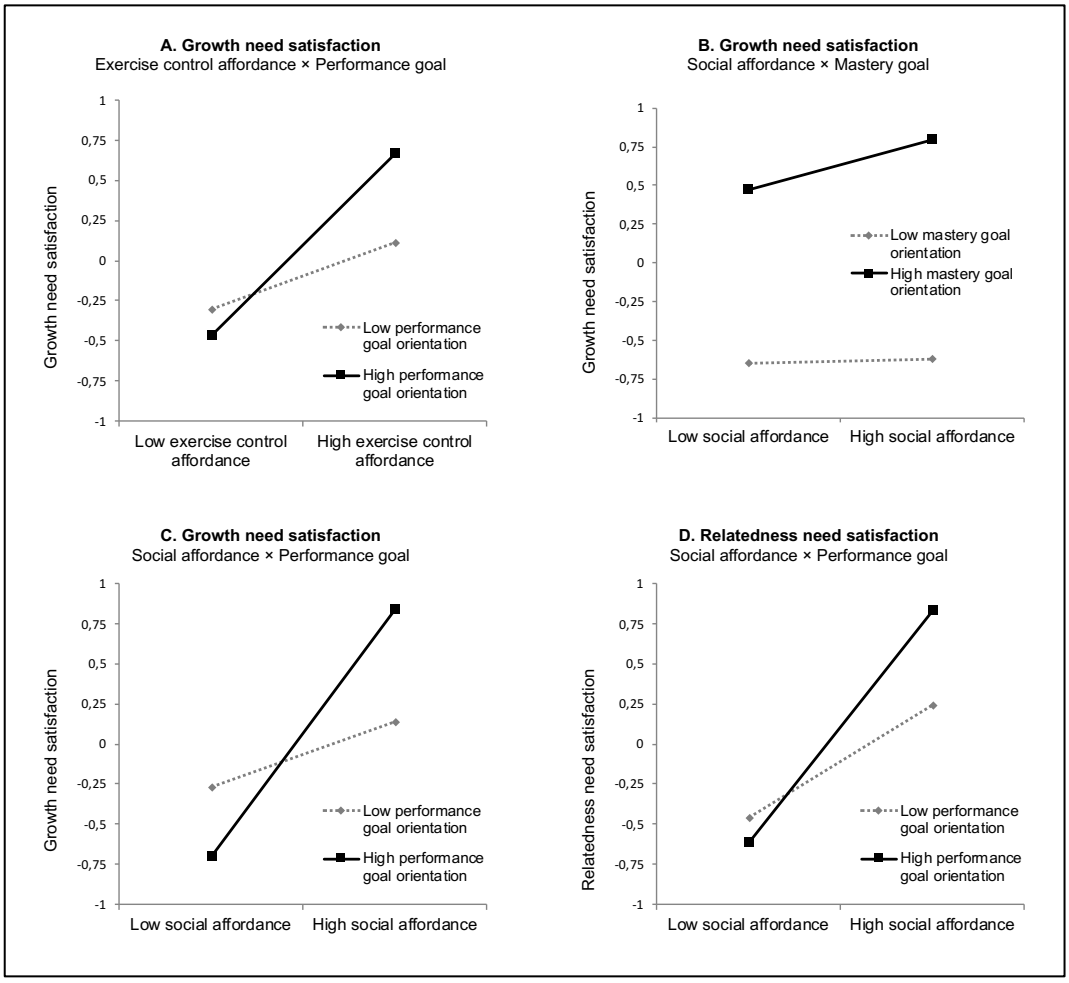


Figure 25. Results of Paper X (interaction effects)

4.11 Paper XI: The Brighter and Darker Sides of Fitness Tracking Technology Underlying Continued Use Intentions[16]

Although fitness tracking technology is expected to promote higher motivation toward physical activity, many users stop using this technology after a short time (Ledger and McCaffrey 2014). User stories indicate that fitness tracking technology use can have the anticipated positive motivational impacts, but also have adverse, demotivational effects which both appear to influence users' willingness to continue using this technology (Barratt 2017; Baumgart 2016; November Project 2017; Sjöklint et al. 2015). The literature on fitness tracking technology, however, neglects these adverse impacts and calls for examination of the negative effects (Koivisto and Hamari 2019; Schmidt-Kraepelin et al. 2019). Paper XI accordingly has two

[16] Rockmann, R. 2019. "Don't Hurt Me… No More? An Empirical Study on the Positive and Adverse Motivational Effects in Fitness Apps." In: *Proceedings of the European Conference on Information Systems*, Stockholm, Sweden.

objectives: 1) to develop a conceptualization that reflects both positive and negative motivational effects and 2) examine their impacts on continued use intentions of fitness tracking technology.

As discussed above, Self-determination Theory posits that satisfaction of basic psychological needs (e.g., competence need) is central to human functioning and motivation and that the motivational impact of social-environmental factors, such as feedback, is mediated by the extent to which they satisfy a person's needs (Ryan and Deci 2017). However, these needs can also be thwarted – that is, actively suppressed – causing motivational depletion, exhaustion, and ill-being (Bartholomew et al. 2011; Gunnell et al. 2013). Focusing on the competence need particularly relevant in the physical activity context (Ng et al. 2012; Teixeira et al. 2012), Paper XI examines competence need satisfaction and competence need thwarting, conceptualizing the positive and negative motivational impacts. Exemplary affordances identified in Paper VII are utilized to theorize how fitness tracking technology features lead to both competence need satisfaction and competence need thwarting. These effects, in turn, are expected to influence users' decisions to continue using the technology and are expected to be particularly strong for users with low exercise self-efficacy. These assertions are empirically evaluated using data collected from 283 users of the fitness tracking application 'Strava' in Study V.

The results, depicted in Figure 26, show that while self-monitoring, rewards, and social comparison affordances can contribute to competence need satisfaction, both rewards and social comparison can also cause competence need thwarting. This is because rewards and social comparison – in contrast to self-monitoring – exert control over the person through external contingencies, which is a condition of need thwarting to occur (Ryan and Deci 2017). In consequence, competence need satisfaction determines users' decisions to continue using the fitness tracking technology whereas competence need thwarting yields surprisingly a non-significant impact.

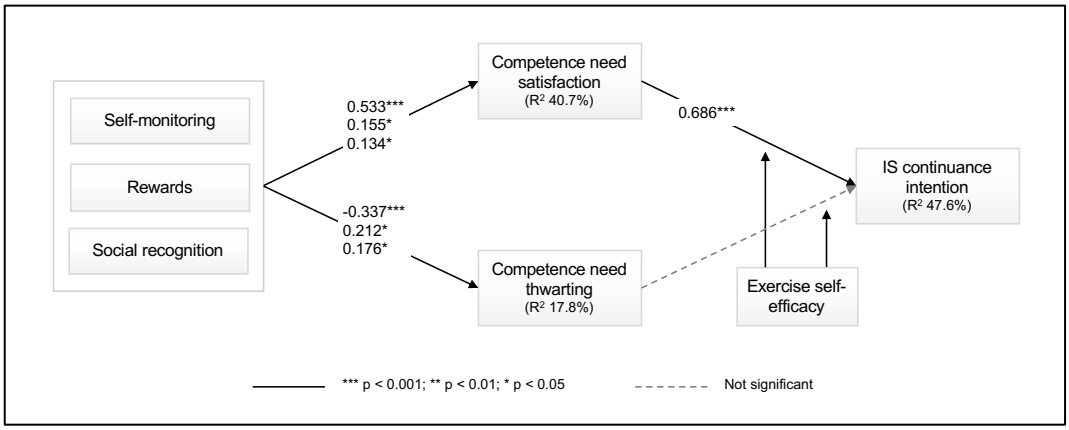


Figure 26. Results of Paper XI (main effects; n=283)

However, the results indicate that the impacts of satisfied and thwarted competence needs on users' continuance decisions vary with users' exercise self-efficacy levels. Specifically, as shown in Figure 27, users with low exercise self-efficacy are more sensitive to the positive and negative effects in determining their decision to continue using the fitness tracking technology than users with high exercise self-efficacy. This is because self-efficacy, in general, serves as personal resource to cope with stressful or threatening situations (Jerusalem and Schwarzer 1992).

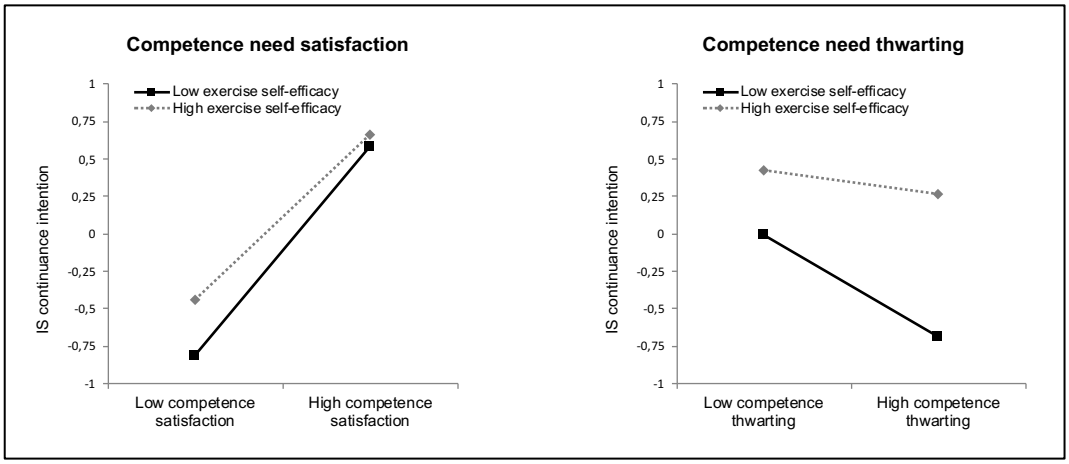


Figure 27. Results of Paper XI (interaction effects)

In summary, Paper XI further extends the relationship between opportunities (i.e., affordances) and the outcomes of consumer health IT use by revealing that fitness tracking technology features can have both positive and negative motivational consequences. Specifically, Paper XI conceptualizes the positive and negative effects in terms of need satisfaction and need thwarting. This paper thus extends the consequences of need satisfaction discussed in Paper X to continued use. Although competence need thwarting only impacts continuance decisions for users with low exercise self-efficacy, competence need thwarting is generally a cause of exhaustion and ill-being, so need thwarting should be still regarded as considerable negative consequence (Bartholomew et al. 2011; Gunnell et al. 2013). People with low exercise self-efficacy are often just starting an exercise regime, and this paper shows that these people, who are expected to benefit a lot from fitness tracking technology, are more likely to decrease or discontinue use due to these demotivational effects.

4.12 Paper XII: Emotional Reactions and Fitness Tracking Technology Continued Use Intentions[17]

One of the main purposes of fitness tracking technology is to monitor one's physical activity behavior and to set according activity goals to improve one's physical conditions (Lupton 2016). However, there are indications that the performance feedback provided by the fitness tracking technology prompts emotional reactions among users – both positive emotions when activity targets are met and negative emotions when they are not (Baumgart 2016; Prasopoulou 2017; Sjöklint et al. 2015). Particularly in the latter case, users have to cope with their negative emotional reactions and one way with which they cope is to avoid using the fitness tracking technology: *"Guilt. That is also one of the reasons I haven't been using it lately"* (Sjöklint et al.

[17] Rockmann, R., Salou, T., and Gewald, H. 2018. "If You Are Happy and DON'T Know IT: Continuance? Analyzing Emotion Carry-Over Effects in Activity Tracking Continuance Decisions." In: *Proceedings of the Pacific Asia Conference on Information Systems*, Yokohama, Japan.

This paper received the AIS SIG Health Best Paper Award under the Junior Scholar category in 2019.

2015, p. 10). This is one example of how peoples' emotions about their physical activity behavior appear to influence their continued use of fitness tracking technology. To better understand this phenomenon, Paper XII examines how and why emotions that originate from one's physical activity performance (and that should be unrelated to the fitness tracking technology itself) can impact users' continuance intentions.

Drawing on emotion research, Paper XII conceptualizes that this particular type of emotion is best understood as an 'incidental' emotion, i.e. an emotion whose source is normatively unrelated to the object of judgment or decisions such as the fitness tracker (Forgas 1995; Pham 2007). Using the 'affect-as-information' mechanism (Schwarz 1990; Schwarz and Clore 1988) and key tenets of the Integrative Framework of Technology Use (Kim and Malhotra 2005), Paper XII theorizes how such technology-unrelated, incidental emotions impact fitness tracking technology continuance intentions. Specifically, the model, shown in Figure 28, posits that emotions triggered by performance feedback, such as happiness or sadness, impact the usefulness and enjoyment the user perceives when using the fitness tracker as well as directly influencing continued use intention. This assertion is grounded in the 'affect-as-information' mechanism where people (mis-)attribute their emotions towards an object as they adopt a 'how-do-I-feel-about-it?' heuristic during object evaluation (Schwarz 1990; Schwarz and Clore 1988). Such evaluations (e.g., perceived usefulness and perceived enjoyment), however, are not solely formed from scratch but also informed by prior evaluations (Kim and Malhotra 2005). That is, both emotions and prior evaluations can be used during object evaluation. The model further posits that whether emotions or prior evaluations are more influential is a matter of actual experience in using the fitness tracking technology, such that novice users are more influenced by emotions and experienced users more by their prior evaluations.

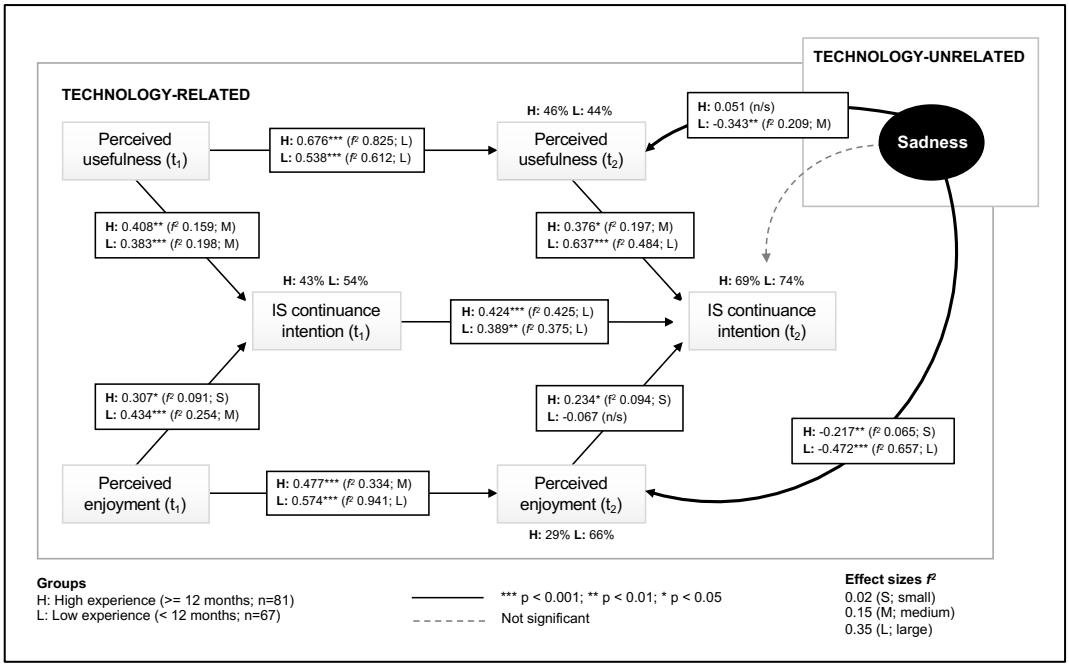


Figure 28. Results of Paper XII (n=148)

The model is empirically evaluated based on a factorial survey research design (see section 3.3 for details on the research design), analyzing data collected from 148 fitness tracking technology users in Study III. The factorial survey design uses vignettes to prompt participants to imagine

themselves in the situation of using a fitness tracker while doing sports. The scenario is that they have the goal to improve and after completion, the fitness tracker provides performance feedback which shows that the users a) met their goal, b) surpassed their goal, c) or did not met their goal. These three scenarios are used to prompt emotional reactions which are assessed during the vignette alongside evaluations of the usefulness, enjoyment and continuance intentions. Before participants were randomly presented one of these vignettes, their general evaluations were assessed which serve as the 'prior evaluations' in the model.

Results, as shown in Figure 28, largely support the model's arguments. First, the provision of performance feedback from a fitness tracking technology prompts both positive and negative emotional reactions. Second, these technology-unrelated emotions can be influential for users' decision to continue using the fitness tracking technology. In particular, for novice users, defined as users with less than 12 months of usage experience, these emotions have a stronger influence on perceived usefulness and perceived enjoyment than for experienced users (i.e., more 12 months usage experience) as shown in the right-hand side of Figure 28. Experienced users, in contrast, rely more strongly on their prior evaluations in evaluating the usefulness, enjoyment, and their continuance intention (left-hand side of Figure 28).

With these results, Paper XII adds to the relationship between the opportunities (i.e., affordances) and the outcomes of consumer health IT. Moreover, this paper provides further evidence of the positive and adverse consequences and – with the case of emotions – another type of these consequences. As with Paper XI discussed before, results imply that particularly novice users are more sensitive about the outcomes of fitness tracking technology use, providing an additional, emotion-theoretical potential explanation of why people might stop using fitness tracking technology, particularly after a comparatively short time (Ledger and McCaffrey 2014).

4.13 Summary

This dissertation includes twelve papers to answer the specific research questions of this dissertation developed in section 2.5 while examining the role of motivation, ability, and opportunity in consumer health IT use (see also Table 6). The main findings on motivation, ability, and opportunity are summarized in Figure 29 in form of a model of effective consumer health IT use, where effective use denotes that type of consumer health IT use that helps individuals to attain the anticipated improvements for health and well-being (adapted from Burton-Jones and Volkoff 2017). The key tenets are described in the following.

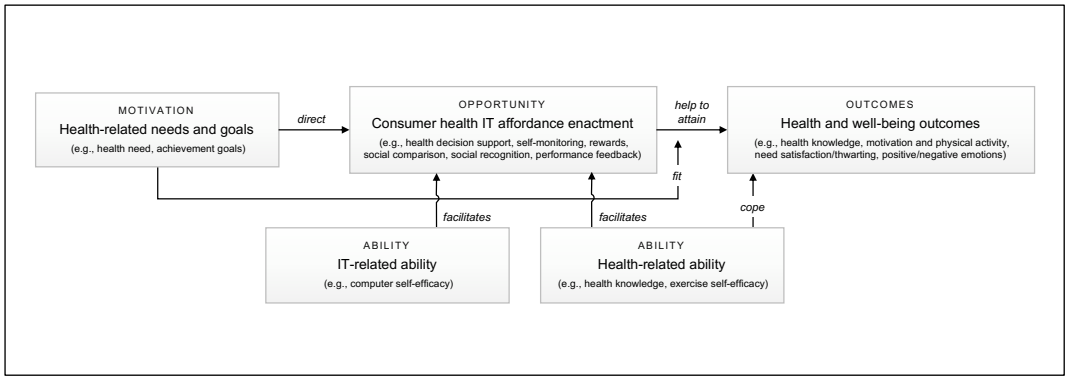


Figure 29. Summary of main research results: towards a model of effective consumer health IT use

Consumer health IT provides different **opportunities** with which people can support their health and well-being. These opportunities are understood in terms of affordances, i.e., the possibilities for goal-oriented action afforded by the tools and applications (Markus and Silver 2008). These can include, amongst others, health decision support or health management (Paper IV); self-monitoring, rewards, social comparison, or social recognition (Paper VII); or performance feedback (Paper XII). These affordances, when enacted, *help to attain* specific **health and well-being outcomes**. For instance, enactment of health decision support affordance supports the attainment of improved health knowledge (Paper VI); enactment of social interaction affordances, such as social comparison and social recognition, supports satisfaction of relatedness needs (Paper X); and enactment of self-monitoring or performance analysis support people's competence needs (Paper X and Paper XI). However, in certain circumstances, the affordances can also bring about detrimental impacts, such as negative emotions emerging from performance feedback (Paper XII) or thwarted competence needs arising from rewards and social recognition affordance enactment (Paper XI).

Motivation involves people's health-related needs and goals, which can include, amongst others, their health needs, their achievement goals, or physical activity improvement goals. Results of the papers indicate that this motivation is the key driver of people's uses of consumer health IT. Specifically, these needs and goals *direct* people's enactment of the specific affordances directly (Paper V and Paper VIII), indirectly by influencing usefulness perceptions or prompting exploratory IT behavior (Paper V), or by strengthening the impact of perceived usefulness (Paper IV). In other words, motivation directs the realization of the opportunities provided by consumer health IT. Despites, this dissertation reveals that the enacted affordances can bring about particular beneficial outcomes when these *fit* with the motivations of the person. For instance, when people pursuing performance goals (competence demonstration) enact affordances that provide corresponding means to attain these goals, such as social comparison or social recognition, they report higher increases in physical activity motivation and behavior (Paper IX) as well as more satisfied autonomy, competence, and relatedness needs (Paper X).

Ability involves both the IT-related ability (e.g., computer self-efficacy) and health-related ability (e.g., health knowledge and exercise self-efficacy). Both generally *facilitate* people's use of consumer health IT. Results have shown that IT-related ability is mostly of concern when it comes to more sophisticated IT uses (Paper I). However, results reveal that IT-related ability mostly has an indirect influence on people's enactment of the consumer health IT affordances such as by influencing ease-of-use perceptions (Paper IV), usefulness perceptions (Paper III), or by enabling exploratory IT behavior (Paper VI) – even in the context of older people. Health-related ability, including health knowledge and exercise self-efficacy, likewise has a facilitating role influencing central beliefs of technology use, such as by rendering consumer health IT as easier to use (Paper IV) and as more useful for one's health and well-being (Paper V). Moreover, health-related ability helps people to *cope* with the – particularly adverse – outcomes on their health and well-being. For instance, exercise self-efficacy serves as a personal resource people draw on when encountering psychological need thwarting and to cope with these adverse effects such that people with high exercise self-efficacy are less likely to give up their fitness tracking technology use (Paper XI).

The next section discusses the main findings of this dissertation in light of their contributions to research and theory, implications for practice, their limitations, and further research avenues.

5 DISCUSSION

The results of the twelve papers of this dissertation alongside this introductory paper contribute to research and theory in various ways and also have practical implications. This section presents and discusses these contributions and implications as well as the limitations and avenues for future research.

5.1 Contribution to Research and Theory

This first section discusses the contribution to research and theory this cumulative dissertation makes. These contributions are organized according to the two central research contexts of this dissertation – the context of older people and the fitness tracking technology context – followed by the synthesized contributions to the general strand of consumer health IT.

5.1.1 Contribution to Research on Older People

The first six papers of this dissertation focus on the context of older people and their use of general IT as well as consumer health IT. This subsection discusses the unique contributions this dissertation makes to the field of age-related IS research (e.g., Niehaves and Plattfaut 2014; Tams et al. 2014).

5.1.1.1 The Past Workplace as Source of Older People's IT-Related Self-Efficacy

Prior age-related IS research stressed the significance of IT-related self-efficacy (e.g., computer self-efficacy, mobile health self-efficacy) for older people's adoption and use of IT (Fox and Connolly 2018; Niehaves and Plattfaut 2014; Tams et al. 2018). However, less is known about how older people develop their IT-related self-efficacy and scholars have thus called for identification of the sources of older people's IT-related self-efficacy (Fox and Connolly 2018; Tams et al. 2014). So far, prior research identified computer trainings (Lam and Lee 2006), as well as computer knowledge and actual computer use as antecedents of older people's IT-related self-efficacy (for a review, see Wagner et al. 2010).

This dissertation conceptually and empirically identifies the past workplace of older people as a source of their IT-related self-efficacy (Papers II, III, and VI). In particular, Paper II identifies prior Internet use at the workplace as a source of older people's Internet self-efficacy. Papers III and VI identify the level of IT intensity at a prior workplace as an antecedent of general computer self-efficacy among older people. While Paper II focuses on past IT use behavior at the workplace as a source of IT-related self-efficacy, Papers III and VI also consider the broader social-environmental characteristics of the workplace, such as the social and formal support older people received as employees (e.g., observing co-workers' use of IT, mutual support, formal IT training), that influence older people's IT-related self-efficacy.

Moreover, this dissertation reveals that the workplace more strongly influences IT-related self-efficacy among retired persons than among non-retired persons (Paper VI) and that these impacts do not attenuate over time after retirement (Paper III). This finding strengthens the identification of the workplace as unique source of older people's IT-related self-efficacy.

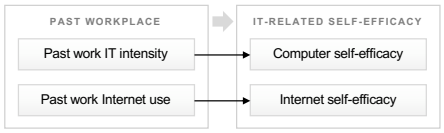
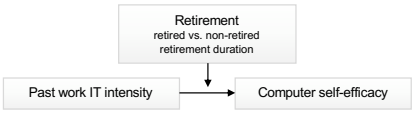
This dissertation …	
	• Identifies the past workplace as antecedent of older people's IT-related self-efficacy. • Empirically validates it at the general level (i.e. Past Work IT Intensity) and contextual level (i.e. Past Work Internet Use). • Provides cross-cultural validation (Germany and United States).
	• Reveals that the past workplace has a stronger impact on computer self-efficacy for retired than for non-retired people. • Reveals that the impact of the past workplace does not weaken over the time after retirement.

Table 11. Research contribution regarding older people's past workplace

In summary, this dissertation conceptualizes and validates the influence of the past workplace on older people's IT-related self-efficacy on a general level (i.e., Past Work IT Intensity; Papers III and VI) and a contextual level (i.e., Past Work Internet Use; Paper II), provides a cross-cultural validation with data from Germany (Study I; Paper II) and the United States (Study II; Papers III and VI), and reveals its significance for retired people (Table 11). This dissertation thus responds to the calls to identify the specific sources of older people's IT-related self-efficacy (e.g., Fox and Connolly 2018) and – in light of the digital divide – to the question of Dewan and Riggins (2005) to what extent the workplace promotes home IT use and IT skill development.

5.1.1.2 Older People's Post-Adoption IT Behavior

As the available age-related IS literature mostly assesses older people's adoption of IT, such as the Internet (Niehaves and Plattfaut 2014) or mobile health technologies (Fox and Connolly 2018), the post-adoption perspective, including the determinants and consequences of older people's actual engagement with IT, is rarely examined (Tams et al. 2014). This dissertation focuses on the post-adoptive IT behaviors of older people involving their specific uses of IT, such as their general Internet use (Papers I–II), general uses of consumer health IT (Papers III–IV) and particular uses of online health information (Papers V–VI), as well as their exploratory IT behavior (Papers V–VI).

Available age-related IS literature stresses older people's IT-related self-efficacy as enabler of their IT acceptance as well as their IT use (e.g., Fox and Connolly 2018; Tams et al. 2018). This dissertation, however, reveals that older people's post-adoptive use of IT is not necessarily solely determined by their ability but also by their motivation to use IT (Papers I–VI). Results reveal that motivation- and ability-related factors can yield distinct influences on the actual IT use behavior (Paper VI). Specifically, older people's IT-related self-efficacy comes into play when the type of IT use behavior can be characterized as more advanced or sophisticated, such as using the Internet for advanced purposes such as commerce or banking (Paper I), or the use of IT for health self-management purposes such as collecting health-related data (Paper IV). Less-advanced IT uses, such as using the Internet for health decision support and health information retrieval, are rather driven by older people's motivations to use IT, such as by their health needs (Papers IV–V), motivations to explore existing IT (Papers V–VI), but also motivation-relevant beliefs about the usefulness of the IT (Papers III–V). In these cases, older people's IT-related self-efficacy has mostly an indirect impact. Results thereby imply for future researchers to consider the nature of older people's IT use behavior in terms of its aspiration level when examining their IT-related self-efficacy. As such, this dissertation contributes to age-related IS

research by 1) focusing on post-adoptive behaviors and outcomes, and by 2) revealing that older people's IT use is not solely influenced by ability-related factors, but also by motivation-related factors (Table 12).

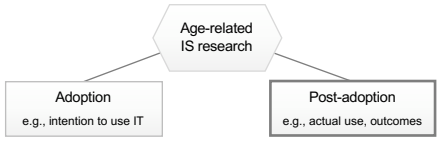
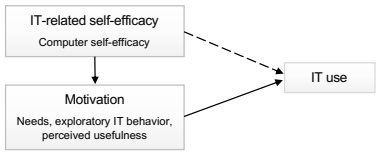
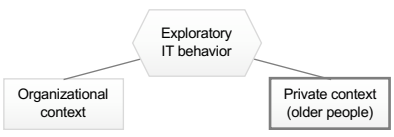
	This dissertation …
	• Extends age-related IS research into post-adoption stage. • Examines older people's actual use of IT and resulting outcomes.
	• Compares the influence of older people's IT-related self-efficacy and motivations on different types of actual IT use. • Reveals that older people's IT-related self-efficacy is mostly of concern when it comes to advanced IT uses. • Reveals that less sophisticated IT uses of older people are much more driven by motivation-related factors.

Table 12. Research contributions to older people's post-adoption behavior

As this dissertation draws upon the notion of 'exploratory IT behavior' as mechanism with which older persons enhance their IT utilization, this dissertation also makes the following contributions to research on exploratory IT behavior (e.g., Ahuja and Thatcher 2005; Liang et al. 2015; Peng and Guo 2019). First, as available research on exploratory IT behavior is largely based on organizational contexts, this dissertation contributes by extending research on exploratory IT behavior into the private context (Papers V–VI). Second, this dissertation contributes to the antecedents of exploratory IT behavior. Hereto, Paper VI confirms computer self-efficacy as an antecedent (Liang et al. 2015; Peng and Guo 2019) and Paper V identifies contextual needs and knowledge (i.e., health need and health knowledge) as antecedents as well. Third, Papers V–VI contribute to the consequences of exploratory IT behavior. These confirm exploratory IT behavior as mechanism enhancing utilization of existing IT (Liang et al. 2015; Maruping and Magni 2012) and extend the literature by revealing that – in the ageing context of IS research – the linkage between exploratory IT behavior and IT utilization is moderated by age-related factors, specifically chronological age (Paper V) and retirement (Paper VI) meaning that exploratory IT behavior results in higher IT utilization particularly for older people. Results imply that future researchers on older people's IT use need to consider exploratory IT behavior as antecedent of their IT utilization. Moreover, future researchers should consider contextual antecedents, such as needs, as triggers of exploratory IT behavior. In summary, this dissertation contributes to exploratory IT behavior by 1) introducing exploratory IT behavior as mechanism underlying older people's IT utilization, 2) by identifying contextual antecedents, and 3) by revealing its impact on IT utilization to be of higher effect for older people (Table 13).

This dissertation …
 • Extends the concept of 'exploratory IT behavior' into the private context of IT use (i.e., older people's use of consumer health IT).

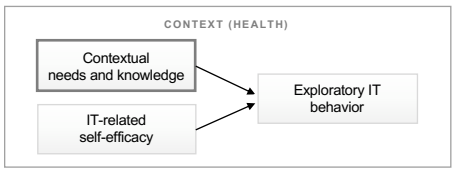
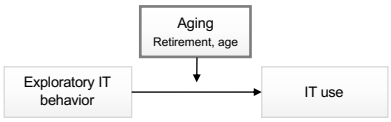
	This dissertation …
	• Identifies contextual antecedents of exploratory IT behavior (i.e., health needs and health knowledge). • Confirms IT-related self-efficacy as antecedent of exploratory IT behavior.
	• Confirms that exploratory IT behavior promotes IT use. • Reveals that exploratory IT behavior is of higher effect for older people.

Table 13. Research contributions to older people's post-adoption behavior

5.1.2 Contribution to Fitness Tracking Technology Research

The second six papers of this dissertation focus on the fitness tracking technology context. This subsection summarizes this dissertation's unique contributions to the emerging field of fitness tracking technology research (e.g., Hamari et al. 2018; Hassan et al. 2019; James et al. 2019a; James et al. 2019b; Suh 2018).

5.1.2.1 Fitness Tracking Technology Feature Use and Motivational Impacts

Although fitness tracking technology is expected to enhance motivation and physical activity behavior, its actual motivational effectiveness is not well understood, as reviews of existing research point out (Alahäivälä and Oinas-Kukkonen 2016; Hamari et al. 2014a; Hamari et al. 2014b; Johnson et al. 2016; Koivisto and Hamari 2019; Orji and Moffatt 2016). Fitness tracking technology incorporates a variety of features designed to facilitate motivation and physical activity, such as activity recording, earning virtual trophies, or connecting with other users to share workouts, to receive 'likes', or to compete with other users (Lister et al. 2014). Yet, with few exceptions, research often neglects the particular motivational impacts of these individual features and rather assess them as a whole (Hamari et al. 2014b; Koivisto and Hamari 2019; Orji and Moffatt 2016). Moreover, the few exceptions provide somewhat inconclusive results where certain features have positive impacts in one, but neutral effects in other studies (Hassan et al. 2019; James et al. 2019a; James et al. 2019b; Suh 2018). To fill this research gap about the motivational effectiveness of fitness tracking technology, this dissertation makes the following contributions to the literature.

First, this dissertation contributes to a better understanding about the motivational characteristics of the fitness tracking technology features. Specifically, this dissertation identifies a set of salient affordances in fitness tracking technology such as self-monitoring, exercise guidance, rewards, social comparison, and social recognition (Paper VII). These affordances reflect the goal-oriented actions afforded by the technology's features (Markus and Silver 2008) and provide an understanding of users' interpretation and concrete uses of these features (Chan et al. 2019; Seidel et al. 2018; Tim et al. 2018). As such, this dissertation provides the conceptual underpinnings to analyze the role of fitness tracking technology features. This dissertation also provides the content-validated measurement instruments to assess these affordances in empirical research, particularly in quantitative survey studies (Paper VII). Content-valid assessment instruments are instruments that have been proven to measure what

they intend to measure (Haynes et al. 1995; Recker 2013) which is critical in empirical research (MacKenzie et al. 2011). Moreover, the validity of the affordances identified and the items developed is strengthened by the affordances and items provided by research published in parallel to this dissertation (Hamari et al. 2018; Hassan et al. 2019; James et al. 2019b).

Based on the affordances identified, this dissertation discusses their motivation-relevant characteristics, i.e. aspects of these affordances that are concerned with motivation (Papers VIII–XI). This dissertation posits that, from a motivational perspective, the affordances have a distinct 'functional significance' for users, i.e., a motivation-psychological meaning users ascribe to these affordances, that are highly relevant in explaining the effects emerging from the affordances respectively features (Ames 1992; Ryan and Grolnick 1986; Vansteenkiste et al. 2008). Specifically, this dissertation identifies three distinct characteristics. First, Papers VIII–X posit that the affordances are to be interpreted as relatively well-defined 'goal structures' – distinct environmental features and possibilities that potentially facilitate an individual's goal accomplishment (Emmons et al. 1986; Ickes et al. 1997). As goal structures, the affordances potentially facilitate attainment of competence development goals (mastery goal) and competence demonstration goals (performance goal) (Ames 1992; Nicholls 1989). Second, Papers X and XI identify the affordances as environmental factors distinctively targeting users' basic psychological needs for autonomy, competence, and relatedness, which are of concern for optimal functioning, motivation and well-being (Ryan and Deci 2017). Specifically, Paper X maps individual affordances and the distinct psychological needs they target, whereas Paper XI focuses particularly on the competence need. Third, Paper XI theorizes the controlling vs. non-controlling nature of the affordances. Specifically, certain affordances, such as rewards and social comparison can exert pressure over the users and induce an external locus of control (Ryan 1982). As will be discussed in more detail later, this distinguishing characteristic is particularly of relevance for the emergence of adverse motivational effects (i.e., need thwarting). Table 14 summarizes the contributions concerning the motivational characteristics of fitness tracking technology features. These theoretical notions provide researchers with a deeper understanding about the motivation-theoretical characteristics of fitness tracking technology features on which future research can build on to theorize and explain the role of these features.

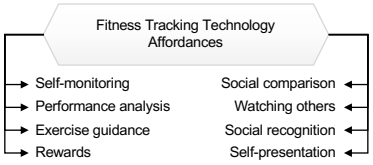
	This dissertation …
	• Identifies eight salient affordances of fitness tracking technology. • Provides corresponding, content-validated measurement instruments.
	Discusses the motivation-relevant characteristics of the affordances in terms of: • *Goal structures* that facilitate the attainment of the users' goals of competence development (mastery goal) and competence demonstration (performance goal). • *Need support* for users' autonomy, competence, and relatedness needs. • *Controlling vs. non-controlling nature,* i.e. whether one's thoughts and actions are controlled and evaluated by others.

Table 14. Contributions to fitness tracking technology research regarding the features' motivational characteristics

Second, this dissertation contributes to a better understanding about interpersonal, motivational differences in fitness tracking technology use. Specifically, this dissertation uncovers two meaningful relationships between users' motivation-related goals and the affordances of fitness tracking technology (Papers VIII–X).

First, users' motivational goals distinctively drive the affordances enacted within the fitness tracking technology (Paper VIII). This is because people pursuing specific goals seek out those environments and situations which they expect will facilitate accomplishing their goal (Emmons et al. 1986; Ickes et al. 1997). In other words, because users interpret the affordances as goal structures, they seek out those that fit their goals. Paper VIII posits and confirms distinct relationships between particular goals and individual affordances enacted; for instance, whereas users' mastery goal (competence development) drives enactment of the self-quantification affordance, users' performance goal (competence demonstration) drives enactment of the social comparison affordance. This dissertation thereby extends and confirms research published parallel to this dissertation examining relationships between motivational differences among users and the features and affordances of fitness tracking technology (Hamari et al. 2018; James et al. 2019a; James et al. 2019b; Stragier et al. 2018).

Second, this dissertation identifies that users' motivation-related goals moderate the effects emerging from the enacted affordances meaning that certain affordances are particularly motivating for users pursuing particular goals (Papers IX–X). For example, users with a performance goal, who focus on competence demonstration, report higher motivation and increases in physical activity when enacting the social comparison and rewards affordance (Paper IX). Likewise, these users report higher satisfaction of their autonomy, competence, and relatedness needs when enacting related affordances (Paper X). As discussed, affordances serve as goal structures that can facilitate the attainment of certain goal. When the goals facilitated by the affordance 'match' or 'fit' the goal pursued by the users, higher motivational outcomes emerge. This dissertation hence reveals the influence of individual motivational differences as one explanation how and why prior research findings on the motivational effects in fitness tracking technology often vary so widely.

This dissertation thus responds to calls to examine the role of user characteristics in fitness tracking technology use (Alahäivälä and Oinas-Kukkonen 2016; Hamari et al. 2014a; Johnson et al. 2016; Koivisto and Hamari 2019). Thereby, this dissertation also contributes to Achievement Goal Theory (Ames 1992; Nicholls 1989) by 1) implying that goal structures can be embedded within digital artifacts, by 2) confirming the 'matching' hypothesis between goal orientations and goal structures (Jagacinski et al. 2001; Murayama and Elliot 2009), and by 3) revealing a fourth type of relationship between goal orientations and goal structures, i.e. that goal orientations drive people to engage in certain goal structures (Murayama and Elliot 2009).

These results imply that that future research needs to consider such interpersonal, motivational differences of the users when examining the motivational impacts of the different features used respectively affordances enacted. Without taking such differences into account, researchers might otherwise draw misleading conclusions about the features' impacts. This dissertation provides the underlying theoretical linkage between features respectively affordances and users' goals and corresponding empirical evidence which enables future research to integrate users' goals into their analyses. Table 15 provides a summary of these two central contributions regarding the role of interpersonal, motivational differences.

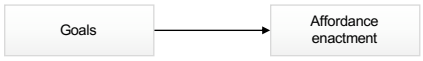
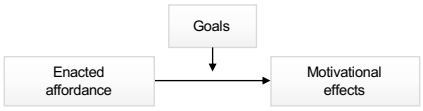
	This dissertation …
	• Identifies that users' goal orientations (mastery, performance) drive enactments of particular, goal-corresponding affordances of fitness tracking technology.
	• Identifies that the motivational effects emerging from the enacted affordances of fitness tracking technology can vary by the motivational goals the users pursue. • Provides evidence of moderating effect of goals for two motivational impacts: psychological need satisfaction and perceived benefits. • Thereby reveals that affordances for exercise control (rewards, exercise guidance) and social interaction (social comparison and social recognition) are particularly effective for people with strong performance goal orientation.

Table 15. Contributions to fitness tracking technology research regarding the role of interpersonal, motivational differences

Third, this dissertation contributes to a better understanding of *how* fitness tracking technology feature use converts into motivation-relevant outcomes. Specifically, this dissertation identifies the underlying motivation-psychological processes that take place when interacting with the features of fitness tracking technology. Results reveal that basic psychological need satisfaction serves as the underlying process with which the affordances exert their motivational impacts on the user (Ryan and Deci 2017). As discussed earlier, this dissertation theorizes distinct linkages between the individual affordances and the specific needs for autonomy, competence, and relatedness, which are empirically confirmed by Papers X and XI. Depending on the extent to which these three needs are satisfied, as Paper X reveals, users realize higher motivational benefits from their fitness tracking technology use, as represented by reported enhancements in physical activity motivation and behavior. Moreover, when considering basic psychological need satisfaction as the antecedent, a multitude of alternative explanations (e.g., demographics, exercise self-efficacy, activity levels, usage experience) have no significant effect on these actualized motivational benefits; this, in turn, strengthens the finding that psychological need satisfaction is a core motivational mechanism promoting the benefits. With these results, this dissertation responds to the call to identify the underlying psychological processes with which these affordances exert motivational impacts (Koivisto and Hamari 2019).

Moreover, Paper X theorizes and provides empirical evidence that users' achievement goals moderate the linkage between enacted affordances and the specific basic psychological needs satisfied. This dissertation thus develops a theoretical linkage between Self-determination Theory (Ryan and Deci 2017) and Achievement Goal Theory (Ames 1992; Nicholls 1989). Specifically, while Self-determination Theory suggests the possibility of interpersonal variations in need satisfaction from environmental factors, empirical evidence and moderating personality factors remain scarce (Ryan et al. 2019). Using Achievement Goal Theory as complimentary theory, this dissertation theorizes goal orientations as a personality factor resulting in different individual responses to environmental factors in terms of their satisfaction of autonomy, competence, and relatedness. Paper X shows that particularly individuals who define their competence on normative bases (i.e., performance goal) gain higher need satisfaction from environmental factors that are inherently others-oriented (i.e., features affording social recognition and social comparison). Moreover, these persons react more strongly to such social interactions in terms of relatedness need satisfaction because of previously neglected relatedness needs.

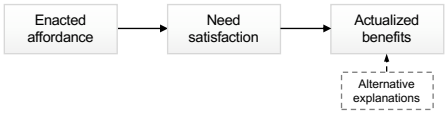
	This dissertation …
	• Identifies basic psychological need satisfaction (autonomy, competence, relatedness) as the motivation-psychological process underlying the actualized motivational benefits from the enacted affordances. • Identifies that specific affordances are associated with specific psychological needs. • Reveals that a multitude of alternative explanations for the actualized motivational benefits have no direct, significant effect when considering psychological need satisfaction. • Adapts measures for psychological need satisfaction to the IS context.
	• Develops a theoretical linkage between Self-determination Theory and Achievement Goal Theory. • Reveals that basic psychological need satisfaction from environmental factors is moderated by achievement goals.

Table 16. Contributions to fitness tracking technology research regarding the motivational process underlying fitness tracking technology use

Table 16 summarizes these contributions to the literature. For future research, the results imply that basic psychological needs constitute a linkage between the features used respectively affordances enacted and the motivation-relevant outcomes. A neglect of these mediating processes can produce inconclusive or misleading results. Particularly when linking affordances with an outcome directly, certain enacted affordances might turn out to have an insignificant impact and researchers might hence conclude that this specific affordance has no motivational impact. Finally, because psychological need satisfaction mediates a broad variety of motivation-relevant outcomes (Ryan and Deci 2017), this dissertation equips future researchers with the necessary theoretical linkage and empirical evidence to examine various, additional motivation-relevant outcomes in future studies.

In summary, this dissertation engages more strongly with the individual features of fitness tracking technology, how users make use of them, and how these features result in the anticipated benefits. Table 14, Table 15, and Table 16 summarize the contributions this dissertation makes to research on fitness tracking technology features.

5.1.2.2 Positive and Adverse Motivational Effects and their Impacts on Continued Fitness Tracking Technology Use

So far, existing literature on fitness tracking technology maintains an overall optimistic view on their motivational effectiveness, suggesting that people are more motivated to engage in physical activity when using fitness tracking technologies. However, there are also indications about adverse, demotivational effects that, in some occasions, cause people to lower their usage of these technologies or to stop using them altogether (Barratt 2017; Foss 2014; Green 2015; Hargrave 2013; November Project 2017). Despite these indications, research has not yet considered these adverse motivational effects (Koivisto and Hamari 2019; Schmidt-Kraepelin et al. 2019). This dissertation hence contributes to the literature by identifying a 'darker side' of fitness tracking technology use in terms of adverse impacts and their implications for continued fitness tracking technology use as follows.

First, this dissertation (Papers XI–XII) generally identifies the co-existence of adverse, demotivational effects when using fitness tracking technology. Specifically, this dissertation

identifies negative emotional reactions occurring when self-tracking one's physical activity (Paper XII) as well as basic psychological need thwarting (Paper XI) as two conceptual adverse motivational effects and empirically confirms their existence. Moreover, Papers XI and XII reveal the co-existence of positive and adverse motivational effects as antecedents of peoples' intention to continue using fitness tracking technology.

Second, and in line with the motivational characteristics of the affordances discussed above, this dissertation reveals that adverse motivational effects can emerge from certain affordances with specific characteristics. In particular, Paper XI identifies that certain affordances have a 'controlling' nature such that, when enacted, users' locus of control becomes external and controlled by rewards and social recognition, introducing external contingencies for their physical activity behavior (Ryan and Deci 2017). These affordances can therefore readily thwart users' basic psychological needs, such as their competence need, as empirically proven by Paper XI. In consequence, need satisfaction and thwarting influences users' willingness to continue using the fitness tracking technology. In this vein, this dissertation identifies exercise self-efficacy as a coping resource on which users draw when confronted with a thwarted competence need: users with low levels of exercise self-efficacy react more strongly to competence need satisfaction and thwarting in terms of their willingness to continue using the fitness tracking technology. As need thwarting assesses a darker side of psychological experiences in which peoples' needs are actively impeded or frustrated (Bartholomew et al. 2011; Gunnell et al. 2013), this dissertation also extends literature on the 'dark side of IT use' (Tarafdar et al. 2015) by introducing the notion of psychological need thwarting into the IS context as a fruitful perspective in assessing the detrimental psychological effects of IT use (D'Arcy et al. 2014).

Third, this dissertation quantitatively confirms the indications of prior research that the performance feedback provided by fitness tracking technology provokes positive and negative emotional reactions among users (Baumgart 2016; Prasopoulou 2017; Sjöklint et al. 2015) and extends this line of research by identifying the theoretical conditions under which certain emotional reactions occur (Paper XII). Moreover, Paper XII reveals that these emotional reactions influence respectively 'infuse' peoples' evaluations concerning the instrumental and hedonic qualities (i.e., perceived usefulness and perceived enjoyment) of the fitness tracking technology in affect-congruent manner and thereby their intentions to continue using the fitness tracking technology. Paper XII shows that particularly novice users are more sensitive to their emotional reactions when evaluating the fitness tracking technology.

In addition to these contributions to fitness tracking technology research, this dissertation makes the following contributions to IS literature. First, Paper XII contributes to the literature on emotions in IS usage (Beaudry and Pinsonneault 2010; Vornewald et al. 2015; Zhang 2013) by identifying the notion of 'system-unrelated' or 'incidental' emotions in the IT usage context, i.e. an emotion whose source is normatively unrelated to the object of judgment or decisions (Forgas 1995; Pham 2007). Moreover, this paper provides an explanation of how and why such emotions can nevertheless influence object-related evaluations such as perceived usefulness and perceived enjoyment based on the 'affect-as-information' mechanism (Schwarz 1990; Schwarz and Clore 1988). It also explains that such emotions are more likely to have an influence in early usage stages, when evaluations are less stable and held with less certainty. In later usage stages, experienced users are more prone to base their evaluations on prior evaluations. Paper XII also contributes to the IS continuance literature by confirming key tenets of the integrative framework of technology use (Kim and Malhotra 2005).

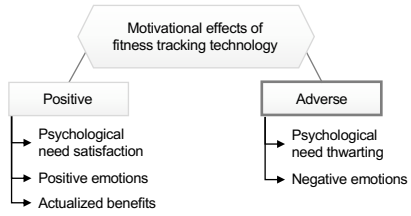
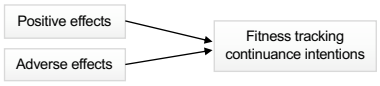
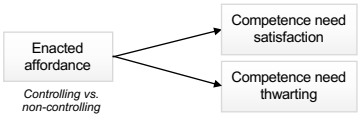
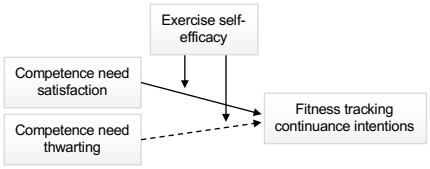
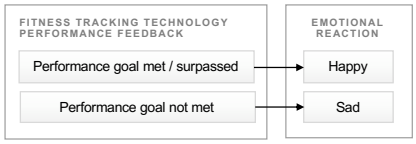
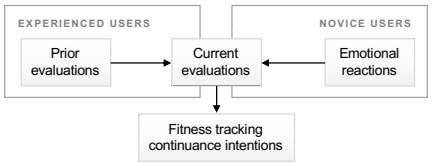
	This dissertation …
	• Discusses positive and adverse motivational effects of fitness tracking technology use. • Identifies psychological need satisfaction, positive emotions, and actualized benefits as positive motivational effects and psychological need thwarting and negative emotions as adverse motivational effects. • Provides evidence that these positive and adverse effects occur during fitness tracking technology use.
	• Identifies the positive and adverse motivational effects as antecedents of users' intention to continue using a fitness tracking technology.
	• Discusses the controlling vs. non-controlling nature of the affordances as exerting control over the individual is the pre-condition for psychological need thwarting to occur. • Identifies that 'self-monitoring' affordance provides positive effects but 'rewards' and 'social recognition' affordances lead to positive and adverse effects on users' competence need.
	• Discusses competence need satisfaction and competence need thwarting as determinants of users' intention to continue using a fitness tracking technology. • Identifies users' exercise self-efficacy as coping resource such that users with lower exercise self-efficacy are more reactive to competence need satisfaction and thwarting.
	• Quantitatively confirms that performance feedback provided by fitness tracking technology causes emotional reactions. • Confirms the theoretical conditions for these emotional reactions to occur.
	• Confirms that evaluations about the technology (perceived usefulness and enjoyment) determine use continuance intentions in the fitness tracking context. • Confirms that prior evaluations inform current evaluations. • Reveals that emotional reactions 'infuse' current evaluations about the technology. • Reveals that experienced users base their current evaluations stronger on prior evaluations and novice users more on their emotional reactions.

Table 17. Contributions to fitness tracking research regarding the positive and adverse effects and impacts on continued use

In summary, this dissertation contributes to fitness tracking technology research by 1) identifying the existence of adverse, demotivational effects, 2) their causes, and 3) their consequences for continued use of fitness tracking technology (Table 17).

5.1.3 Contribution to Consumer Health IT Research

In addition to the contributions to the two research contexts discussed above, this dissertation makes the following contributions to the strand of consumer health IT within the IS literature.

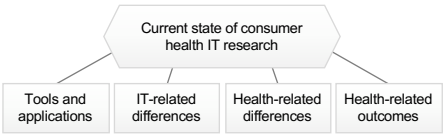
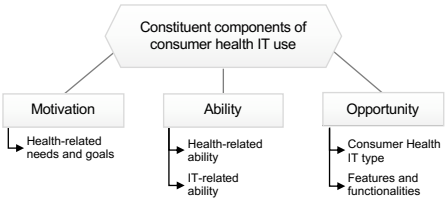
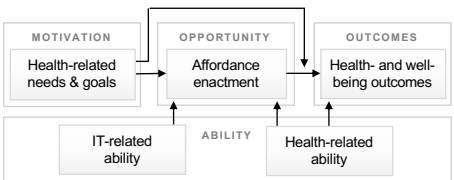
First, this dissertation contributes to the consumer health IT literature by providing an overview of the current state of research published in the major journals of the IS discipline (Lowry et al. 2013). The consumer perspective on health IT perspective has been called for in the IS literature (Agarwal et al. 2010), yet research appeared rather slowly, albeit scholarly interest is increasingly growing. To better understand how this strand evolved so far, the literature review of this Introductory Paper (section 2.1.1) entails an overview of the different contexts, tools and applications, the individual health-related and IT-related differences of the consumers, as well as the outcomes of consumer health IT use examined in the available literature. This overview enables researchers to identify additional research gaps and to build upon the available findings to further advance the field.

Second, this dissertation contributes to the literature with a better understanding of the key components in consumer health IT use. As the review of available research (section 2.1.1) has shown, a variety of different contexts, tools, applications, consumer health-related factors, consumer IT-related factors, and outcomes have been examined in existing research making it difficult to keep track of the key components determining consumer health IT overarchingly. In order to address this shortcoming in the literature, this dissertation analyzed the literature on a meta-level and identified theory-guided, constituent components in terms of the person's motivation and ability as well as the opportunity provided by the technology. The resultant theoretical meta research framework on consumer health IT serves research to examine various types and contexts of consumer health IT while having guidance on the selection of key variables necessary to understand the particular consumer health IT tool or applications used. In line with the overview of the current state of research, this framework brings scholars in a better position to advance the emerging field of consumer health IT.

Third, this dissertation contributes with a fine-grained understanding of the nature and role the components of motivation, ability, and opportunity in the consumer health IT use context. This dissertation applied the research framework just discussed in the contexts of older people's use of consumer health IT and fitness tracking technology using different theoretical angles. The synthesized findings of these two contexts (section 4.13) indicate that people's motivation (health-related needs and goals) drive the realization of the opportunities provided by consumer health IT. The specific features embedded within the IT (opportunities) need to be understood in terms of affordances and goal structures which potentially facilitate people's goal attainment and need satisfaction. Consequently, people seek out those affordances that correspond to their motivation. The main insight is that it is the enactments of these affordances that bring about the outcomes of consumer health IT use. Finally, people's IT-related and health-related ability facilitate enactments of these affordances. This derived core logic of motivation, ability, and opportunity implies that future researchers seeking to understand the outcomes of consumer health IT need to center on the notion of affordances, identify the salient affordances specific to the IT of interest (Markus and Silver 2008; Mettler et al. 2017), and the health-related goals and needs potentially facilitated by these affordances.

Fourth and finally, this dissertation contributes to the understanding of the health and well-being outcomes of consumer health IT use. Analysis of the literature revealed that only a few articles examined the outcomes of consumer health IT use so far (section 2.1.1.2) yet that a wide variety of impacts can be achieved using consumer health IT, including impacts on health-

related cognition, affect, behavior, bodily outcomes, well-being, and life outcomes. This dissertation extends the strand on outcomes of consumer health IT as follows. Paper VI reveals that increased use of online health information can enhance people's health knowledge thereby contributing to cognitive outcomes and by responding to the question raised by Agarwal et al. (2010) how health information provided by the Internet impacts health and well-being. Papers IX-X extend the literature on cognitive and behavioral outcomes by increased physical activity motivation and behavior as an outcome of fitness tracking technology use. This dissertation also contributes to affective outcomes of consumer health IT revealing that IT-based, health-behavioral feedback (i.e., physical activity performance feedback) prompts emotional reactions (Paper XI). Moreover, Papers X-XI contribute to cognitive outcomes in terms of basic psychological need satisfaction and thwarting. Thereby, this dissertation contributes with psychological mediators underlying consumer health IT use which enables researchers to develop linkages between consumer health IT use and a variety of well- and ill-being outcomes as posited by Self-determination Theory (Ryan and Deci 2017). Finally, this dissertation extends the outcomes of consumer health IT by discussing the existence of adverse effects and by providing first empirical evidence regarding negative emotions (Paper XII) and psychological need thwarting (Paper XI). As this dissertation theoretically and empirically established the linkages between specific opportunities provided by consumer health IT (i.e., affordances) and the specific health and well-being outcomes discussed by now, future research is now in a better position to explain and predict which types of health and well-being outcomes can emerge through consumer health IT use and how.

	This dissertation …
	• Reviews the current state of the literature on consumer health IT concerning the tools and applications, individual IT-related and health-related differences, and health-related outcomes examined so far. • Enables scholars to build upon the available research.
	• Synthesizes the key factors underlying of consumer health IT use. • Provides a theory-guided meta research framework involving motivation, ability, and opportunity as constituent components and their corresponding factors examined so far.
	• Examines the nature and role of motivation, ability and opportunity in the consumer health IT context. • Provides a model on effective consumer health IT use by identifying core relationships to achieve different health and well-being outcomes.

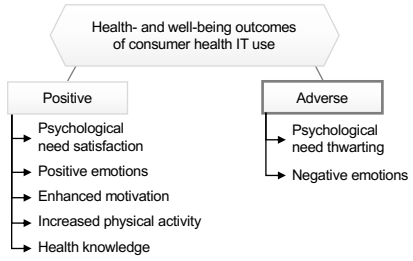
	This dissertation …
	• Extends research on the health- and well-being related outcomes. • Reveals positive impacts: psychological needs satisfaction, positive emotions, enhanced motivation and increases in physical activity, enhanced health literacy. • Identifies adverse impacts: psychological need thwarting and negative emotions.

Table 18. Research contribution on consumer health IT

In summary, this dissertation contributes to consumer health IT research by 1) providing an overview of the current state of research, 2) by providing a meta-theoretical research framework involving the constituent components of ability, motivation, and opportunity, 3) by developing a fine-grained understanding of the nature and role of the components to achieve health and well-being outcomes from consumer health IT, and 4) by extending the literature with several positive and adverse outcomes on healthy behavior and well-being (Table 18).

5.2 Implications for Practice and Policy

By summarizing the practical implications of the twelve papers included in this dissertation, this section provides synthesized guidance for practice and policy on supporting older people's use of consumer health IT and on designing and using fitness tracking technology. Accordingly, these implications are structured into two parts.

5.2.1 Supporting Older People's Use of Consumer Health IT

Most developed countries are confronted with an ever-increasing proportion of older people (United Nations 2017; WHO 2015). The older persons' health is not only of significance for the well-being and quality of life of the individual but also challenges many healthcare systems (Pew Research Center 2013; Statistisches Bundesamt 2017). Accordingly, older people's use of consumer health IT is expected to benefit both the individual and the society (Fox and Connolly 2018). Based on the results of this dissertation, the following implications can be derived.

First, it is often assumed that older people lack IT-related ability and find IT difficult to use and therefore avoid using IT. The research results of this dissertation, however, indicate that this is not necessarily always the case. Older people's IT-related ability is mostly needed when it comes to sophisticated and advanced IT uses. For instance, when using more of the available features the Internet offers, such as banking and commerce (Paper I) or when using IT for health management purposes, such as for collecting and storing health data with personal health records (Paper IV). In less advanced cases, such as online health information retrieval, older people's IT-related ability has a rather facilitating than enabling role. Hence, when seeking to attract older people for digital offerings, practice and policy need to reflect upon to which extent these offerings demand sophisticated IT-related abilities.

Second, even though older people's IT-related ability is in certain instances of a facilitating role, it constitutes an essential facet of digital inequalities and the digital divide. As Paper VI has shown, the digital divide amongst older people is a unique one: starting with disparities in prior

access to IT at the workplace and ending in health literacy disparities in later life. While policy nowadays invests in public access to IT and development of digital abilities from early on (e.g., schools), the continuous advancement of digital technologies requires lifelong learning and on-going adjustments of IT-related abilities. Workplaces constitute an influential source for people's development of such IT-related abilities and have a lasting impact on older people. As such, governments should encourage firms to keep investing in IT access and education for their employees, even if they are close to retirement. In Germany, for instance, the government currently discusses sponsoring companies in training their employees in new technologies, and for employees aged 45 years and above, this training should be entirely grant-aided (FAZ 2018). The results of this dissertation encourage these considerations.

Third, results indicate that older people's use of consumer health IT is strongly driven by the usefulness they perceive from using IT to support their health as well as by their exploratory IT behavior (Papers V-VI). Because older people often stick with established media practices (Nimrod 2017), media should report about the benefits and advantages of using consumer health IT, such as online health information to better care for oneself and to maintain independence in later life. At the same time, older people should also be encouraged to 'try out' and explore the possibilities provided by their IT, particularly in older age. However, older people perceive more health-related benefits from consumer health IT, are more driven from these benefits to use consumer health IT, and are more likely to explore their existing IT when they have more severe health needs (Papers IV-V). Against this backdrop, the benefits of consumer health IT must also be stronger communicated as a means for health prevention. Additionally, results indicate that older people perceive consumer health IT as more useful and as easier to use when they possess higher health knowledge. For providers of online health information, this means that they need to provide their contents in more accessible ways such that is written for people without sophisticated health knowledge.

5.2.2 Design and Use of Fitness Tracking Technology

Insufficient regular physical activity is a serious concern for the individual and society at large. Physical inactivity is a leading cause of mortality (OECD 2017) and causes billions in healthcare and lost productivity (WHO 2018a). Fitness tracking technology aims to support people's physical activity motivation and behavior and currently gains huge interest (Statista 2018; WHO 2018b). The results of this dissertation provide implications for providers and users to achieve the anticipated benefits of fitness tracking technology use.

Vendors of fitness tracking technology face intense competition in the market and hence need to possess a distinct understanding of the motivational effects of the developed features and about their target group to develop fitness tracking technology that fulfills its expectations. Hereto, vendors might consider the offered or envisaged features in terms of their affordances. Using affordances, providers get an augmented understanding of the features, i.e., how users interpret these features in light of their goals (Paper XII). For instance, a leaderboard – a frequently incorporated feature – can act as a means of 'Social Comparison' but also as 'Reward' when becoming better than others or as a means of 'Watching Others'. Because individuals have different physical activity goals, they require individualized 'motivational environments' that fit their exercise-relevant goals. This dissertation provides the patterns between the users' goals, corresponding affordances and resulting motivational effects (Papers VIII–X) which facilitates the understanding of distinct user-profiles and assists in the development and invention of features. The results also suggest that these features might be dynamically adjusted according to the goal orientations of the users to provide optimal motivational environments. For instance,

for users with a strong performance goal orientation, those features should be brought to the fore, which provide means to compare and compete with others, such as leaderboards. Thereby, vendors need to consider the motivational processes underlying feature use so that features should be designed in such a way that they satisfy the psychological needs for autonomy, competence, and relatedness (Papers X-XI). Yet, Paper XI has shown that such design can be quite challenging as that certain features can result in need satisfaction but can equally harm users' needs. Here, vendors need to bear in mind that certain features can interfere with users' autonomy and thereby introduce the potential of negative motivational impacts. To counteract this, vendors can again dynamically adjust the presence of certain features with lowered continued use potentially serving as an indicator of experienced negative impacts (Paper XI).

For users, the results suggest that they can create their individual, optimally motivating environment by selecting and engaging with those features that best fit their personal goals. Although results suggest that using features providing means for self-monitoring is motivating and beneficial for all users, exercise controlling features, such as virtual rewards, and social interaction features are particularly motivating for users with a strong performance goal orientation (Papers X-XI). However, as particularly the latter features can also have adverse motivational impacts, users should gradually explore these features and to seek out whether using these is motivating. If not, then users should switch back to other features in order to keep up their satisfying experiences, which is especially important for users who are just beginning with their physical activity regimen and who usually possess lower exercise self-efficacy (Paper XI). Moreover, particularly when just having started to use fitness tracking technology, users must be aware that the performance feedback can sometimes provoke adverse emotional reactions when not meeting an exercise target.

5.3 Limitations

As with any research, the findings are not without limitations. While most specific limitations are discussed in the individual papers, this section discusses the overarching limitations.

First, the literature review on consumer health IT presented in section 2.1.1 focused on the timeframe 2008–2019 and on articles published in 'major' outlets of the IS discipline (Lowry et al. 2013) so that other articles in other journals or conferences are excluded from this review.

Second, this dissertation focused on the contexts of older people and fitness tracking technology to develop an understanding of how consumer health IT can support healthy behavior and well-being. Albeit these two contexts are of high practical significance, the findings concerning the nature and role of ability, motivation, and opportunity are limited to these contexts. As discussed in the background on consumer health IT, there are also other tools and applications, such as online health communities, specific health self-management applications, or specific health consultation platforms (see section 2.1.1.1), which provide other opportunities (affordances) and that are driven by other types of motivations (i.e., need and goals) and abilities (i.e., IT- and health-related abilities). As such, the findings of this dissertation are limited in their generalizability to these two contexts.

Third, this dissertation examined specific outcomes and consequences related to health and well-being, including health knowledge (Paper VI), increases in motivation and physical activity (Papers IX-X), psychological need satisfaction (Papers X-XI) and emotions (Paper XII). However, results are limited as this dissertation relied on self-reported outcomes, which is not without criticism as people might not accurately report their actual outcomes. Moreover, diverse

other outcomes can result from consumer health IT, as shown in section 2.1.1.2, including self-care activities or actual bodily improvements (Kelley et al. 2011). As such, the findings of this dissertation are limited to the examined outcomes.

Fourth, this dissertation comes with limitations concerning the study participants. In the context of older people, Study I and II accordingly targeted elderly individuals. As online surveys might have attracted the technology-savvy segment of this population, both studies recruited respondents from public locations (e.g., train stations, libraries, gyms, adult schools, or senior citizen centers). However, this approach comes with the drawback that respondents, who are less outgoing or have severe physiological issues forcing them to stay at home, might have been missed. In the context of fitness tracking technology, Study V and associated Papers VIII–XI involve respondents from the fitness tracking application 'Strava'. Sample characteristics indicate that respondents are quite physically active, which suggests that respondents are already motivated to be physically active. Albeit this characteristic is in line with related literature and studies (Hamari et al. 2018; Higgins 2016; Stragier et al. 2018), there are also other fitness tracking applications that might attract less motivated individuals and which might differently interact with and react to the fitness tracking features (Papers VIII-XI). In line with this, Strava positions itself as 'the social network for athletes' so that this application might be particularly attractive for users with a generally strong performance goal orientation. Hence, the results of this dissertation are bound to these specific characteristics of the respondents and who appear to not suffer strongly from health issues.

Fifth, the empirical results are bound to responses from Germany and the United States, which are both developed countries with developed healthcare systems and developed technological infrastructures. Results might thus differ for less developed countries.

5.4 Future Research Opportunities

The contributions and implications discussed above provide different and intriguing avenues for future research. This section discusses some of them.

For IS research on older people, an examination of further, alternative conceptualizations of age might provide novel insights on the meaning of age in IS-related phenomena. Most of the available IS research so far examines age in terms of chronological age, assessed by the number of years since birth (Hong et al. 2013; Tams et al. 2014). Aging literature, however, sees chronological age as problematic, particularly when examining behaviors of older people (Barak and Schiffman 1981), mainly as it does not "reflect the idiosyncratic meaning of this number to different individuals" (Hong et al. 2013, p. 122). Consequently, calls have been made in the IS literature to examine alternative conceptualizations of age (Tams et al. 2014). Whereas this dissertation proposed and revealed 'retirement' as a qualitative marker of the aging process reflecting a change in life phase (Paper VI), a variety of other conceptualizations are suggested including the functional or biological age and the subjective or perceived age (Tams et al. 2014). Particularly in the latter case, initial indications in the IS literature exist that subjective age (i.e., feeling younger or older than one's chronological age) can impact established relationships of technology acceptance (Hong et al. 2013) or reveal counter-intuitive findings, such as that older persons with higher subjective age prefer more comprehensive user interfaces (Ghasemaghaei et al. 2019). As more examinations of subjective age have been called for in IS research on older people (Gewald and Currie 2017; Gewald et al. 2019), an avenue for future research is the theoretical integration of subjective age into the notion of older people's IT-related traits, such

as their computer self-efficacy and anxiety or personal innovativeness in IT (Maier 2012). Because subjective age reflects a state of mind (Schiffman and Sherman 1991), subjective age appears to be a personality characteristic and might, therefore, to be theorized with IT-related traits. An initial approach for this has been presented in Rockmann and Gewald (2016).

Moreover, as this dissertation identified exploratory IT behavior as a meaningful mechanism with which older people enhance their IT uses, future research should identify additional antecedents and outcomes of older people's IT exploration. In this regard, the type and characteristics of the device with which older people interact could provide an interesting perspective. Older people increasingly use smartphones and tablets instead of traditional desktop computers (Anderson and Perrin 2017). Because tablets and smartphones are less complex, they might not require strong IT-related abilities, so that an intriguing question is, whether the type of device impacts older people's exploratory IT behavior and resulting IT uses.

In the context of fitness tracking technology, this dissertation applied a static view on the relationships between users' goals, enacted affordances, and resulting motivational impacts. Future research should examine whether – and if so, how – enacted affordances and users' goals change or adjust over time. Motivation research suggests that goals emphasized within the personal environment promote adoption of this goal by the individual (see section 2.4.1); for instance, when being situated in performance goal structures, i.e., environments emphasizing competitions, people are likely to adopt a personal performance goal in consequence (Murayama and Elliot 2009). In the fitness tracking technology context, there are indications that users are often automatically exposed to the social dimension of fitness tracking technology such that users might unintentionally engage in social comparison and competition (Hafermalz et al. 2015). In consequence, users might adopt a performance goal which might alter their physical activity motivation and behavior but also their use of the fitness tracking technology. Future research should examine this dynamic perspective on fitness tracking technology use to understand the motivational impacts and adjustments better.

In line with this, this dissertation focused on actual users of fitness tracking technology, the goals they pursue, and the corresponding affordances they enact. In future research, the affordance perspective of fitness tracking technology could be extended towards the adoption stage to examine which goals users have, which affordances they thereby perceive, and which combinations of affordances and goals drive decisions to adopt fitness tracking technology.

Lastly, the characteristics of the social network with which users engage and their resulting impacts on motivation provide an avenue for future research. Social Comparison Theory (Festinger 1954), for instance, posits that people make downward and upward comparisons, i.e., comparisons with people who are 'worse' or 'better' than oneself, and do so for different reasons including self-enhancement for downward and self-improvement for upward comparisons. Hence, fitness tracking technology users might achieve different motivational outcomes depending upon whether they compare with better- or worse-performing users and depending upon their relative position, i.e., whether they belong to the better or worse performing users themselves. As such, zooming into the social dimension of fitness tracking technology by examining different network characteristics, users' social-oriented behaviors and cognitions, and their resulting motivational effects presents an intriguing avenue for future research.

6 CONCLUSION

The main objective of this dissertation was to develop an understanding of how consumer health IT can support healthy behavior and well-being. To this end, building on prior research, this dissertation identified people's motivation and ability as well as the opportunities provided by the IT as constituent components of consumer health IT use. To understand their nature, role, and impacts on health and well-being outcomes, this dissertation examined two contexts: older people and fitness tracking technology. Both contexts are of high significance with unique questions for practice and research for which this dissertation provides answers.

Based on the synthesized findings of these two contexts, this dissertation provides a meta-model of effective consumer health IT use positing that a person's motivation, in terms of health-related needs and goals, directs people to engage with the opportunities provided by consumer health IT and its features, such as health decision support, self-monitoring, or social recognition. It is the engagement with these distinct opportunities that brings about the distinct impacts for people's health and well-being, including improvements in health knowledge, the satisfaction of psychological needs, or enhanced physical activity motivation and behavior. Also, in some cases, these opportunities unleash their impacts mostly when they 'fit' with people's motivations. People's IT-related and health-related abilities facilitate acting upon these opportunities provided by consumer health IT.

With this conclusion on how consumer health IT can support healthy behavior and well-being, this dissertation aims to assist society in their pursuit of healthy lives and well-being.

REFERENCES

Agarwal, R., Anderson, C., Crowley, K., and Kannan, P. 2011. "Understanding Development Methods From Other Industries to Improve the Design of Consumer Health IT: Background Report," Agency for Healthcare Research and Quality, Rockville, MD.

Agarwal, R., Gao, G., DesRoches, C., and Jha, A. K. 2010. "The Digital Transformation of Healthcare: Current Status and the Road Ahead." *Information Systems Research* (21:4), pp. 796-809.

Aguinis, H., Beaty, J. C., Boik, R. J., and Pierce, C. A. 2005. "Effect Size and Power in Assessing Moderating Effects of Categorical Variables Using Multiple Regression: A 30-Year Review." *Journal of Applied Psychology* (90:1), pp. 94-107.

Aguinis, H. and Bradley, K. J. 2014. "Best Practice Recommendations for Designing and Implementing Experimental Vignette Methodology Studies." *Organizational Research Methods* (17:4), pp. 351-371.

Aguirre-Urreta, M. I. and Hu, J. 2019. "Detecting Common Method Bias: Performance of the Harman's Single-Factor Test." *ACM SIGMIS Database: the DATABASE for Advances in Information Systems* (50:2), pp. 45-70.

Ahuja, M. K. and Thatcher, J. B. 2005. "Moving Beyond Intentions and Toward the Theory of Trying: Effects of Work Environment and Gender on Post-Adoption Information Technology Use." *MIS Quarterly* (29:3), pp. 427-459.

Akhlaghpour, S., Wu, J., Lapointe, L., and Pinsonneault, A. 2013. "The ongoing quest for the IT artifact: Looking back, moving forward." *Journal of Information Technology* (28:2), pp. 150-166.

Al-Natour, S. and Benbasat, I. 2009. "The Adoption and Use of IT Artifacts: A New Interaction-Centric Model for the Study of User-Artifact Relationships." *Journal of the Association for Information Systems* (10:9), pp. 661-685.

Alahäivälä, T. and Oinas-Kukkonen, H. 2016. "Understanding persuasion contexts in health gamification: A systematic analysis of gamified health behavior change support systems literature." *International Journal of Medical Informatics* (96), pp. 62-70.

Ames, C. 1984. "Achievement attributions and self-instructions under competitive and individualistic goal structures." *Journal of Educational Psychology* (76:3), pp. 478-487.

Ames, C. 1992. "Classrooms: Goals, structures, and student motivation." *Journal of Educational Psychology* (84:3), pp. 261-271.

Anderson, C. L. and Agarwal, R. 2011. "The Digitization of Healthcare: Boundary Risks, Emotion, and Consumer Willingness to Disclose Personal Health Information." *Information Systems Research* (22:3), pp. 469-490.

Anderson, M. and Perrin, A. 2017. "Tech Adoption Climbs Among Older Adults." Retrieved August 17th, 2017 from http://www.pewinternet.org/2017/05/17/technology-use-among-seniors/

Angst, C. M. and Agarwal, R. 2009. "Adoption of Electronic Health Records in the Presence of Privacy Concerns: The Elaboration Likelihood Model and Individual Persuasion." *MIS Quarterly* (33:2), pp. 339-370.

ARD/ZDF. 2019. "ARD/ZDF-Onlinestudie: Internetnutzer* in Deutschland 1997 bis 2018." Retrieved July 7th, 2019 from http://www.ard-zdf-onlinestudie.de/onlinenutzung/internetnutzer/in-prozent/

Atzmüller, C. and Steiner, P. M. 2010. "Experimental Vignette Studies in Survey Research." *Methodology* (6:3), pp. 128-138.

Bagozzi, R. P. and Yi, Y. 1991. "Multitrait-Multimethod Matrices in Consumer Research." *Journal of Consumer Research* (17:4), pp. 426-439.

Bagozzi, R. P. and Yi, Y. 2012. "Specification, evaluation, and interpretation of structural equation models." *Journal of the Academy of Marketing Science* (40:1), pp. 8-34.

Bandura, A. 1977. “Self-efficacy: toward a unifying theory of behavioral change.” *Psychological Review* (84:2), pp. 191–215.

Bandura, A. 1982. “Self-efficacy mechanism in human agency.” *American Psychologist* (37:2), pp. 122-147.

Bandura, A. 1986. *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. 1997. *Self-Efficacy: The Exercise of Control*. New York: Freeman.

Barak, B. and Schiffman, L. G. 1981. “Cognitive age: A nonchronological age variable.” *Advances in Consumer Research* (8:1), pp. 602-606.

Baron, R. M. and Kenny, D. A. 1986. “The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations.” *Journal of Personality and Social Psychology* (51:6), pp. 1173-1182.

Barratt, P. 2017. “Healthy competition: A qualitative study investigating persuasive technologies and the gamification of cycling.” *Health & Place* (46), pp. 328-336.

Bartholomew, K. J., Ntoumanis, N., Ryan, R. M., and Thøgersen-Ntoumani, C. 2011. “Psychological need thwarting in the sport context: Assessing the darker side of athletic experience.” *Journal of Sport and Exercise Psychology* (33:1), pp. 75-102.

Baumgart, R. 2016. “How Does Quantified Self Run?” In: *Proceedings of the Americas Conference on Information Systems*, San Diego.

BBC. 2018. “John Hancock adds fitness tracking to all policies.” Retrieved September 21st, 2018 from https://www.bbc.com/news/technology-45590293

Beaudry, A. and Pinsonneault, A. 2010. “The Other Side of Acceptance: Studying the Direct and Indirect Effects of Emotions on Information Technology Use.” *MIS Quarterly* (34:4), pp. 689-710.

Bem, D. J. 1967. “Self-perception: An alternative interpretation of cognitive dissonance phenomena.” *Psychological Review* (74:3), pp. 183-200.

Benbasat, I. and Zmud, R. W. 2003. “The Identity Crisis Within the IS Discipline: Defining and Communicating the Discipline's Core Properties.” *MIS Quarterly* (27:2), pp. 183-194.

Benbunan-Fich, R. 2019. “An affordance lens for wearable information systems.” *European Journal of Information Systems* (28:3), pp. 256-271.

Best, A. 2016. “Self-Tracking: Ärzte und Versicherungen erwarten hohes Potenzial.” Retrieved April 24th, 2017 from http://www.healthrelations.de/self-tracking/

Bhattacherjee, A. 2001. “Understanding Information Systems Continuance: An Expectation-Confirmation Model.” *MIS Quarterly* (25:3), pp. 351-370.

Blohm, I. and Leimeister, J. M. 2013. “Design of IT-Based Enhancing Services for Motivational Support and Behavioral Change.” *Business & Information Systems Engineering* (5:4), pp. 275-278.

Blumberg, M. and Pringle, C. D. 1982. “The missing opportunity in organizational research: Some implications for a theory of work performance.” *Academy of Management Review* (7:4), pp. 560-569.

Brug, J. 2008. “Determinants of healthy eating: motivation, abilities and environmental opportunities.” *Family Practice* (25:Suppl. 1), pp. i50-i55.

Burton-Jones, A. and Straub, D. W. J. 2006. “Reconceptualizing System Usage: An Approach and Empirical Test.” *Information Systems Research* (17:3), pp. 228-246.

Burton-Jones, A. and Volkoff, O. 2017. “How Can We Develop Contextualized Theories of Effective Use? A Demonstration in the Context of Community-Care Electronic Health Records.” *Information Systems Research* (28:3), pp. 468-489.

Campbell, R. J. 2008. “Meeting seniors' information needs: Using computer technology.” *Home Health Care Management & Practice* (20:4).

Chan, T. K. H., Cheung, C. M. K., and Wong, R. Y. M. 2019. "Cyberbullying on Social Networking Sites: The Crime Opportunity and Affordance Perspectives." *Journal of Management Information Systems* (36:2), pp. 574-609.

Chatterjee, S. and Price, A. 2009. "Healthy living with persuasive technologies: framework, issues, and challenges." *Journal of the American Medical Informatics Association* (16:2), pp. 171-178.

Cheikh-Ammar, M. 2018. "The IT artifact and its spirit: a nexus of human values, affordances, symbolic expressions, and IT features." *European Journal of Information Systems* (27:3), pp. 278-294.

Chemero, A. 2003. "An Outline of a Theory of Affordances." *Ecological Psychology* (15:2), pp. 181-195.

Chen, K. and Chan, A. 2011. "A review of technology acceptance by older adults." *Gerontechnology* (10:1), pp. 1-12.

Chen, L., Baird, A., and Straub, D. 2019. "Fostering Participant Health Knowledge and Attitudes: An Econometric Study of a Chronic Disease-Focused Online Health Community." *Journal of Management Information Systems* (36:1), pp. 194-229.

Chen, W. and Hirschheim, R. 2004. "A paradigmatic and methodological examination of information systems research from 1991 to 2001." *Information Systems Journal* (14:3), pp. 197-235.

Chin, W. W. 1998. "The Partial Least Squares Approach to Structural Equation Modeling," in *Modern Methods for Business Research,* G.A. Marcoulides (ed.). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers, pp. 295-336.

Chin, W. W., Kim, Y. J., and Lee, G. 2013. "Testing the Differential Impact of Structural Paths in PLS Analysis: A Bootstrapping Approach," in *New Perspectives in Partial Least Squares and Related Methods,* H. Abdi, W.W. Chin, V. Esposito Vinzi, G. Russolillo and L. Trinchera (eds.). New York, NY: Springer New York, pp. 221-229.

Chin, W. W., Thatcher, J. B., and Wright, R. T. 2012. "Assessing Common Method Bias: Problems with the ULMC Technique." *MIS Quarterly* (36:3), pp. 1003-1019.

Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*. Mahwah, NJ: Lawrence Erlbaum.

Compeau, D., Higgins, C. A., and Huff, S. 1999. "Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study." *MIS Quarterly* (23:2), pp. 145-158.

Compeau, D. R. and Higgins, C. A. 1995a. "Application of Social Cognitive Theory to Training for Computer Skills." *Information Systems Research* (6:2), pp. 118-143.

Compeau, D. R. and Higgins, C. A. 1995b. "Computer Self-Efficacy: Development of a Measure and Initial Test." *MIS Quarterly* (19:2), pp. 189-211.

Czaja, S. J., Charness, N., Fisk, A. D., Hertzog, C., Nair, S. N., Rogers, W. A., and Sharit, J. 2006. "Factors predicting the use of technology: findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE)." *Psychology and Aging* (21:2), pp. 333-352.

D'Arcy, J., Gupta, A., Tarafdar, M., and Turel, O. 2014. "Reflecting on the "Dark Side" of Information Technology Use." *Communications of the Association for Information Systems* (35), pp. 109-118.

Dadgar, M. and Joshi, K. D. 2018. "The Role of Information and Communication Technology in Self-Management of Chronic Diseases: An Empirical Investigation through Value Sensitive Design." *Journal of the Association for Information Systems* (19:2), pp. 86-112.

Davern, M., Shaft, T., and Te'eni, D. 2012. "Cognition Matters: Enduring Questions in Cognitive IS Research." *Journal of the Association for Information Systems* (13:4), pp. 273-314.

Davis, F. D. 1989. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology." *MIS Quarterly* (13:3), pp. 319-340.

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. 1989. "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models." *Management Science* (35:8), pp. 982-1003.

Davis, J. M. and Mun, Y. Y. 2012. "User disposition and extent of Web utilization: A trait hierarchy approach." *International Journal of Human-Computer Studies* (70:5), pp. 346-363.

Deci, E. L. and Ryan, R. M. 2012. "Motivation, Personality, and Development Within Embedded Social Contexts: An Overview of Self-Determination Theory," in *The Oxford Handbook of Human Motivation,* R.M. Ryan (ed.). New York: Oxford University Press, pp. 85-107.

Demiris, G. 2016. "Consumer Health Informatics: Past, Present, and Future of a Rapidly Evolving Domain." *IMIA Yearbook of Medical Informatics* (25:S01), pp. S42-S47.

Dennis, A. R., Robert Jr, L. P., Curtis, A. M., Kowalczyk, S. T., and Hasty, B. K. 2012. "Trust Is in the Eye of the Beholder: A Vignette Study of Postevent Behavioral Controls' Effects on Individual Trust in Virtual Teams." *Information Systems Research* (23:2), pp. 546-558.

Deterding, S. 2011. "Situated motivational affordances of game elements: A conceptual model," *Proceedings of the Gamification: Using game design elements in non-gaming contexts, a workshop at CHI*.

Deterding, S., Dixon, D., Khaled, R., and Nacke, L. 2011. "From Game Design Elements to Gamefulness: Defining "Gamification"." In: *Proceedings of the International Academic MindTrek Conference*: ACM, pp. 9-15.

Dewan, S. and Riggins, F. J. 2005. "The Digital Divide: Current and Future Research Directions." *Journal of the Association for Information Systems* (6:12), pp. 298-337.

Diener, E., Larsen, R. J., and Emmons, R. A. 1984. "Person × Situation Interactions: Choice of Situations and Congruence Response Models." *Journal of Personality and Social Psychology* (47:3), pp. 580-592.

DIVSI. 2016. "DIVSI Ü60-Studie: Die digitalen Lebenswelten der über 60-Jährigen in Deutschland." Retrieved July 7th, 2019 from https://www.divsi.de/publikationen/studien/divsi-ue60-studie-die-digitalen-lebenswelten-der-ueber-60-jaehrigen-deutschland/

Du, W., Pan, S. L., Leidner, D. E., and Ying, W. 2019. "Affordances, experimentation and actualization of FinTech: A blockchain implementation study." *The Journal of Strategic Information Systems* (28:1), pp. 50-65.

Duda, J. L. 2013. "The conceptual and empirical foundations of Empowering Coaching™: Setting the stage for the PAPA project." *International Journal of Sport and Exercise Psychology* (11:4), pp. 311-318.

Duda, J. L. and Appleton, P. R. 2016. "Empowering and Disempowering Coaching Climates: Conceptualization, Measurement Considerations, and Intervention Implications," in *Sport and Exercise Psychology Research,* M. Raab, P. Wylleman, R. Seiler, A.-M. Elbe and A. Hatzigeorgiadis (eds.). San Diego: Academic Press, pp. 373-388.

Dweck, C. S. and Leggett, E. L. 1988. "A Social-Cognitive Approach to Motivation and Personality." *Psychological Review* (95:2), pp. 256-273.

Edmondson, A. C. and McManus, S. E. 2007. "Methodological Fit in Management Field Research." *Academy of Management Review* (32:4), pp. 1246-1264.

Edwards, J. R. 2001. "Multidimensional Constructs in Organizational Behavior Research: An Integrative Analytical Framework." *Organizational Research Methods* (4:2), pp. 144-192.

Elliot, A. J. and McGregor, H. A. 2001. "A 2×2 Achievement Goal Framework." *Journal of Personality and Social Psychology* (80:3), pp. 501-519.

Emmons, R. A., Diener, E., and Larsen, R. J. 1986. "Choice and Avoidance of Everyday Situations and Affect Congruence: Two Models of Reciprocal Interactionism." *Journal of Personality and Social Psychology* (51:4), pp. 815-826.

Eysenbach, G. 2000. "Consumer health informatics." *BMJ* (320:7251), pp. 1713-1716.

Fan, H. and Lederman, R. 2018. "Online health communities: how do community members build the trust required to adopt information and form close relationships?" *European Journal of Information Systems* (27:1), pp. 62-89.

FAZ. 2018. “Staatsgeld für Computerkurse.” Retrieved September 17th, 2018 from https://www.faz.net/-ikh-9dxdq

Festinger, L. 1954. “A theory of social comparison processes.” *Human Relations* (7:2), pp. 117-140.

Fichman, R. G., Kohli, R., and Krishnan, R. 2011. “Editorial Overview—The Role of Information Systems in Healthcare: Current Research and Future Trends.” *Information Systems Research* (22:3), pp. 419-428.

Fishbein, M. and Ajzen, I. 1975. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison-Wesley.

Fogg, B. 2003. *Persuasive Technology: Using Computers to Change What We Think and Do*. San Francisco, CA: Morgan Kaufmann.

Forgas, J. P. 1995. “Mood and Judgment: The Affect Infusion Model (AIM).” *Psychological Bulletin* (117:1), pp. 39-66.

Fornell, C. and Larcker, D. F. 1981. “Evaluating Structural Equation Models with Unobservable Variables and Measurement Error.” *Journal of Marketing Research* (18:1), pp. 39-50.

Foss, J. 2014. “The Tale of a Fitness-Tracking Addict’s Struggles with Strava.” Retrieved April 11th, 2017 from https://www.wired.com/2014/10/my-strava-problem/

Fox, G. and Connolly, R. 2018. “Mobile health technology adoption across generations: Narrowing the digital divide.” *Information Systems Journal* (28:6), pp. 995–1019.

Fox, S. 2011. “The Social Life of Health Information, 2011.” Retrieved June 3rd, 2016 from http://www.pewinternet.org/2011/05/12/the-social-life-of-health-information-2011/

Fox, S. and Duggan, M. 2013. “Health Online 2013.” Retrieved March 11th, 2016 from http://www.pewinternet.org/files/old-media//Files/Reports/PIP_HealthOnline.pdf

Froböse, I., Biallas, B., and Wallmann-Sperlich, B. 2018. “DKV-Report 2018: Wie gesund lebt Deutschland?” Retrieved August 9th, 2018 from https://www.ergo.com/-/media/ergocom/pdf-mediathek/studien/dkv-report-2018/dkv-report-2018.pdf

Gable, G. G., Sedera, D., and Chan, T. 2008. “Re-Conceptualizing Information System Success: The IS-Impact Measurement Model.” *Journal of the Association for Information Systems* (9:7), pp. 377-408.

Gefen, D., Straub, D. W., and Rigdon, E. E. 2011. “An Update and Extension to SEM Guidelines for Administrative and Social Science Research.” *MIS Quarterly* (35:2), pp. iii-xiv.

Gewald, H. and Currie, W. 2017. “Introduction to the Seniors’ Use of Health Information Technology Minitrack.” In: *Proceedings of the Hawaii International Conference on System Sciences*, Waikoloa, Hawaii.

Gewald, H., Vogel, D., and Bozan, K. 2019. “Introduction to the Minitrack on Seniors' Use of Digital Resources.” In: *Proceedings of the Hawaii International Conference on System Sciences*, Maui, Hawaii.

Ghasemaghaei, M., Hassanein, K., and Benbasat, I. 2019. “Assessing the Design Choices for Online Recommendation Agents for Older Adults: Older Does Not Always Mean Simpler Information Technology.” *MIS Quarterly* (43:1), pp. 329-346.

Gianchandani, E. P. 2011. “Toward smarter health and well-being: an implicit role for networking and information technology.” *Journal of Information Technology* (26:2), pp. 120-128.

Gibbons, M. C., Wilson, R. F., Samal, L., Lehman, C. U., Dickersin, K., Lehmann, H. P., Aboumatar, H., Finkelstein, J., Shelton, E., Sharma, R., and Bass, E. B. 2009. “Impact of consumer health informatics applications.” *Evidence Report/Technology Assessment*:188), pp. 1-546.

Gibson, J. J. 1986. *The Ecological Approach to Visual Perception*. Mahwah, NJ: Lawrence Earlbaum.

Giddens, L., Leidner, D., and Gonzalez, E. 2017. “The Role of Fitbits in Corporate Wellness Programs: Does Step Count Matter?” In: *Proceedings of the Hawaii International Conference on System Sciences*.

Gould, D. 1996. "Using vignettes to collect data for nursing research studies: how valid are the findings?" *Journal of Clinical Nursing* (5:4), pp. 207-212.

Green, D. 2015. "Why I Got Rid of My Fitbit." Retrieved March 17th, 2017 from http://www.douglas-green.com/why-i-got-rid-of-my-fitbit/

Grgecic, D., Holten, R., and Rosenkranz, C. 2015. "The Impact of Functional Affordances and Symbolic Expressions on the Formation of Beliefs." *Journal of the Association for Information Systems* (16:7), pp. 580-607.

Gunnell, K. E., Crocker, P. R., Wilson, P. M., Mack, D. E., and Zumbo, B. D. 2013. "Psychological need satisfaction and thwarting: A test of basic psychological needs theory in physical activity contexts." *Psychology of Sport and Exercise* (14:5), pp. 599-607.

Guo, X., Sun, Y., Wang, N., Peng, Z., and Yan, Z. 2013. "The dark side of elderly acceptance of preventive mobile health services in China." *Electronic Markets* (23:1), pp. 49-61.

Guthold, R., Stevens, G. A., Riley, L. M., and Bull, F. C. 2018. "Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants." *The Lancet Global Health* (6:10), pp. e1077-e1086.

Hafermalz, E., Hovorka, D., and Riemer, K. 2015. "Shared Secret Places: Social Media and Affordances." In: *Proceedings of the Australasian Conference on Information Systems*, Adelaide.

Hair, J. F., Ringle, C. M., and Sarstedt, M. 2011. "PLS-SEM: Indeed a silver bullet." *The Journal of Marketing Theory and Practice* (19:2), pp. 139-152.

Hair, J. F. J., Hult, G. T. M., Ringle, C., and Sarstedt, M. 2014. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Sage Publications.

Hamari, J., Hassan, L., and Dias, A. 2018. "Gamification, quantified-self or social networking? Matching users' goals with motivational technology." *User Modeling and User-Adapted Interaction* (28:1), pp. 35-74.

Hamari, J. and Koivisto, J. 2015. ""Working out for likes": An empirical study on social influence in exercise gamification." *Computers in Human Behavior* (50), pp. 333-347.

Hamari, J., Koivisto, J., and Pakkanen, T. 2014a. "Do Persuasive Technologies Persuade? - A Review of Empirical Studies." In: *Proceedings of the International Conference on Persuasive Technology*, pp. 118-136.

Hamari, J., Koivisto, J., and Sarsa, H. 2014b. "Does Gamification Work? — A Literature Review of Empirical Studies on Gamification." In: *Proceedings of the Hawaii International Conference on System Sciences*.

Harackiewicz, J. M. and Elliot, A. J. 1993. "Achievement Goals and Intrinsic Motivation." *Journal of Personality and Social Psychology* (65:5), pp. 904-915.

Hargrave, J. 2013. "The Silly Self Importance of Strava." Retrieved May 3rd, 2017 from http://utahadvjournal.com/index.php/the-silly-self-importance-of-strava

Hassan, L., Dias, A., and Hamari, J. 2019. "How motivational feedback increases user's benefits and continued use: A study on gamification, quantified-self and social networking." *International Journal of Information Management* (46), pp. 151-162.

Haynes, S. N., Richard, D., and Kubany, E. S. 1995. "Content Validity in Psychological Assessment: A Functional Approach to Concepts and Methods." *Psychological Assessment* (7:3), pp. 238-247.

Heart, T. and Kalderon, E. 2013. "Older adults: are they ready to adopt health-related ICT?" *International Journal of Medical Informatics* (82:11), pp. e209-e231.

Henseler, J., Ringle, C. M., and Sarstedt, M. 2015. "A new criterion for assessing discriminant validity in variance-based structural equation modeling." *Journal of the Academy of Marketing Science* (43:1), pp. 115-135.

Hesse, B. W., Nelson, D. E., Kreps, G. L., Croyle, R. T., Arora, N. K., Rimer, B. K., and Viswanath, K. 2005. "Trust and Sources of Health Information." *Archives of Internal Medicine* (165:22), pp. 2618-2624.

Higgins, J. P. 2016. “Smartphone Applications for Patients’ Health and Fitness.” *The American Journal of Medicine* (129:1), pp. 11-19.

Hogarth, R. M. and Einhorn, H. J. 1992. “Order Effects in Belief Updating: The Belief-Adjustment Model.” *Cognitive Psychology* (24:1), pp. 1-55.

Hong, S.-J., Lui, C. S. M., Hahn, J., Moon, J. Y., and Kim, T. G. 2013. “How old are you really? Cognitive age in technology acceptance.” *Decision Support Systems* (56), pp. 122-130.

Hoyer, W. D., MacInnis, D. J., and Pieters, R. 2012. *Consumer Behavior*, (6th ed.). Mason, USA: Cengage Learning.

Hughes, J. 2007. “The Ability – Motivation - Opportunity Framework for Behavior Research in IS.” In: *Proceedings of the Hawaii International Conference on System Sciences*, Big Island, Hawaii.

Hur, I., Cousins, K. C., and Stahl, B. C. 2019. “A critical perspective of engagement in online health communities.” *European Journal of Information Systems* (28:5), pp. 523-548.

Hutchby, I. 2001. “Technologies, Texts and Affordances.” *Sociology* (35:2), pp. 441-456.

Iacobucci, D. 2008. *Mediation Analysis*. Thousand Oaks, CA: Sage.

Ickes, W., Snyder, M., and Garcia, S. 1997. “Personality Influences on the Choice of Situations,” in *Handbook of Personality Psychology,* R. Hogan, J. Johnson and S. Briggs (eds.). San Diego: Academic Press, pp. 165-195.

Jagacinski, C. M., Madden, J. L., and Reider, M. H. 2001. “The Impact of Situational and Dispositional Achievement Goals on Performance.” *Human Performance* (14:4), pp. 321-337.

James, T. L., Deane, J. K., and Wallace, L. 2019a. “An application of goal content theory to examine how desired exercise outcomes impact fitness technology feature set selection.” *Information Systems Journal* (29:5), pp. 1010-1039.

James, T. L., Wallace, L., and Deane, J. K. 2019b. “Using Organismic Integration Theory to Explore the Associations Between Users’ Exercise Motivations and Fitness Technology Feature Set Use.” *MIS Quarterly* (43:1), pp. 287-312.

Jasperson, J. S., Carter, P. E., and Zmud, R. W. 2005. “A Comprehensive Conceptualization of the Post-Adoptive Behaviors Associated with IT-Enabled Work Systems.” *MIS Quarterly* (29:3), pp. 525-557.

Jerusalem, M. and Schwarzer, R. 1992. “Self-efficacy as a resource factor in stress appraisal processes,” in *Self-Efficacy: Thought Control of Action,* R. Schwarzer (ed.). Washington, DC: Hemisphere, pp. 195–213.

Jia, R., Steelman, Z. R., and Reich, B. H. 2017. “Using Mechanical Turk Data in IS Research: Risks, Rewards, and Recommendations.” *Communications of the Association for Information Systems* (41:1), pp. 301-318.

Jõesaar, H., Hein, V., and Hagger, M. S. 2011. “Peer influence on young athletes’ need satisfaction, intrinsic motivation and persistence in sport: A 12-month prospective study.” *Psychology of Sport and Exercise* (12:5), pp. 500-508.

Johnson, D., Deterding, S., Kuhn, K.-A., Staneva, A., Stoyanov, S., and Hides, L. 2016. “Gamification for health and wellbeing: A systematic review of the literature.” *Internet Interventions* (6), pp. 89-106.

Johnson, R. D. and Marakas, G. M. 2000. “Research Report: The Role of Behavioral Modeling in Computer Skills Acquisition: Toward Refinement of the Model.” *Information Systems Research* (11:4), pp. 402-417.

Johnston, A. C., Warkentin, M., McBride, M., and Carter, L. 2016. “Dispositional and situational factors: influences on information security policy violations.” *European Journal of Information Systems* (25:3), pp. 231-251.

Karahanna, E., Xu, S. X., and Zhang, A. N. 2018. “The Needs–Affordances–Features Perspective for the Use of Social Media.” *MIS Quarterly* (42:3), pp. 737-756.

Kelley, H., Chiasson, M., Downey, A., and Pacaud, D. l. 2011. "The Clinical Impact of eHealth on the Self-Management of Diabetes: A Double Adoption Perspective." *Journal of the Association for Information Systems* (12:3), pp. 208-234.

Kenny, D. A. 2015. "Moderation." Retrieved March 20th, 2018 from http://davidakenny.net/cm/moderation.htm

Kettinger, W. J., Li, Y., Davis, J. M., and Kettinger, L. 2015. "The roles of psychological climate, information management capabilities, and IT support on knowledge-sharing: an MOA perspective." *European Journal of Information Systems* (24:1), pp. 59-75.

Kim, S. S. and Malhotra, N. K. 2005. "A Longitudinal Model of Continued IS Use: An Integrative View of Four Mechanisms Underlying Postadoption Phenomena." *Management Science* (51:5), pp. 741-755.

Kock, N. 2017. "Common Method Bias: A Full Collinearity Assessment Method for PLS-SEM," in *Partial Least Squares Path Modeling: Basic Concepts, Methodological Issues and Applications,* H. Latan and R. Noonan (eds.). Cham, Switzerland: Springer, pp. 245-257.

Koivisto, J. and Hamari, J. 2019. "The rise of motivational information systems: A review of gamification research." *International Journal of Information Management* (45), pp. 191-210.

Kordzadeh, N. and Warren, J. 2017. "Communicating Personal Health Information in Virtual Health Communities: An Integration of Privacy Calculus Model and Affective Commitment." *Journal of the Association for Information Systems* (18:1), pp. 45-81.

Lai, H.-M., Hsiao, Y.-L., and Hsieh, P.-J. 2018. "The role of motivation, ability, and opportunity in university teachers' continuance use intention for flipped teaching." *Computers & Education* (124), pp. 37-50.

Lam, J. C. Y. and Lee, M. K. O. 2006. "Digital Inclusiveness-Longitudinal Study of Internet Adoption by Older Adults." *Journal of Management Information Systems* (23:4), pp. 177-206.

Landis, J. R. and Koch, G. G. 1977. "The Measurement of Observer Agreement for Categorical Data." *Biometrics* (33:1), pp. 159-174.

Lau, S. and Nie, Y. 2008. "Interplay Between Personal Goals and Classroom Goal Structures in Predicting Student Outcomes: A Multilevel Analysis of Person–Context Interactions." *Journal of Educational Psychology* (100:1), pp. 15-29.

Lauder, W. 2002. "Factorial survey methods: A valuable but under-utilised research method in nursing research?" *NT Research* (7:1), pp. 35-43.

Laumer, S., Maier, C., Eckhardt, A., and Weitzel, T. 2016. "User Personality and Resistance to Mandatory Information Systems in Organizations: A Theoretical Model and Empirical Test of Dispositional Resistance to Change." *Journal of Information Technology* (31:1), pp. 67-82.

Lazarus, R. S. 1991. *Emotion and Adaptation*. New York: Oxford University Press.

Ledger, D. and McCaffrey, D. 2014. "Inside Wearables: How the Science of Human Behavior Change Offers the Secret to Long-term Engagement." Retrieved June 13th, 2017 from http://endeavourpartners.net/assets/Wearables-and-the-Science-of-Human-Behavior-Change-EP4.pdf

Lehrer, C., Wieneke, A., vom Brocke, J., Jung, R., and Seidel, S. 2018. "How Big Data Analytics Enables Service Innovation: Materiality, Affordance, and the Individualization of Service." *Journal of Management Information Systems* (35:2), pp. 424-460.

Leonardi, P. M. 2013. "When Does Technology Use Enable Network Change in Organizations? A Comparative Study of Feature Use and Shared Affordances." *MIS Quarterly* (37:3), pp. 749-775.

Liang, H., Peng, Z., Xue, Y., Guo, X., and Wang, N. 2015. "Employees' Exploration of Complex Systems: An Integrative View." *Journal of Management Information Systems* (32:1), pp. 322-357.

Liang, H., Saraf, N., Hu, Q., and Xue, Y. 2007. "Assimilation of Enterprise Systems: The Effect of Institutional Pressures and the Mediating Role of Top Management." *MIS Quarterly* (31:1), pp. 59-87.

Liang, H., Xue, Y., and Zhang, Z. 2017. "Understanding Online Health Information Use: The Case of People with Physical Disabilities." *Journal of the Association for Information Systems* (18:6), pp. 433-460.

Limayem, M., Hirt, S. G., and Cheung, C. M. 2007. "How Habit Limits the Predictive Power of Intention: The Case of Information Systems Continuance." *MIS Quarterly* (31:4), pp. 705-737.

Linnenbrink, E. A. 2005. "The Dilemma of Performance-Approach Goals: The Use of Multiple Goal Contexts to Promote Students' Motivation and Learning." *Journal of Educational psychology* (97:2), pp. 197-213.

Lister, C., West, J. H., Cannon, B., Sax, T., and Brodegard, D. 2014. "Just a Fad? Gamification in Health and Fitness Apps." *JMIR Serious Games* (2:2), p. e9.

Lochbaum, M. and Gottardy, J. 2015. "A meta-analytic review of the approach-avoidance achievement goals and performance relationships in the sport psychology literature." *Journal of Sport and Health Science* (4:2), pp. 164-173.

Lowry, P. B., Gaskin, J., Humpherys, S. L., Moody, G. D., Galletta, D. F., and Barlow, J. B. 2013. "Evaluating Journal Quality and the Association for Information Systems Senior Scholars' Journal Basket Via Bibliometric Measures: Do Expert Journal Assessments Add Value?" *MIS Quarterly* (37:4), pp. 993-1012.

Lowry, P. B., Gaskin, J. E., and Moody, G. D. 2015. "Proposing the Multimotive Information Systems Continuance Model (MISC) to Better Explain End-User System Evaluations and Continuance Intentions." *Journal of the Association for Information Systems* (16:7), pp. 515-579.

Lowry, P. B., Zhang, J., Wang, C., and Siponen, M. 2016. "Why Do Adults Engage in Cyberbullying on Social Media? An Integration of Online Disinhibition and Deindividuation Effects with the Social Structure and Social Learning Model." *Information Systems Research* (27:4), pp. 962-986.

Lupton, D. 2016. *The Quantified Self*. Malden, MA: Polity Press.

MacKenzie, S. B. and Podsakoff, P. M. 2012. "Common Method Bias in Marketing: Causes, Mechanisms, and Procedural Remedies." *Journal of Retailing* (88:4), pp. 542-555.

MacKenzie, S. B., Podsakoff, P. M., and Podsakoff, N. P. 2011. "Construct Measurement and Validation Procedures in MIS and Behavioral Research: Integrating New and Existing Techniques." *MIS Quarterly* (35:2), pp. 293-334.

Maclnnis, D. J., Moorman, C., and Jaworski, B. J. 1991. "Enhancing and Measuring Consumers' Motivation, Opportunity, and Ability to Process Brand Information from Ads." *Journal of Marketing* (55:4), pp. 32-53.

Maehr, M. L. and Zusho, A. 2009. "Achievement Goal Theory: The Past, Present, and Future," in *Handbook of Motivation at School,* K.R. Wentzel and A. Wigfield (eds.). New York, NY: Routledge, pp. 77-104.

Mahoney, J. and Goertz, G. 2006. "A Tale of Two Cultures: Contrasting Quantitative and Qualitative Research." *Political Analysis* (14:3), pp. 227-249.

Maier, C. 2012. "Personality within Information Systems Research: A Literature Analysis." In: *Proceedings of the European Conference on Information Systems*.

Maier, C., Laumer, S., Weinert, C., and Weitzel, T. 2015. "The effects of technostress and switching stress on discontinued use of social networking services: a study of Facebook use." *Information Systems Journal* (25:3), pp. 275-308.

Majchrzak, A., Faraj, S., Kane, G. C., and Azad, B. 2013. "The Contradictory Influence of Social Media Affordances on Online Communal Knowledge Sharing." *Journal of Computer-Mediated Communication* (19:1), pp. 38-55.

Malhotra, N. K., Kim, S. S., and Patil, A. 2006. "Common Method Variance in IS Research: A Comparison of Alternative Approaches and a Reanalysis of Past Research." *Management Science* (52:12), pp. 1865-1883.

Markus, M. L. and Silver, M. S. 2008. "A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole's Concepts of Structural Features and Spirit." *Journal of the Association for Information Systems* (9:10/11), pp. 609-632.

Maruping, L. M. and Magni, M. 2012. "What's the weather like? The effect of team learning climate, empowerment climate, and gender on individuals' technology exploration and use." *Journal of Management Information Systems* (29:1), pp. 79-114.

Maruping, L. M. and Magni, M. 2015. "Motivating Employees to Explore Collaboration Technology in Team Contexts." *MIS Quarterly* (39:1), pp. 1-16.

Mettler, T., Sprenger, M., and Winter, R. 2017. "Service robots in hospitals: new perspectives on niche evolution and technology affordances." *European Journal of Information Systems* (26:5), pp. 451–468.

Michie, S., Van Stralen, M. M., and West, R. 2011. "The behaviour change wheel: a new method for characterising and designing behaviour change interventions." *Implementation Science* (6:1), p. 42.

Moore, G. C. and Benbasat, I. 1991. "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation." *Information Systems Research* (2:3), pp. 192-222.

Moorman, C. and Matulich, E. 1993. "A Model of Consumers' Preventive Health Behaviors: The Role of Health Motivation and Health Ability." *Journal of Consumer Research* (20:2), pp. 208-228.

Murayama, K. and Elliot, A. J. 2009. "The Joint Influence of Personal Achievement Goals and Classroom Goal Structures on Achievement-Relevant Outcomes." *Journal of Educational Psychology* (101:2), pp. 432–447.

Nahm, A. Y., Rao, S. S., Solis-Galvan, L. E., and Ragu-Nathan, T. 2002. "The Q-Sort Method: Assessing Reliability And Construct Validity Of Questionnaire Items At A Pre-Testing Stage." *Journal of Modern Applied Statistical Methods* (1:1), pp. 114-125.

Ng, J. Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., and Williams, G. C. 2012. "Self-Determination Theory Applied to Health Contexts: A Meta-Analysis." *Perspectives on Psychological Science* (7:4), pp. 325-340.

Nicholls, J. G. 1989. *The Competitive Ethos and Democratic Education*. Cambridge, MA: Harvard University Press.

Niehaves, B. and Plattfaut, R. 2014. "Internet adoption by the elderly: employing IS technology acceptance theories for understanding the age-related digital divide." *European Journal of Information Systems* (23:6), pp. 708-726.

Nimrod, G. 2017. "Older audiences in the digital media environment." *Information, Communication & Society* (20:2), pp. 233-249.

Norman, D. A. 1999. "Affordances, Conventions and Design." *Interactions* (6:3), pp. 38-43.

November Project. 2017. "I quit Strava." Retrieved April 21st, 2018 from https://november-project.com/i-quit-strava-den

Ntoumanis, N. 2001. "Empirical links between achievement goal theory and self-determination theory in sport." *Journal of Sports Sciences* (19:6), pp. 397-409.

Ntoumanis, N., Edmunds, J., and Duda, J. L. 2009. "Understanding the coping process from a self-determination theory perspective." *British Journal of Health Psychology* (14:2), pp. 249-260.

Nunnally, J. C. and Bernstein, I. 1994. *Psychometric Theory*, (3 ed.). New York: McGraw-Hill.

OECD. 2017. "Health at a Glance 2017: OECD Indicators." Retrieved September 20th, 2018 from http://dx.doi.org/10.1787/health_glance-2017-en

Oinas-Kukkonen, H. and Harjumaa, M. 2009. "Persuasive Systems Design: Key Issues, Process Model, and System Features." *Communications of the Association for Information Systems* (24), pp. 485-500.

Ölander, F. and Thøgersen, J. 1995. "Understanding of Consumer Behaviour as a Prerequisite for Environmental Protection." *Journal of Consumer Policy* (18:4), pp. 345-385.

Or, C. K. and Karsh, B.-T. 2009. "A Systematic Review of Patient Acceptance of Consumer Health Information Technology." *Journal of the American Medical Informatics Association* (16:4), pp. 550-560.

Orji, R. and Moffatt, K. 2016. "Persuasive technology for health and wellness: State-of-the-art and emerging trends." *Health Informatics Journal* (24:1), pp. 66-91.

Parkinson, J., Schuster, L., and Russell-Bennett, R. 2016. "Insights into the complexity of behaviours: the MOAB framework." *Journal of Social Marketing* (6:4), pp. 412-427.

Pavlou, P. A., Liang, H., and Xue, Y. 2007. "Understanding and Mitigating Uncertainty in Online Exchange Relationships: A Principal-Agent Perspective." *MIS Quarterly* (31:1), pp. 105-136.

Payton, F. C., Paré, G., LeRouge, C., and Reddy, M. 2011. "Health Care IT: Process, People, Patients and Interdisciplinary Considerations." *Journal of the Association for Information Systems* (12:2/3), pp. i-xiii.

Peng, Z. and Guo, X. 2019. "A multilevel investigation on antecedents for employees' exploration of enterprise systems." *European Journal of Information Systems* (28:4), pp. 439-456.

Peters, D., Calvo, R. A., and Ryan, R. M. 2018. "Designing for Motivation, Engagement and Wellbeing in Digital Experience." *Frontiers in Psychology* (9:797), pp. 1-15.

Pew Research Center. 2013. "The Diagnosis Difference." Retrieved June 3rd, 2016 from http://www.pewinternet.org/files/old-media//Files/Reports/2013/PewResearch_DiagnosisDifference.pdf

Pew Research Center. 2014. "Americans Feel Better Informed Thanks to the Internet." Retrieved June 3rd, 2016 from http://www.pewinternet.org/files/2014/12/PI_InformedWeb_120814_02.pdf

Pham, M. T. 2007. "Emotion and Rationality: A Critical Review and Interpretation of Empirical Evidence." *Review of General Psychology* (11:2), pp. 155–178.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., and Podsakoff, N. P. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies." *Journal of Applied Psychology* (88:5), pp. 879–903.

Podsakoff, P. M., MacKenzie, S. B., and Podsakoff, N. P. 2012. "Sources of Method Bias in Social Science Research and Recommendations on How to Control It." *Annual Review of Psychology* (63), pp. 539-569.

Prasopoulou, E. 2017. "A half-moon on my skin: a memoir on life with an activity tracker." *European Journal of Information Systems* (26:3), pp. 287-297.

Preacher, K. J. and Hayes, A. F. 2004. "SPSS and SAS procedures for estimating indirect effects in simple mediation models." *Behavior Research Methods* (4:36), pp. 717-731.

Prey, J. E., Woollen, J., Wilcox, L., Sackeim, A. D., Hripcsak, G., Bakken, S., Restaino, S., Feiner, S., and Vawdrey, D. K. 2014. "Patient engagement in the inpatient setting: a systematic review." *Journal of the American Medical Informatics Association* (21:4), pp. 742-750.

Recker, J. 2013. *Scientific Research in Information Systems: A Beginner's Guide*. Berlin, Heidelberg: Springer Berlin Heidelberg.

Reeve, J. 2005. *Understanding Motivation and Emotion*, (4th ed.). New York: John Wiley & Sons, Inc.

Richardson, H. A., Simmering, M. J., and Sturman, M. C. 2009. "A Tale of Three Perspectives: Examining Post Hoc Statistical Techniques for Detection and Correction of Common Method Variance." *Organizational Research Methods* (12:4), pp. 762-800.

Ringle, C. M., Wende, S., and Becker, J.-M. 2015. "SmartPLS 3." Boenningstedt: SmartPLS GmbH.

Robert, L. P., Denis, A. R., and Hung, Y.-T. C. 2009. "Individual swift trust and knowledge-based trust in face-to-face and virtual team members." *Journal of Management Information Systems* (26:2), pp. 241-279.

Roberts, G. C., Treasure, D. C., and Conroy, D. E. 2007. "Understanding the Dynamics of Motivation in Sport and Physical Activity: An Achievement Goal Interpretation," in *Handbook of Sport Psychology,* G. Tenenbaum and R.C. Eklund (eds.). Hoboken, New Jersey: John Wiley & Sons, Inc., pp. 3-30.

Rockmann, R. and Gewald, H. 2016. "The Role of Cognitive Age as Predictor of Individual Differences and Use of E-Health by the Elderly." In: *Proceedings of the European Conference on Information Systems*, İstanbul, Turkey.

Rossi, P. H. and Nock, S. L. 1982. *Measuring Social Judgments: The Factorial Survey Approach*. New York: Sage Publications.

Rothschild, M. L. 1999. "Carrots, sticks, and promises: A conceptual framework for the management of public health and social issue behaviors." *Journal of Marketing* (63:4), pp. 24-37.

Ryan, R. M. 1982. "Control and Information in the Intrapersonal Sphere: An Extension of Cognitive Evaluation Theory." *Journal of Personality and Social Psychology* (43:3), pp. 450-461.

Ryan, R. M. and Deci, E. L. 2017. *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. New York, NY: The Guilford Press.

Ryan, R. M. and Grolnick, W. S. 1986. "Origins and Pawns in the Classroom: Self-Report and Projective Assessments of Individual Differences in Children's Perceptions." *Journal of Personality and Social Psychology* (50:3), pp. 550-558.

Ryan, R. M., Soenens, B., and Vansteenkiste, M. 2019. "Reflections on self-determination theory as an organizing framework for personality psychology: Interfaces, integrations, issues, and unfinished business." *Journal of Personality* (87:1), pp. 115-145.

Sabherwal, R., Jeyaraj, A., and Chowa, C. 2006. "Information System Success: Individual and Organizational Determinants." *Management Science* (52:12), pp. 1849-1864.

Sardi, L., Idri, A., and Fernández-Alemán, J. L. 2017. "A systematic review of gamification in e-Health." *Journal of Biomedical Informatics* (71), pp. 31-48.

Schiffman, L. G. and Sherman, E. 1991. "Value orientations of new-age elderly: The coming of an ageless market." *Journal of Business Research* (22:2), pp. 187-194.

Schmidt-Kraepelin, M., Thiebes, S., Stepanovic, S., Mettler, T., and Sunyaev, A. 2019. "Gamification in Health Behavior Change Support Systems - A Synthesis of Unintended Side Effects." In: *Proceedings of the International Conference on Wirtschaftsinformatik*, Siegen, Germany.

Schwarz, A., Rizzuto, T., Carraher-Wolverton, C., Roldán, J. L., and Barrera-Barrera, R. 2017. "Examining the Impact and Detection of the "Urban Legend" of Common Method Bias." *ACM SIGMIS Database: the DATABASE for Advances in Information Systems* (48:1), pp. 93-119.

Schwarz, N. 1990. "Feelings as information: Informational and motivational functions of affective states," in *Handbook of motivation and cognition: Foundations of social behavior,* E.T. Higgins and R. Sorrentino (eds.). New York: Guilford Press, pp. 527-567.

Schwarz, N. and Clore, G. L. 1988. "How do I feel about it? Informative functions of affective states," in *Affect, Cognition and Social Behavior,* J. Forgas and K. Fiedler (eds.). Toronto: Hogrefe International.

Seaborn, K. and Fels, D. I. 2015. "Gamification in theory and action: A survey." *International Journal of Human-Computer Studies* (74), pp. 14-31.

Seidel, S., Chandra Kruse, L., Székely, N., Gau, M., and Stieger, D. 2018. "Design principles for sensemaking support systems in environmental sustainability transformations." *European Journal of Information Systems* (27:2), pp. 221-247.

Seidel, S., Recker, J. C., and Vom Brocke, J. 2013. "Sensemaking and Sustainable Practicing: Functional Affordances of Information Systems in Green Transformations." *MIS Quarterly* (37:4), pp. 1275-1299.

Siemsen, E., Roth, A. V., and Balasubramanian, S. 2008. "How motivation, opportunity, and ability drive knowledge sharing: The constraining-factor model." *Journal of Operations Management* (26:3), pp. 426-445.

Sjöklint, M., Constantiou, I., and Trier, M. 2015. "The Complexities of Self-Tracking - An Inquiry into User Reactions and Goal Attainment." In: *Proceedings of the European Conference on Information Systems*, Münster, Germany.

Sorgenfrei, C., Ebner, K., Smolnik, S., and Jennex, M. E. 2014. "From Acceptance to Outcome: Towards an Integrative Framework for Information Technology Adoption." In: *Proceedings of the Twenty Second European Conference on Information Systems*, Tel Aviv.

Spagnoletti, P., Resca, A., and Sæbø, Ø. 2015. "Design for social media engagement: Insights from elderly care assistance." *The Journal of Strategic Information Systems* (24:2), pp. 128-145.

Srivastava, S. K. and Panigrahi, P. K. 2019. "Social Participation among the Elderly: Moderated Mediation Model of Information and Communication Technology (ICT)." *Communications of the Association for Information Systems* (44), pp. 698-717.

Statisches Bundesamt. 2016. "Ältere Menschen in Deutschland und der EU." Retrieved July 28th, 2019 from https://www.bmfsfj.de/blob/93214/95d5fc19e3791f90f8d582d61b13a95e/aeltere-menschen-deutschland-eu-data.pdf

Statista. 2018. "eServices Report 2018 – Fitness." Retrieved July 23th, 2018 from https://de.statista.com/statistik/studie/id/36673/dokument/fitness-outlook/

Statistisches Bundesamt. 2017. "Herz-Kreislauf-Erkrankungen verursachen die höchsten Kosten." Retrieved May 7th, 2019 from https://www.destatis.de/DE/Presse/Pressemitteilungen/2017/09/PD17_347_236.html

Statistisches Bundesamt. 2019. "Fakten rund um die Gesundheit als Motivationshilfe für Neujahrsvorsätze." Retrieved May 7th, 2019 from https://www.destatis.de/DE/Presse/Pressemitteilungen/2019/01/PD19_002_p001.html

Steelman, Z. R., Hammer, B. I., and Limayem, M. 2014. "Data Collection in the Digital Age: Innovative Alternatives to Student Samples." *MIS Quarterly* (38:2), pp. 355-378.

Stoffregen, T. A. 2003. "Affordances as properties of the animal-environment system." *Ecological Psychology* (15:2), pp. 115-134.

Stragier, J., Vanden Abeele, M., and De Marez, L. 2018. "Recreational athletes' running motivations as predictors of their use of online fitness community features." *Behaviour & Information Technology* (37:8), pp. 815-827.

Strong, D. M., Johnson, S. A., Tulu, B., Trudel, J., Volkoff, O., Pelletier, L. R., Bar-On, I., and Garber, L. 2014. "A Theory of Organization-EHR Affordance Actualization." *Journal of the Association for Information Systems* (15:2), pp. 53-85.

Suh, A. 2018. "Sustaining the Use of Quantified-Self Technology: A Theoretical Extension and Empirical Test." *Asia Pacific Journal of Information Systems* (28:2), pp. 114-132.

Tagesschau. 2019. "Digitalisierung im Gesundheitswesen: Ärzte sollen Apps verschreiben dürfen." Retrieved July 11th, 2019 from http://www.tagesschau.de/digitalisierung-gesundheitswesen-101.html

Tams, S., Grover, V., and Thatcher, J. 2014. "Modern information technology in an old workforce: Toward a strategic research agenda." *The Journal of Strategic Information Systems* (23:4), pp. 284-304.

Tams, S., Thatcher, J. B., and Grover, V. 2018. "Concentration, Competence, Confidence, and Capture: An Experimental Study of Age, Interruption-based Technostress, and Task Performance." *Journal of the Association for Information Systems* (19:9), pp. 857-908.

Tarafdar, M., Gupta, A., and Turel, O. 2015. "Special issue on 'Dark side of information technology use': an introduction and a framework for research." *Information Systems Journal* (25:3), pp. 161-170.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., and Ryan, R. M. 2012. "Exercise, physical activity, and self-determination theory: a systematic review." *International Journal of Behavioral Nutrition and Physical Activity* (9:1), p. 78.

Thatcher, J. B. and Perrewe, P. L. 2002. "An Empirical Examination of Individual Traits as Antecedents to Computer Anxiety and Computer Self-Efficacy." *MIS Quarterly* (26:4), pp. 381-396.

The Office of the National Coordinator for Health Information Technology. 2014. "Federal Health IT Strategic Plan: 2015-2020." Retrieved July 2nd, 2019 from https://dashboard.healthit.gov/strategic-plan/federal-health-it-strategic-plan-exec-summary.php

Tim, Y., Pan, S. L., Bahri, S., and Fauzi, A. 2018. "Digitally enabled affordances for community-driven environmental movement in rural Malaysia." *Information Systems Journal* (28:1), pp. 48-75.

Triandis, H. C. 1977. *Interpersonal Behavior*. Monterey, CA: Brooks/Cole.

United Nations. 2015a. "Transforming Our World: The 2030 Agenda for Sustainable Development." Retrieved July 2nd, 2019 from https://sustainabledevelopment.un.org/post2015/transformingourworld

United Nations. 2015b. *World Population Ageing 2015*.

United Nations. 2017. *World Aging Population 2017: Highlights*.

Vallerand, R. J. and Losier, G. F. 1999. "An Integrative Analysis of Intrinsic and Extrinsic Motivation in Sport." *Journal of Applied Sport Psychology* (11:1), pp. 142-169.

van der Heijden, H. 2004. "User Acceptance of Hedonic Information Systems." *MIS Quarterly* (28:4), pp. 695-704.

Vansteenkiste, M., Ryan, R. M., and Deci, E. L. 2008. "Self-Determination Theory and the Explanatory Role of Psychological Needs in Human Well-Being," in *Capabilities and Happiness,* L. Bruni, F. Comim and M. Pugno (eds.). Oxford, UK: Oxford University Press, pp. 187–223.

Venkatesh, V. 2000. "Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model." *Information Systems Research* (11:4), pp. 342-365.

Venkatesh, V. and Bala, H. 2008. "Technology acceptance model 3 and a research agenda on interventions." *Decision Sciences* (39:2), pp. 273-315.

Venkatesh, V., Brown, S. A., Maruping, L. M., and Bala, H. 2008. "Predicting Different Conceptualizations of System Use: The Competing Roles of Behavioral Intention, Facilitating Conditions, and Behavioral Expectation." *MIS Quarterly* (32:3), pp. 483-502.

Venkatesh, V. and Davis, F. D. 2000. "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies." *Management Science* (46:2), pp. 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. 2003. "User Acceptance of Information Technology: Toward a Unified View." *MIS Quarterly* (27:3), pp. 425-478.

Venkatesh, V., Rai, A., Sykes, T. A., and Aljafari, R. 2016a. "Combating Infant Mortality in Rural India: Evidence from a Field Study of eHealth Kiosk Implementations." *MIS Quarterly* (40:2), pp. 353-380.

Venkatesh, V., Thong, J. Y., and Xu, X. 2012. "Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology." *MIS Quarterly* (36:1), pp. 157-178.

Venkatesh, V., Thong, J. Y. L., Chan, F. K. Y., Hu, P. J.-H., and Brown, S. A. 2011. "Extending the two-stage information systems continuance model: incorporating UTAUT predictors and the role of context." *Information Systems Journal* (21:6), pp. 527-555.

Venkatesh, V., Thong, J. Y. L., and Xu, X. 2016b. "Unified Theory of Acceptance and Use of Technology: A Synthesis and the Road Ahead." *Journal of the Association for Information Systems* (17:5), pp. 328-376.

Vodanovich, S., Sundaram, D., and Myers, M. 2010. "Research Commentary—Digital Natives and Ubiquitous Information Systems." *Information Systems Research* (21:4), pp. 711-723.

Vornewald, K., Eckhardt, A., and Krönung, J. 2015. "Emotions in Information Systems Research-A Five Component View." In: *Proceedings of the Wirtschaftsinformatik*, Osnabrück, Germany, pp. 1756-1770.

Wagner, N., Hassanein, K., and Head, M. 2010. "Computer use by older adults: A multi-disciplinary review." *Computers in Human Behavior* (26:5), pp. 870-882.

Wang, Q. E., Myers, M. D., and Sundaram, D. 2013a. "Digital Natives and Digital Immigrants." *Business & Information Systems Engineering* (5:6), pp. 409-419.

Wang, W., Li, X., and Hsieh, J. P.-A. 2013b. "The contingent effect of personal IT innovativeness and IT self-efficacy on innovative use of complex IT." *Behaviour & Information Technology* (32:11), pp. 1105-1124.

Waschinski, G. 2019. "So will Jens Spahn Gesundheits-Apps schneller zu den Patienten bringen." Retrieved July 11th, 2019 from https://www.handelsblatt.com/24344290.html

Webster, J. and Watson, R. T. 2002. "Analyzing the Past to Prepare for the Future: Writing a Literature Review." *MIS Quarterly* (26:2), pp. xiii-xxiii.

Wei, K.-K., Teo, H.-H., Chan, H. C., and Tan, B. C. 2011. "Conceptualizing and Testing a Social Cognitive Model of the Digital Divide." *Information Systems Research* (22:1), pp. 170-187.

Weiß, C., Stubbe, J., Naujoks, C., and Weide, S. 2017. "Digitalisierung für mehr Optionen und Teilhabe im Alter." Retrieved November 18th, 2018 from https://www.bertelsmann-stiftung.de/fileadmin/files/Projekte/Smart_Country/DigitaleTeilhabe_2017_final.pdf

Wetzels, M., Odekerken-Schröder, G., and Van Oppen, C. 2009. "Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration." *MIS Quarterly* (33:1), pp. 177-195.

WHO. 2010. "Global recommendations on physical activity for health." Retrieved August 14th, 2018 from http://www.who.int/dietphysicalactivity/publications/9789241599979/en/

WHO. 2012. "Proposed working definition of an older person in Africa for the MDS Project." Retrieved May 18th, 2018 from http://www.who.int/healthinfo/survey/ageingdefnolder/en/

WHO. 2015. *World Report on Ageing And Health*. Geneva, Switzerland: WHO Press.

WHO. 2018a. "Global action plan on physical activity 2018–2030: more active people for a healthier world." Retrieved September 20th, 2018 from http://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf

WHO. 2018b. "WHO and Google Fit announcement." Retrieved September 20th, 2018 from http://www.who.int/behealthy/digital-health/promoting-health-in-the-21st-century

Williams, L. J., Edwards, J. R., and Vandenberg, R. J. 2003. "Recent advances in causal modeling methods for organizational and management research." *Journal of Management* (29:6), pp. 903-936.

Wilson, E. V. and Lankton, N. K. 2004. "Modeling patients' acceptance of provider-delivered e-health." *Journal of the American Medical Informatics Association* (11:4), pp. 241-248.

Wright, R. T., Campbell, D. E., Thatcher, J. B., and Roberts, N. 2012. "Operationalizing Multidimensional Constructs in Structural Equation Modeling: Recommendations for IS Research." *Communications of the Association for Information Systems* (30:1), pp. 367-412.

Wu, J. and Lu, X. 2013. "Effects of Extrinsic and Intrinsic Motivators on Using Utilitarian, Hedonic, and Dual-Purposed Information Systems: A Meta-Analysis." *Journal of the Association for Information Systems* (13:3), pp. 153-191.

Yan, L., Peng, J., and Tan, Y. 2015. "Network Dynamics: How Can We Find Patients Like Us?" *Information Systems Research* (26:3), pp. 496-512.

Yan, L. and Tan, Y. 2014. "Feeling Blue? Go Online: An Empirical Study of Social Support Among Patients." *Information Systems Research* (25:4), pp. 690-709.

Yan, L. and Tan, Y. 2017. "The Consensus Effect in Online Health-Care Communities." *Journal of Management Information Systems* (34:1), pp. 11-39.

Zahedi, F. M., Walia, N., and Jain, H. 2016. "Augmented Virtual Doctor Office: Theory-based Design and Assessment." *Journal of Management Information Systems* (33:3), pp. 776-808.

Zhang, P. 2007. "Toward a Positive Design Theory: Principles for Designing Motivating Information and Communication Technology," in *Designing Information and Organizations with a Positive Lens,* M. Avital, R. Bolland and D. Cooperrider (eds.). Emerald Group Publishing Limited, pp. 45-74.

Zhang, P. 2008. "Motivational Affordances: Reasons for ICT Design and Use." *Communications of the ACM* (51:11), pp. 145-147.

Zhang, P. 2013. "The Affective Response Model: A Theoretical Framework of Affective Concepts and Their Relationships in the ICT Context." *MIS Quarterly* (37:1), pp. 247-274.

Zhang, X., Guo, X., Lai, K.-h., and Yi, W. 2019. "How does online interactional unfairness matter for patient–doctor relationship quality in online health consultation? The contingencies of professional seniority and disease severity." *European Journal of Information Systems* (28:3), pp. 336-354.

Zhao, X., Lynch Jr, J. G., and Chen, Q. 2010. "Reconsidering Baron and Kenny: Myths and truths about mediation analysis." *Journal of Consumer Research* (37:2), pp. 197-206.

Paper I

How Do IT-related Traits Drive the Internet Use of Mature Adults?

The Interplay of Curiosity and Control

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Paper II

Digital Services for the Aging Society

The Impact of Previous Workplace Privileges on Mature Adults' Use of the Internet

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https://www.thinkmind.org/index.php?view=article&articleid=icds_2016_4_20_10014

Paper III

Mature Adults' Use of Digital Health Services

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Paper IV

Technology-Mediated Health Activities

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Paper V

Older Adults' Use of Online Health Information

Do They Even Try?

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Paper VI

Equal Access for Everyone?

A Digital Divide Cascade for Retired Senior Citizens

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Paper VII

Activity Tracking Affordances

Identification and Instrument Development

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Paper VIII

Individual Fitness App Use

The Role of Goal Orientations and Motivational Affordances

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Paper IX

On the Fit in Fitness Apps

Studying the Interaction of Motivational Affordances and Users' Goal Orientations in Affecting the Benefits Gained

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Paper X

Motivating Individually

Needs, Goals, and Affordances in Fitness Tracking Technology

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Motivating Individually

Needs, Goals, and Affordances in Fitness Tracking Technology

ABSTRACT

Physical inactivity is a prevailing issue of our society causing billions in healthcare, productivity losses, and million deaths. To counteract this problem, fitness tracking technology is increasingly considered as a means to enhance motivate individuals' physical activity motivation and behavior. Extant research, however, provides an overall inconclusive picture about the 'motivational effectiveness' of fitness tracking technology, reporting, positive, mixed, and even adverse impacts on physical activity motivation and behavior. To better understand these motivational impacts, this paper theorizes the role of the motivational affordances, the underlying motivation-psychological process, and the role of interpersonal, motivational differences of the users. Based on an empirical study involving 286 fitness tracking technology users, results reveal how individual motivational affordances distinctively satisfy users' needs for autonomy, competence, and relatedness, and thereby enhance the physical activity motivation and behavior of the individuals. Moreover, results support interpersonal variations stemming from motivational affordances as that users pursuing certain physical activity goal obtain higher need satisfaction from the enacted affordances. In essence, this paper contributes with a deeper understanding about the motivation-psychological processes and variations underlying fitness tracking technology use which guides practice in the development of effective interventions.

Keywords: Fitness tracking technology, Motivational affordances, Achievement goal theory, Self-determination theory

1 INTRODUCTION

January, 12th is now dubbed Quitters' Day; the day when most people give up their New Years' resolutions to be more physically active – according to analysis of millions of exercise activities recorded by the fitness tracking technology 'Strava' (Whipple 2018). The worldwide prevailing physical inactivity (Guthold et al. 2018) is a major issue of our contemporary society causing billions in healthcare costs and productivity losses (WHO 2018a) and has become a leading factor of mortality (OECD 2017). Aiming to counteract this issue by enhancing people's motivation to be physically active, fitness tracking technology currently attracts millions of individuals (Statista 2018), health insurance companies (BBC 2018; Best 2016), employers

(Giddens et al. 2017), and even the World Health Organization (WHO 2018b). Between the lines, however, the striking insight of the Quitters' Day raises another concern: if people use a fitness tracking technology but still end up failing to keep up their motivations after only twelve days, do we then need to question the 'motivational effectiveness' of such technology?

Fitness tracking technology is a practical embodiment of motivational information systems (IS), systems centering on the idea to motivate and support its users in a particular activity, such as exercising (Koivisto and Hamari 2019). At the core of such systems are the motivational affordances – the central features users engage with to support their motivational needs (Koivisto and Hamari 2019; Zhang 2008). Fitness tracking technologies offer features to record, document, and analyze exercise activities (self-quantification); features that assist in structuring, assisting, and rewarding physical activities (exercise guidance); and social-network based features facilitating users to praise or compare each other's activities and to engage in competitions (social interaction) (Hamari et al. 2018; James et al. 2019a; Stragier et al. 2018).

Whilst research agrees that motivational affordances are the lynchpin of supporting motivation through IS, their actual motivational benefits are not well understood (Koivisto and Hamari 2019). The nascent research available so far often examined the fitness tracking technology as a 'whole' hence neglecting the particular impacts stemming from the individual motivational affordances incorporated (Hamari et al. 2014b; Koivisto and Hamari 2019). Despite frequent calls to pay attention to the particular effects of the motivational affordances (e.g., Koivisto and Hamari 2019; Orji and Moffatt 2016), research responding to this remains scarce with few exceptions (Hassan et al. 2019; James et al. 2019a; James et al. 2019b; Suh 2018). Yet these few exceptions provide inconclusive results. For instance, whilst social interaction related affordance was found to enhance users' subjective vitality (James et al. 2019a; James et al. 2019b), another study found neither impacts on users' perceived benefits nor on IS continuance (Hassan et al. 2019). Similarly inconclusive, self-quantification related affordances seemingly enhanced users' perceived benefits and IS continuance intentions (Hassan et al. 2019; Suh 2018) as well as users' subjective vitality (James et al. 2019b) whilst another study implies no gains in users' subjective vitality from this affordance (James et al. 2019a). Thus, the motivational affordance-motivational outcome relationship warrants finer scrutiny.

Contemporary motivation literature informs about two distinct aspects how techniques like performance feedback, rewards, or social comparisons impact one's motivation: the underlying motivation-psychological processes (Ryan and Deci 2017) and the interpersonal motivational differences with which individuals differently react to such techniques (Murayama and Elliot 2009). In essence, motivation literature calls into our attention how such techniques motivate and who they motivate.

First, the literature explicates that to strengthen one's motivation, one's motivation-relevant needs for autonomy, competence, and relatedness must be satisfied (Ryan and Deci 2017). Although some reflect upon such need satisfying mechanisms when linking the motivational affordances with motivational benefits of fitness tracking technology (e.g., James et al. 2019b; Suh 2018), the actual impact of motivational affordances on these motivational needs has not been investigated. As such, this underlying process of need satisfaction might constitute a missing link to explain the affordance-outcome relationship. Second, because persons hold different motivations and goals for a given activity, such as exercising, not every technique motivates every person to the same extent. Competitions, for example, can be motivating for persons with a competitive personality but also demotivating for others. Initial research revealed that users' different motivations and goals drive which motivational affordances they

prefer and enact (Hamari et al. 2018; James et al. 2019a; Stragier et al. 2018). Whether and how the motivational effects of the motivational affordances vary due to such different motivations and goals is unknown despite first indications (James et al. 2019b). Thus, interpersonal differences might be an explanation of the inconclusive affordance-outcome relationship in prior research alike.

In essence, prior research neglected two decisive aspects of human motivation that might potentially explain the inconclusive results concerning the motivational benefits of motivational affordances and of fitness tracking technology at large. Given these considerable knowledge gaps that have been echoed from scholars alike (Hamari et al. 2014a; Johnson et al. 2016; Koivisto and Hamari 2019; Orji and Moffatt 2016; Rapp et al. 2019), we seek to fill these gaps and hence answers to the following research questions (RQ):

> ***RQ1:*** *How do motivational affordances motivate? In particular, how do motivational affordances impact users' motivational needs (autonomy, competence, and relatedness) and in consequence users' perceived benefits of using fitness tracking technology?*
>
> ***RQ2:*** *Who is motivated by motivational affordances? In particular, how do the impacts of the motivational affordances vary by users' different motivational goals?*

Our aim is to zoom into the motivational affordance-motivational outcome relationship of fitness tracking technology to better understand its' motivational benefits and to resolve prior inconsistencies in the literature. To this end, we draw on two theoretical underpinnings of the motivation literature: Self-determination Theory (Ryan and Deci 2017) explicating the psychological processes in terms motivational need satisfaction (autonomy, competence, and relatedness) and Achievement Goal Theory (Ames 1992; Nicholls 1989) explaining inter-individual variations with optimal motivational outcomes emerging when a motivational technique 'fits' the motivational goal of the person (Murayama and Elliot 2009). We propose a model that translates these tenets to the motivational affordances in explaining the motivational benefits of fitness tracking technology. As empirical validation with users of the popular fitness tracking application Strava (n=286) supports most of the developed arguments, this paper contributes to the nascent research on motivational IS and the motivational affordance-outcome relationship by explicating 1) the underlying psychological processes and 2) inter-individual variations of the motivational effects.

2 THEORETICAL BACKGROUND

2.1 Fitness Tracking Technology and Motivational Affordances

Fitness tracking technology belongs to the class of Motivational Information Systems[18]: systems designed and built for the purpose of inducing motivation, engagement, or behavior change (Koivisto and Hamari 2019). Motivational Information Systems are increasingly applied in

[18] Synonyms include: Persuasive Systems (Oinas-Kukkonen and Harjumaa 2009) or Persuasive Technology (Fogg 2003), Gamified Systems or Gamification (Blohm and Leimeister 2013; Deterding et al. 2011), Positive Computing (Diefenbach 2018; Peters et al. 2018) or Positive Design (Zhang 2007)

many aspects of our daily lives such as education (van Roy and Zaman 2018b), work tasks (Mekler et al. 2017), or health (Hamari and Koivisto 2015). The general motivational benefits such systems are expected to bring with include, amongst others, increased participation, improved performance, or greater compliance concerning the targeted activity (Seaborn and Fels 2015). Motivational benefits of fitness tracking technology include, for instance, increases in exercises, exercise performance improvements, and increased enjoyment of physical activity (Hassan et al. 2019).

The core of motivational IS are the motivational affordances incorporated within (Koivisto and Hamari 2019). Formally defined as "the properties of an object that determine whether and how it can support one's motivational needs" (Zhang 2008, p. 145), motivational affordances reflect the features and functionalities designed into the motivational IS and what they allow users to do – their action potentials (Tim et al. 2018). Leaderboards, for example, rank fitness tracking technology users according to their exercise performance and thereby provide users means for social comparison and social recognition. As such, the notion of motivational affordances is anchored in the general concept of affordances (Gibson 1977; Markus and Silver 2008) that attracts IS scholars to study how users' distinct technology uses help them to attain their goals (Burton-Jones and Volkoff 2017).

Across contexts, a broad variety of motivational affordances have been considered (Koivisto and Hamari 2019). In the case of fitness tracking technology, motivational affordances fall into the dimensions of self-quantification, exercise control, and social interaction (Hamari et al. 2018; James et al. 2019a; James et al. 2019b; Stragier et al. 2018). Table 1 depicts the according motivational affordances, definitions and feature examples that are explained in the following.

Affordance		Definition: The possibility …	Feature examples
Self-quantification	Self-monitoring	… to systematically document and observe one's sport behavior.	Recording of GPS and steps; training log and diaries, reports of step rates, pulse frequency, speed, distance, or calories
	Performance analysis	… to systematically analyze and evaluate performance indicators.	Statistics on recorded parameters, side by side comparison of records from the logged activities
Exercise control	Exercise guidance	… to get instructed for physical activity.	Textual or audio-visual media with exercise tips, alerts for pulse zones or interval training, live performance feedback
	Rewards	… to obtain rewards for physical activity.	Points, badges, trophies
Social interaction	Social comparison	… to compare one's own performance against others.	Leaderboards, rankings, competitions, activity reports of others, other's profile pages
	Social recognition	… to receive social feedback and respect from others.	Leaderboards, rankings, "likes" or "kudos", comments on posted activities

Table 1. Motivational affordances of fitness tracking technology (Rockmann and Gewald 2018)

Self-quantification affordances. Self-quantification describes the regular collection, processing, and presentation of health-related data like bodyweight, steps taken, or heart rate (Choe et al. 2014; Li et al. 2010; Lupton 2016; Swan 2013). Self-quantification in fitness apps provides users with possibilities for self-monitoring and performance analysis through features that allow them to record, document and analyze their physical activity related data (Hamari et al. 2018; James et al. 2019b). *Self-monitoring* considers systematic recording and observation of target behaviors, like physical activity (Baker and Kirschenbaum 1993). Fitness app users can

record their activities, including bodily parameters or GPS, directly within the apps but also using external devices such as wristbands (e.g., Fitbits) or bicycle computers. Based on this data, users can observe trends within their recordings whether they are making progress or to ensure themselves in maintaining their target behavior (Barratt 2017; Li et al. 2011; Sjöklint et al. 2015). *Performance analysis* entails statistics and visualizations of recorded parameters that allows fitness app users perform sophisticated analyses on their performance indicators, such as distance, speed, pulse, etc. (James et al. 2019a). Thereby, users can obtain deeper understanding about their behavior and performance (Gimpel et al. 2013).

Exercise control affordances. Exercise control provides fitness app users features that assist in structured and controlled exercises including affordances for exercise guidance and rewards (James et al. 2019b). *Exercise guidance* provides users with information and instructions for conducting physical activity. Users can obtain informational contents regarding exercise and workout tips and instructions. Exercise guidance also allows users to manage their exercise goals such as by creating workout schedules or setup activity goals so that users can receive alerts reminding them to exercise. During workout, users can oftentimes receive live audio-visual performance feedback, for example about current distance or pace. *Rewards* are another affordance that assist users in their structured exercises (James et al. 2019b). Motivational information systems often grant points, badges or trophies as virtual rewards for achieving activity targets (Blohm and Leimeister 2013; Oinas-Kukkonen and Harjumaa 2009). The Nike+ Running app, for instance, praises the user after having completed a certain running distance such as '5k' or '10k' and grants virtual trophies (Oinas-Kukkonen and Harjumaa 2009). Rewards also offer a mechanism to decompose larger goals into smaller and attainable steps and goals (Oinas-Kukkonen and Harjumaa 2009).

Social interaction affordances. Motivational systems often incorporate social network capabilities to allow users social interactions with other exercisers in several forms (James et al. 2019b). The premise is to develop social relationships and feelings of social integration for users (Sardi et al. 2017). In particular, s*ocial comparison* allows users to compare their physical activity behavior and performance against other users (Festinger 1954). It is assumed to support individuals in performing the target behavior when they can compare their performance and progress with that of others (Oinas-Kukkonen and Harjumaa 2009). Often, social comparison can invoke a sense of competition where users strive to achieve higher positions, and hence higher social status, in leaderboards resulting in gains in self-esteem and pride (Sardi et al. 2017). *Social recognition* is the social feedback users receive on their physical activity from other users (Hamari and Koivisto 2013), such as support, respect or approval (Lin and Bhattacherjee 2010).

2.2 Knowledge Gaps on Motivational Affordances

Whilst these motivational affordances are theoretically expected to bring upon the anticipated motivational benefits of increased exercise motivation and engagement, in research, however, we actually do not know a lot about their motivational effectiveness (i.e., the extent to which the anticipated motivational effects are realized). First, the nascent research available often examined fitness apps as a 'whole' neglecting the particular effects each individual motivational affordance has (Hamari et al. 2014b; Koivisto and Hamari 2019). Second, the few studies available examining the particular role of each affordance draw an overall inconclusive, sometimes conflicting picture (see Table 2 for an overview). That is, as laid out introductorily, the motivational impacts of the motivational affordances appear to vary between studies.

Article	Affordances	Outcome	Individual	Process	Findings
(Stragier et al. 2018)	• Activity evaluation • Progress evaluation • Off-platform social features • On-platform social features		• Physical Motives (weight, health) • Social Motives (affiliation, recognition) • Achievement Motives (competition, personal goal) • Psychological motives (psychological coping, life meaning, self-esteem)		Investigates how fitness app motives (i.e. goals; physical, social, achievement, psychological) influence fitness app feature use (i.e. self-regulation features, off-platform social features, on-platform social features)
(Hamari et al. 2018)	• Quantified-self • Gamification • Social networking		• Goal Focus (outcome, process) • Goal Orientation (proving, avoidance, mastery) • Goal Attributes (difficulty, specifity)		Investigates how different goals (i.e. outcome, process; proving, avoidance, mastery; difficulty, specifity) influence fitness app feature use (i.e. gamification, social networking, quantified-self)
(Suh 2018)	• Tracking • Social sharing • Visualizing	• IS Continuance Intention		IS usage motivations (utilitarian, hedonic, eudemonic)	Investigates quantified-self continuance: role of affordances (tracking, social sharing, visualizing) influencing usage motivations (i.e. utilitarian, hedonic, eudemonic motivation) influencing IS continuance
(Hassan et al. 2019)	• Quantified-self • Gamification • Social networking	• Perceived Benefits • IS Continuance Intention		Motivational feedback (affective, social, informational)	
(James et al. 2019a)	• Data Management • Exercise Control • Social Interaction	Subjective Vitality	Exercise Goals (Determinants of Affordances and Outcome)		• Exercise goals predict affordance uses • Of all affordances, only Social Interaction enhances Subjective Vitality
(James et al. 2019b)	• Data Management • Exercise Control • Social Interaction	Subjective Vitality	Intrinsic-Extrinsic Continuum (Determinants and Moderator)		• Exercise motivation predict affordance uses • Data Management and Social Interaction Affordances enhance Subjective Vitality • Influence of Affordances on Subjective Vitality is moderated by Individual Motivations

Table 2. Research on fitness tracking technology

To potentially explain these inconclusive, sometimes contradictory results of prior research, several scholars call for considering the *underlying motivation-psychological processes* and the *motivational differences of the users* in regards to the motivational affordances (Alahäivälä and Oinas-Kukkonen 2016; Hamari et al. 2014a; Hamari et al. 2014b; Johnson et al. 2016; Koivisto and Hamari 2019; Nacke and Deterding 2017; Orji and Moffatt 2016; Rapp et al. 2019; Schmidt-Kraepelin et al. 2018; Seaborn and Fels 2015).

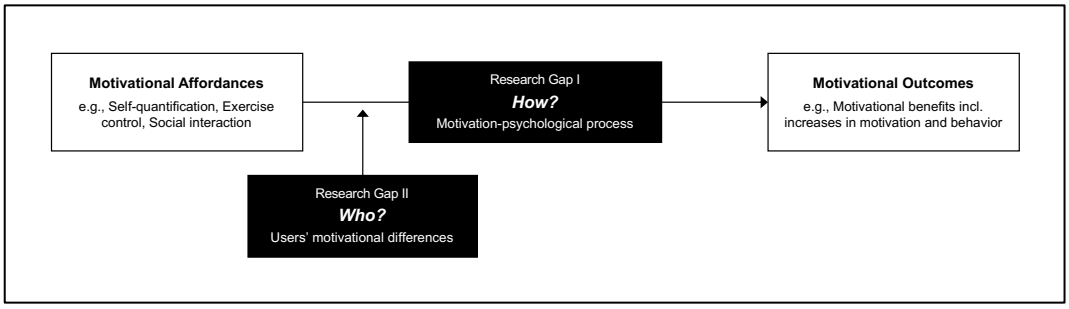

Figure 1. Research gaps on the effectiveness of motivational affordances

In the following, we explicate these two research gaps (Figure 1) in light of the existing literature that focuses on the individual motivational affordances.

2.2.1 Research Gap I: Motivation-psychological Processes Linking Motivational Affordances with Motivational Outcomes

The first research gap identified centers on the question of *how motivational affordances motivate* and therewith on the underlying motivation-psychological processes. Existing studies in the PA context linked the individual motivational affordances with a variety of outcomes including continued use of the system (Hassan et al. 2019; Suh 2018), users' well-being (James et al. 2019a; James et al. 2019b), or the perceived motivational benefits of using the system including increased exercising, heightened exercise enjoyment, or feeling healthier (Hassan et al. 2019). Whilst some linked the motivational affordances directly with the outcome of interest (James et al. 2019a; James et al. 2019b), others did so indirectly via system-related beliefs like usefulness and enjoyment of using the system (Suh 2018) or the affective, social, and informational feedback provided by the motivational affordances (Hassan et al. 2019). However, as affordance within the motivational IS context aim to support users' motivational needs (Zhang 2008), little has been put forth in the physical activity context to examine how enacted affordances actually facilitate users' motivational needs. So far, scholars speculate upon such potential influences on motivational needs when arguing about the motivational impacts, such as on well-being variables like subjective vitality (James et al. 2019b). Some initial attempts to link affordances with motivational needs have been made outside the physical activity context yet with inconclusive results (Mekler et al. 2017; Sailer et al. 2017; van Roy and Zaman 2018a; b). In a study on motivational IS in education, for example van Roy and Zaman (2018b) report that certain affordances can satisfy distinct psychological needs but they can equally thwart other users' needs. That is, whilst these approaches initially advance understanding about the underlying processes –need satisfaction– of affordances in motivational IS, these attempts are limited in explaining differing outcomes for different individuals, which brings us to the second research gap.

2.2.2 Research Gap II: Users' Motivational Differences Influencing the Motivational Affordances' Effectiveness

The second research gap identified is concerned with the question of *who is motivated by the motivational affordances* – how differences in the motivational goals pursued by the users influences the motivational affordances' effects. Individuals greatly differ in their underlying motivations and goals concerning a focal activity. In the case of PA, for example, some persons have the goal to improve their physical abilities aiming to run 10 km faster than ever before

whereas others are motivated by outperforming others and winning competitions. Initial research on motivational IS in the PA context has accordingly shown that users differently prefer and make use of the individual motivational affordances due to their different motivations and goals (Hamari et al. 2018; James et al. 2019a; Stragier et al. 2018). For instance, social interaction affordances are particularly preferred and utilized by persons who are socially motivated to exercise such as being with friends (James et al. 2019a) or who have the goal the prove their abilities to others (Hamari et al. 2018). Available studies hence inform that motivational differences guide users' perception and enactment of corresponding motivational affordances. Rather unknown is whether, and if so how and why, such users' motivational differences account for variations of the motivational effects from individual motivational differences. For example, will socially-motivated users gain higher exercise motivation when using social interaction affordances? Answers to such interactive effects between individual motivations and affordances have been called for (Nacke and Deterding 2017; Rapp et al. 2019) but barely assessed so far. First evidence supporting interactive effects exists recently appeared in James et al. (2019b).

2.2.3 Summary

As discussed, there are two research gaps concerning the motivational effectiveness of motivational affordances: 1) the motivation-psychological processes underlying the motivational effects and 2) the role of users' motivational differences interacting with the motivational affordances. Given the inconclusive results reported in prior literature, both knowledge gaps inhibit a deeper understanding about the motivational effectiveness of the motivational affordances and of the motivational IS at large. To fill these gaps, we draw upon motivation literature providing key tenets about the effectiveness of motivation techniques and corresponding theoretical explanations next. After that, we transfer these insights into the context of motivational IS and motivational affordances in developing our theoretical approach.

2.3 Motivation Theories

Our research aims to better understand the relationship between motivational affordances and their motivational outcomes in the context of motivational IS supporting PA. Specifically, we are interested in the motivation-psychological processes underlying the motivational affordances as well as their interactions with individual motivational differences to explain the motivational benefits gained from using a motivational IS. Here, we review motivation literature focusing on the motivational effects of social-environmental factors that we aim to adapt to the context of motivational IS.

Human motivation is generally understood as the processes that give behavior its energy and direction (Reeve 2005). Scholars hence seek to understand how external events, such as motivation techniques applied by social actors like sports coaches or parents, influence a person's motivation-relevant cognitions, affect, and behavior. *Self-determination Theory* (Deci and Ryan 2012; Ryan and Deci 2017) and *Achievement Goal Theory* (Ames 1992; Nicholls 1989) –two established theories on human motivation– center on the motivational role such external events play. Both theories explicate key characteristics of such external events that jointly define the *'motivational climate'* for a person. In brief, Achievement Goal Theory characterizes a motivational climate by the goals that are emphasized: development of abilities and demonstration of abilities (Ames 1992; Nicholls 1989). Self-determination Theory characterizes the motivational climate by extent it supports a person's psychological needs for autonomy,

competence, and relatedness (Ryan and Deci 2017). Below, we briefly outline the key tenets of both theories and then review how these theories inform about the *underlying motivation-psychological processes* and the role of *individual motivational differences*.

Achievement Goal Theory (AGT; Ames 1992; Nicholls 1989) centers on how individuals define success in achievement-related activities such as physical activity (Duda 2013). Achievement motivation is accordingly influenced by the goals one adopts and which can be characterized as mastery and performance goals. *Mastery goals* focus on competence development, emphasizing improvement and effort in a self-referential manner. *Performance goals* are normative-referenced definitions of competence emphasizing interpersonal comparisons, evaluations and demonstration of ability to others (Harackiewicz and Elliot 1993). These two goal dimensions can be emphasized by the person (goal orientations) but also stressed within the motivational climate (Ames 1984; Dweck and Leggett 1988). By inducing a mastery climate, sports coaches, for example, orient their athletes toward improvement emphasizing working hard and doing their best (Duda 2013). A performance climate is created when sports coaches judge individual's abilities in comparison with other athletes and emphasize outperforming teammates (Duda 2013).

Self-determination Theory (SDT; Deci and Ryan 2012; Ryan and Deci 2017) focuses on how social-environmental factors satisfy a person's basic psychological needs to determine any sorts of motivational outcomes. SDT thereby posits that all human beings have three innate, basic psychological needs for *autonomy* (acting volitional and congruent with one's true values), *competence* (operating effectively in different life contexts and feeling mastery), and *relatedness* (feeling connected with and cared for by others) (Deci and Ryan 1985b; 2000; 2012). Greater satisfaction of these three needs is linked to optimal motivational outcomes, human functioning, and well-being (Ryan and Deci 2017) including peoples' motivation, engagement, and persistence in physical activity (see e.g., Ng et al. 2012; Teixeira et al. 2012). By acknowledging athletes' individual preferences and providing choice, for instance, a sports coach satisfies athletes' autonomy need. By providing optimal challenges and constructive feedback, sports coaches satisfy competence needs. And when peers and teammates encourage each other, one's relatedness need is satisfied (Jõesaar et al. 2011).

In essence, both AGT and SDT focus on the motivational influence of external events and personal environments. Their theoretical linkage has been discussed on these grounds (Allen and Hodge 2006; Deci and Ryan 2000; Ntoumanis 2001a; Standage et al. 2003b) and is now referred to as the 'motivational climate' (Appleton et al. 2016; Duda 2013; Smith et al. 2017; Smith et al. 2016). An empowering motivational climate is mastery-focused, emphasizing the value of effort, self-improvement, and cooperation resulting in higher satisfaction of autonomy, competence, and relatedness needs (Duda 2013; Smith et al. 2017). Disempowering motivational climate are characterized as controlling and pressuring, where mistakes are punished and rivalry between peers is emphasized so that the autonomy, competence, and relatedness needs are actively thwarted (Duda 2013; Smith et al. 2017).

2.3.1 Motivation-psychological Processes Underlying External Events

Several motivation scholars adopt the core principles of SDT's basic psychological needs when discussing the motivational impacts of external events, such as those of motivational techniques like feedback, rewards, or competitions (Duda and Appleton 2016; Vallerand 1997). That is, SDT informs about the underlying psychological processes that take place between external events and motivational outcomes (Figure 2). The satisfaction of basic psychological needs for

autonomy, competence, and relatedness mediate the motivational impacts of external events of the personal environment (i.e., motivational climate) (Duda and Appleton 2016; Ryan and Deci 2017).

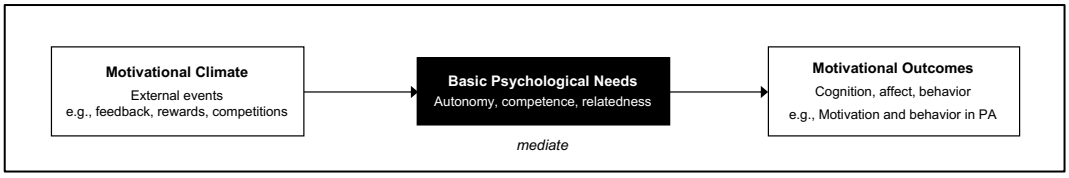

Figure 2. Psychological processes

Some motivational IS research alike adopts the notion of basic psychological need satisfaction when speculating about the motivational impacts of the motivational affordances of interest (e.g., Blohm and Leimeister 2013; James et al. 2019b; Zhang 2008). Yet research explicitly testing the mediating mechanisms of need satisfaction is scarce. The few available studies also draw a mixed picture about this linkage. Some studies report positive linkages between affordances and satisfaction of autonomy, competence, and relatedness (e.g., Peng et al. 2012; Sailer et al. 2017; Suh et al. 2015; Xi and Hamari 2019). Others, however, found no effects at all (Mekler et al. 2017) and also negative effects (Kerner and Goodyear 2017; van Roy and Zaman 2018b). In the latter case, for example, Kerner and Goodyear (2017) report significant reductions in autonomy, competence, and relatedness satisfaction after 8 weeks of using a fitness tracking technology in a sample adolescents. Additional focus group insights also revealed that certain affordances had positive impacts for some but also negative impacts on need satisfaction for others, such as competition-oriented affordances. This dual –or ambivalent– motivational impact equally satisfying but also thwarting users' needs has been observed in another study alike (van Roy and Zaman 2018b). As motivation literature further assumes that motivational impacts are likely to vary due to inter-individual differences, we next outline the role of individual motivational differences for the impact of external events (i.e. motivational climate).

2.3.2 Individual Variations in Responses to External Events

People diverge in several forms of personality, hold different motivations or strive for different goals. Consequently, research on the motivational climate including its theoretical underpinnings of SDT and AGT, assumes that different people also respond differently to the same external event (i.e., motivational climate) (Deci and Ryan 1985a; Deci and Ryan 1987; Murayama and Elliot 2009). In general, scholars consider a conventional 'person-situation interaction' view suggesting that optimal outcomes emerge when there is a 'fit' or 'congruence' between the person and the situation, i.e. when characteristics of the motivational climate match the characteristics of the person (Diener et al. 1984; Emmons et al. 1986).

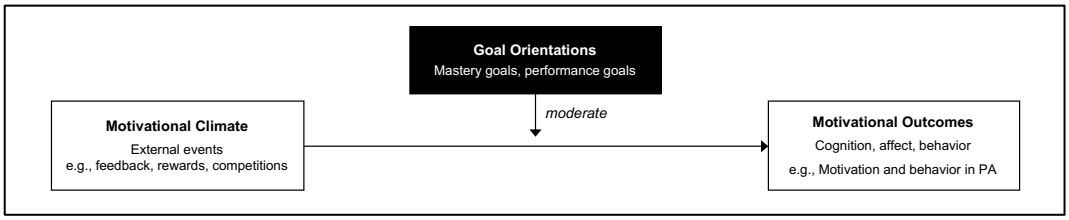

Figure 3. Individual differences

To identify and theorize the shared characteristics of both the motivational climate and the person, AGT is particularly well-suited (Ickes et al. 1997). Clearly, AGT posits that mastery goals (ability development) and performance goals (ability demonstration) can be both salient within the environment but also within the person including their personal dispositions (Ames 1992). As such, a match between the motivational climate and the person occurs when both emphasize mastery or performance goals (Murayama and Elliot 2009). When matching, the motivational climate provides well-defined goal structures facilitating individual's goal accomplishment (Emmons et al. 1986; Ickes et al. 1997). Thus, for optimal motivational effects, a mastery-oriented person is assumed to be best situated within a mastery climate and a performance-oriented person in a performance climate (Linnenbrink 2005; Linnenbrink and Pintrich 2001; Murayama and Elliot 2009; Newton and Duda 1999; Treasure and Roberts 1998). For example, when persons with a strong mastery goal are situated in a mastery climate, they exhibit higher task performance (Jagacinski et al. 2001), higher intrinsic motivation for PA (Standage et al. 2003a), and report more positive experience when conducting PA (Bortoli et al. 2009; Treasure and Roberts 1998). Similarly, performance-oriented persons have higher intrinsic interest in educational courses when these act as performance climate (Murayama and Elliot 2009). In the context of motivational IS, however, little is known about this interaction between motivational affordances (motivational climate) and individual, motivational differences although initial indications exist supporting these considerations (James et al. 2019b).

2.3.3 Summary

In sum, motivation literature informs about the motivational impacts that external events (motivational climate), including motivation techniques like feedback, rewards, and competitions, have on persons. First, the literature explains the *underlying psychological processes* as that the motivational impact of external events takes place by the extent to which these satisfy a person's basic psychological needs for autonomy, competence, and relatedness (Deci and Ryan 2012; Ryan and Deci 2017). Second, the literature posits that *individual motivational differences* in terms of the achievement goals pursued by the individual (ability development and ability demonstration) interact with external events such that optimal motivational outcomes are expected when both person and the external event emphasize the same goals. Next, we adapt these two aspects of motivation into the context of motivational IS to better understand the motivational impacts of the motivational affordances.

2.4 Theoretical Approach

The key promise of motivational IS it to positively affect users' motivation and behavior (Koivisto and Hamari 2019). The motivational affordances embedded are expected to play a central role but their motivational impacts are less well understood (Koivisto and Hamari 2019). Specifically, we aim to better understand *how* and *whom* motivational affordances motivate. Drawing on the insights on human motivation just discussed, we now translate these aspects (underlying processes, individual differences) into the context of motivational IS (cf. Figure 4).

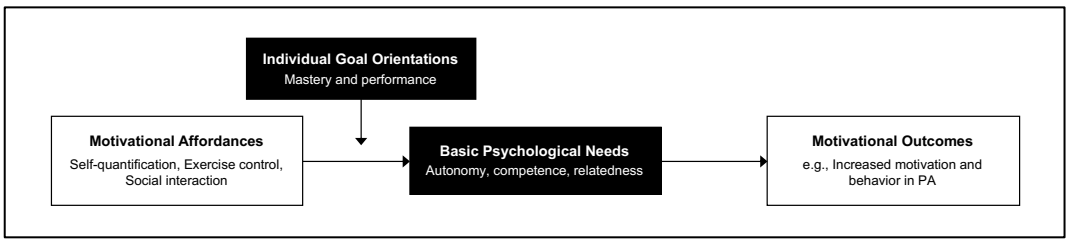

Figure 4. Theoretical approach

In line with theoretical considerations proposed earlier (James et al. 2019b; Zhang 2007), we posit that the motivational affordances provide a set of environmental factors that users can draw upon to support their physical activity. As such, the motivational affordances a distinct 'motivational climate' in the user's personal environment whereby their motivational impact takes place through the extent they satisfy user's needs for autonomy, competence, and relatedness (Deci and Ryan 2012; Ryan and Deci 2017).

Moreover, following a person-situation interaction approach (Diener et al. 1984; Emmons et al. 1986), we assume that the extent of need satisfaction is a function of the match between the goals the user pursues and the goals the corresponding motivational affordances facilitates to attain. When persons encounter an environmental feature or external event (i.e., motivational affordance), they construct a motivation-relevant interpretation of this feature (Deci and Ryan 1987; Ryan 1982; Vansteenkiste et al. 2008). Because of individual differences, such as goals, persons' interpretations differ so that persons are likely to respond differently to the same environmental feature (Deci and Ryan 1987; Ryan 1982; Vansteenkiste et al. 2008). The goal persons pursue creates a mental framework within they interpret and react to environmental features with which persons ask different questions and seek for different information in their environment (Dweck and Leggett 1988). When individuals find that the environment offers those features that correspond to their goals, the environment facilitates their individual goal attainment whereas an incongruent environment obstructs their goal attainment (Sagiv and Schwartz 2000).

In Table 3, we mapped the corresponding characteristics of the motivational affordances against the achievement goals (mastery, performance) they emphasize as well as the basic psychological needs (autonomy, competence, relatedness) they most likely address. The mapping procedure was guided through an extensive literature analysis including relevant literature on the theoretical tenets of AGT (Ames 1992; Nicholls 1989) and SDT (Ryan and Deci 2017), general IS literature (Karahanna et al. 2018) and specific motivational IS literature (Blohm and Leimeister 2013; James et al. 2019b; Mekler et al. 2017; Peng et al. 2012; Sailer et al. 2017; Seaborn and Fels 2015; Suh et al. 2015; Xi and Hamari 2019; Zhang 2007; 2008). Below, we briefly explicate these characteristics before detailing those during hypotheses development.

Affordance	Achievement Goals		Basic Psychological Needs		
	Mastery	*Performance*	*Autonomy*	*Competence*	*Relatedness*
Self-quantification	x	–	x	x	–
Exercise control	x	x	(x)	x	–
Social interaction	–	x	(x)	x	x

Table 3. Motivational characteristics of motivational affordances

Self-quantification affordances target users' mastery goal as well as their autonomy and competence needs. Through features allowing documentation, self-monitoring, and analysis, an emphasis is placed on self-referenced improvements as pronounced by mastery goals. The self-quantification affordances target users' competence need by providing competence-relevant information such as distance or speed. Likewise, these affordances support users' autonomy need as users can freely determine how to act upon the information gained (Suh 2018).

Exercise control affordances target both mastery and performance goals as well as autonomy and competence need of the users. Exercise control affordances assist users in structuring, controlling, and adhering to their PA regimen through guidance and rewards features (James et al. 2019b). It hence supports users' mastery goals providing guidance to improve in PA and also rewards their self-set goal attainments such as 'running 5km' (Oinas-Kukkonen and Harjumaa 2009). As challenges and rewards are also often built around the social network capabilities of motivational IS where users can compete against each other for the virtual reward of being the best performing user, these affordances also support users' performance goal to outperform others (Oinas-Kukkonen and Harjumaa 2009). As exercise control affordances provide means to improve physical abilities, they target users' competence need (Seaborn and Fels 2015). Support for autonomy, however, varies. On the one hand, users are free in selecting guidance and challenges but these affordances can also interfere with users' autonomy by putting control over their PA regimen.

Social interaction affordances provide a performance goal structure to the user and target all three needs. Social interaction affordances provide means to be receive other users' recognition for one's PA achievements (e.g., likes and comments) and also provide means to make interpersonal comparisons which hence promotes a performance goal. Social recognition and comparison provide ability-related feedback to the user and hence targets users' competence needs (Seaborn and Fels 2015). Like the exercise control affordances, however, autonomy need satisfaction might vary as these affordances introduce external contingencies. Uniquely, these affordances also target users' relatedness need through the interaction with other users (Seaborn and Fels 2015).

We detail our theoretical approach into testable hypotheses in the following section.

3 RESEARCH MODEL AND HYPOTHESES

This research seeks to better understand *how* and *whom* motivational affordances motivate, exemplified in the context of PA. That is, we seek to understand the *underlying motivation-psychological processes* and the role of *individual motivational differences*. We now translate the motivation-theoretical approach just developed (Figure 4) into our research model depicted in Figure 5. Our research model posits that the motivational impacts of the motivational affordances take place through extent they satisfy users' basic psychological needs for autonomy, competence, and relatedness. Because individuals are differently motivated, their mastery and performance goals are expected to further influence the extent to which the motivational affordances affect users' basic psychological needs. Below, we specify our arguments.

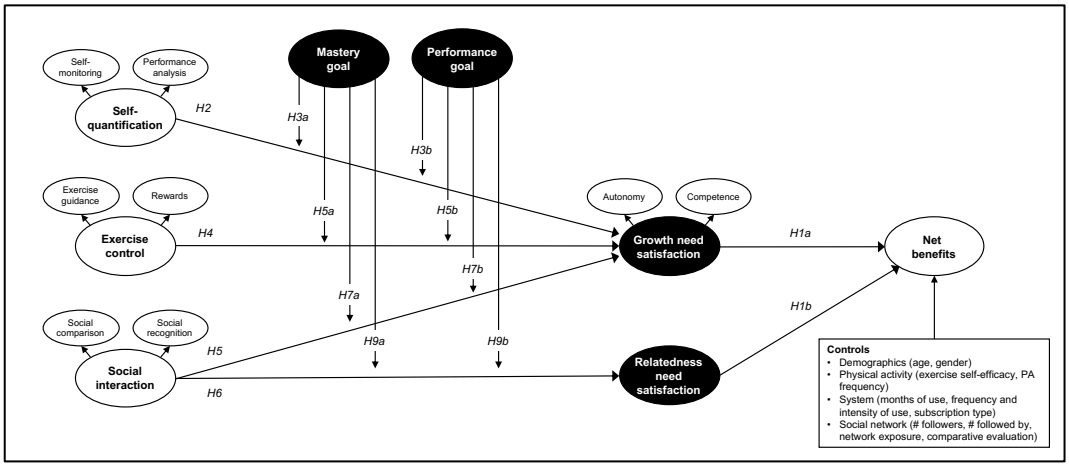

Figure 5. Research model

3.1 Need Satisfaction and Perceived Benefits

In the case of PA, motivational IS and their embedded motivational affordances aim to enhance people's motivation to be more physically active (Koivisto and Hamari 2019). Accordingly, the motivational benefits of having higher motivation, enjoyment, and being more physically active users attribute to the use of the motivational IS reflects the overall effectiveness of the IS (Hassan et al. 2019; Zhang and Venkatesh 2018). Hence, we contextualize our dependent variable 'perceived benefits' as individual's subjective perceptions about the positive impacts on motivation and PA behavior gained from using the motivational IS. In line with motivation literature, we expect that the motivational affordances' influence on the benefits perceived takes place through the satisfaction of basic psychological needs (Ryan and Deci 2017). Motivation research in the PA context has consistently shown that the satisfaction of these needs drives peoples' motivation, engagement, and persistence in PA (for extensive reviews in the PA context see, e.g., Ng et al. 2012; Teixeira et al. 2012). Following this, we hypothesize:

> ***H1(a/b):*** *The higher the* ***a)*** *growth need satisfaction and* ***b)*** *relatedness need satisfaction, the higher the perceived benefits of using the motivational IS.*

Next, we discuss how each affordance contributes to the need satisfaction of the user but also can vary in dependence upon the goal orientation the user pursues.

3.2 Self-Quantification Affordances

Self-quantification assists users to gain insights about their PA behavior for the purpose of self-optimization (Li et al. 2010). Self-quantification centers on documenting, monitoring and analyzing one's PA behavior with corresponding digital PA metrics (Lupton 2016; Suh 2018). That is, users obtain immediate feedback about their PA performance based on metrics like time, distance, or heart rates. Users can observe trends in these metrics, set metrics intro relation, or compare their PA performances over time. In essence, users receive feedback about their PA effectance which conveys rich information that satisfies their competence need (Ryan and Deci 2017). With this this information, users can freely determine their own PA goals and actions to pursue (Suh 2018) and does not impose any targets and goals on the user so that the

autonomy need is equally satisfied (Ryan and Deci 2017). Self-quantification affordances should thus promote satisfaction of users' growth need and motivation research in the PA and in the digital environment context lends initial empirical support. Plenty of PA research provides evidence that the provision of feedback about one's sports abilities without imposing any goals is an ideal condition that satisfies person's growth needs and thereby promotes sustained engagement to improve, higher intrinsic motivation, and sports performance (Ng et al. 2012; Ntoumanis et al. 2009). Supporting this, initial research in the general strand of motivational IS has shown that performance graph features visualizing one's task performance, and other achievement visualizing features, significantly contribute to competence need satisfaction (Sailer et al. 2017; Xi and Hamari 2019) and autonomy need satisfaction (Xi and Hamari 2019). In the PA context of motivational IS, research has shown that self-quantification affordances significantly enhance users' understanding about their PA behavior (Hassan et al. 2019) and improvement efforts (Suh 2018). We

> ***H2:*** *The stronger engagement with the self-quantification affordance, the higher the growth need satisfaction.*

Because self-quantification affordances facilitate understanding, effort, and improvement, they should be particularly motivating for mastery-oriented users (Ames 1992; Murayama and Elliot 2009). Individuals high in a mastery goal orientation seek to enhance their competencies and to acquire new skills (Dweck and Leggett 1988) and hence engage deeper with the contents that provide new information (Coutinho and Neuman 2008; Elliot et al. 1999). In support of a matching perspective, motivation research revealed that when mastery-oriented individuals are situated in educational classroom emphasizing mastery goals alike, they are more motivated and report stronger satisfactorily experiences while striving for perfection (Standage et al. 2003a). In the PA context of motivational IS, initial research demonstrated that self-quantification features are particularly attractive for and used by persons pursuing physical improvement and achievement motives (Stragier et al. 2018), hold intrinsic exercise motivations (James et al. 2019a), or have indeed a mastery goal orientation (Hamari et al. 2018). Given this, we expect that self-quantification affordances facilitate the attainment of mastery goals, support mastery-oriented in their striving to improve, which should consequently increase the satisfaction of their growth needs.

For performance-oriented users, in contrast, we do not assume additional gains in growth need satisfaction from the enactment of self-quantification affordances. Performance goals are normative-referenced definitions of competence and focus on demonstration of ability to others (Harackiewicz and Elliot 1993). Performance-oriented users show less interest in informational, objective performance feedback which could facilitate their learning of a sports activity (Cury et al. 1997; Duda and Ntoumanis 2003). Motivation research hence found that the pursuit of performance goals in environments emphasizing mastery goals is unrelated to intrinsic motivation (Murayama and Elliot 2009). In the PA context of motivational IS, evidence reveals that performance goals (Hamari et al. 2018), extrinsic motivations (James et al. 2019b), or social-oriented exercise motives (James et al. 2019a) are unrelated to self-quantification feature use. In essence, performance-oriented users do not get opportunities to compare and demonstrate their competence relative to others when enacting the self-quantification affordances so that their normative-defined competencies get not satisfied.

> ***H3(a/b):*** *The relationship between quantified-self affordance engagement and need satisfaction is moderated by users' goal orientations so that the relationship is* ***a)***

*stronger for users high in a mastery goal orientation but **b)** neutral for users high in a performance goal orientation.*

3.3 Exercise Control Affordances

The exercise control affordances assist users in structuring, controlling, and adhering to their PA regimen (James et al. 2019b). The inherent exercise guidance serves a 'virtual coach' that controls users exercises by setting up exercise goals and plans, receiving live performance feedback, and receiving informational content such as exercise tips and instructions. Virtual rewards can be obtained for meeting exercise goals, such as for completing a 10 km run or for high ranks in social leaderboards (Oinas-Kukkonen and Harjumaa 2009). With rewards, users can also structure their exercises into smaller and more attainable steps (Oinas-Kukkonen and Harjumaa 2009). As such, the exercise control affordance targets users' competence need supporting them to improve their physical abilities. Rewards, for instance, carry rich feedback about one's competence as these are provided for competence-based achievements (Ryan and Deci 2017). Research in the general strand of motivational IS supports this as reward-like features significantly increased satisfaction of users' competence needs (Sailer et al. 2017; Suh et al. 2015; Xi and Hamari 2019). The impact of such elements on user's autonomy need is, though, controversially discussed as it can exert control over the individual to engage freely in PA (Duda and Appleton 2016; James et al. 2019b). Some users, for example, feel pressurized to perform their activities for the sake of rewards or by the alerts and reminders prompted (Barratt 2017; Kerner and Goodyear 2017). Motivation literature alike reports that surveillance, task-contingent rewards, imposed goals, and other sorts of external pressures are often autonomy-thwarting and undermine intrinsic motivation (Ng et al. 2012; Ntoumanis et al. 2009; Ryan and Deci 2000; 2017). However, motivational IS research also reports positive influences on autonomy need satisfaction (Suh et al. 2015; Xi and Hamari 2019). In general, we assume that the positive influences dominate.

***H4:** The stronger engagement with the exercise control affordance, the higher the growth need satisfaction.*

Because the exercise control affordances aim to support development and improvement of physical abilities and skills, they should be particularly motivating for mastery-oriented users and their striving to build physical competencies. That is, mastery-oriented users' inherent need for competence should be facilitated when having the according means that facilitate attainment of their improvement goals. In the PA context of motivational IS, research has shown that users assign higher importance and engage more strongly with exercise control related features when they hold improvements motivations (James et al. 2019a), intrinsic exercise motivations (James et al. 2019b), when they seek to compare their current against their past physical conditions or aim at reaching a particular sports goal (Hamari et al. 2018).

Likewise, we assume that performance-oriented users' growth need satisfaction excels with enactment of the exercise control affordances yet through different means. First, performance-oriented persons have an external locus of control because they define their competence on normative bases (Brunel 1999; Ntoumanis 2001a) and because they are more interested in the outcomes of an activity than in the activity itself (Nicholls 1989; Ntoumanis 2001a). By the means of structuring and controlling PA behavior, exercise control affordances provide externally motivating structures facilitating performance-oriented users' motivations. Initial evidence on motivational IS for PA indicates that users pursuing performance goals assign

higher importance to such control-oriented features like rewards (Hamari et al. 2018) and users with an extrinsic motivation are more likely to engage with exercise control affordances (James et al. 2019b) indicating a potential match between performance goals and exercise control affordances. Second, the inherent rewards affordances is often tied to social network based capabilities of motivational IS so that rewards are also associated with social-based challenges and competitions and the obtained virtual trophies signify superior ability compared to other users (Barratt 2017; van Roy and Zaman 2018b). As such, these rewards serve as visualizations of high competencies which stimulates performance-oriented users' desire to outperform others and to demonstrate ability, which should result in growth need satisfaction (Linnenbrink and Pintrich 2001). Supporting this, highly competitive persons report higher enjoyment of exercise games that have competitive elements incorporated, whereas less competitive persons responded with lowered competence self-evaluations compared to the non-competitive gameplay (Song et al. 2013).

> ***H5(a/b):*** *The relationship between control affordance engagement and need satisfaction is moderated by users' goal orientations so that the relationship is* ***a)*** *stronger for users high in a mastery goal orientation and* ***b)*** *stronger for users high in a performance goal orientation.*

3.4 Social Interaction Affordances

The social affordances center on social network capabilities integrated in motivational IS allowing users to connect with friends or like-minded persons likewise using the application (Hamari et al. 2018; James et al. 2019b). Once connected, users can follow each other's sports activities, which they can comment or 'like' (i.e. social recognition) and which allow them to make comparisons with one's own and other's activities and to engaging in competitions (i.e. social comparison) (Oinas-Kukkonen and Harjumaa 2009).

The social interaction affordances are likely to satisfy users' growth needs as they provide social feedback about the physical activities recorded and uploaded via recognition, praise, and comparisons (Babar et al. 2018; Hassan et al. 2019). Literature suggests that it others' praise and encouragement makes one feel good about oneself and therewith enhances an individuals' sense of competence (Ryan and Deci 2000). Motivation research reports that socially supportive and caring others (e.g., coaches, teammates) provide constructive competence feedback and encourage each other and thereby satisfy one's growth needs for competence and autonomy (Hodge and Gucciardi 2015; Jõesaar et al. 2011; Reinboth et al. 2004). In the context of motivational IS for PA, the social recognition gained plays an important role in enhancing users' exercise motivation (Hamari and Koivisto 2015; Karapanos et al. 2016). For some, this social feedback is taken very serious as it provides validation and confirmation about their physical abilities (Smith and Treem 2016). Equally, social comparisons and competitions serve as information sources for one's competence evaluations (Festinger 1954; Velez et al. 2018). That is, winning competitions or outperforming others informs about high abilities and satisfies competence needs (Reeve and Deci 1996). Initial evidence in the videogame and motivational IS context further lends support that enactment of social network-based motivational features affording communication, recognition and status, comparison, and competition satisfies users' growth needs (Suh et al. 2015; Velez et al. 2018; Xi and Hamari 2019). We put forth:

> ***H6:*** *The stronger engagement with the social interaction affordances, the higher the growth need satisfaction.*

Given the normative nature of the social interaction affordances, we assume that growth need satisfaction excels particularly for performance-oriented users. Performance goals are tied to normative comparisons (Régner et al. 2007) and the belief that sport serves to enhance one's social status and recognition (Biddle et al. 2003). For these persons, social comparisons serve for self-evaluation purposes (Régner et al. 2007) and provide means to demonstrate ability (Biddle et al. 2003). Research on motivational IS in the PA context indicates that performance-oriented users are consequently more inclined towards social interaction features as they assign higher importance to other users' activity logs and leaderboards (Hamari et al. 2018). Moreover, users with social exercise motivations (e.g., gaining others' recognition) or with competitive motives are more likely to interact with social interaction features that allow interpersonal performance comparisons and that provide them recognition from their social network such as 'likes' (Stragier et al. 2018). As such, performance-oriented users' striving for recognition and demonstration of competence should be particularly facilitated by the means of social interaction affordances so that their growth need satisfaction is particularly strong. Generally supporting this kind of interaction, motivation research found that performance-oriented students are more intrinsically motivated when they were situated in a classroom emphasizing performance goals and demonstration of ability (Murayama and Elliot 2009). In an experimental study on a videogame facilitating PA, players with a high competitive orientation –a determinant of performance goals (Harackiewicz et al. 1997)– responded with higher intrinsic exercise motivation and with higher positive affect when playing the videogame version with competitive elements than individuals low in competitiveness (Song et al. 2013).

Mastery-oriented users define their competence in self-referenced manner and place less emphasis on normative references when evaluating their competence (Ames 1992). However, mastery-oriented persons are not avoidant of social feedback including that gained from social comparisons. Whilst social comparison serves for self-enhancement purposes for performance-oriented persons, social comparison serves for self-improvement purposes when directed by mastery goals (Butler 1992; Park and Park 2017; Régner et al. 2007). That is, mastery-oriented persons utilize social comparison information –particularly that of better performing persons– to learn and improve (Park and Park 2017). Supporting mastery-oriented users' interest in social interaction affordances, motivational IS research reports that such social interaction features are also likely to be used by persons who are motivated to improve their physical abilities or seek to achieve their personal PA goals (Stragier et al. 2018). Moreover, intrinsic motivations –which are related to mastery goals– have been found to enhance the motivational impact of the social interaction affordances (James et al. 2019b). As such, we also assume that mastery-oriented persons' growth need satisfaction excels from the enactment of the social interaction affordances.

> ***H7(a/b):*** *The relationship between social affordance enactment and relatedness need satisfaction is moderated by users' goal orientations so that the relationship is* ***a)*** *stronger for users high in a performance goal orientation but* ***b)*** *neutral for users high in a mastery goal orientation.*

An additional, yet unique motivational impact of the social interaction affordance is assumed to be rooted in their potentials to satisfy users' relatedness need (i.e. being connected to and feeling cared by others). Emphatic and caring others, such as sports coaches and teammates, provide assistance and emotional support and thereby contribute to a persons' relatedness need satisfaction and in turn to a host of motivational benefits (Hodge and Gucciardi 2015; Jõesaar et al. 2011; Ntoumanis 2001b; Reinboth et al. 2004; Teixeira et al. 2012). The social interaction affordances facilitate forming social bonds with other users by following, commenting, or

acknowledging each other's uploaded activities as well as by challenging each other (James et al. 2019b). Such social interactions stimulates users' sense of belonging to the community (Karapanos et al. 2016). It is therefore straightforward to assume that enactment of the social interaction affordance satisfies users relatedness need. Initial empirical support for this relationship is lend from research on motivational IS (Suh et al. 2015; van Roy and Zaman 2018b; Xi and Hamari 2019), social media (Sheldon et al. 2011), and videogames (Ryan et al. 2006). We hypothesize:

> ***H8:*** *The stronger engagement with the social interaction affordance, the higher the relatedness need satisfaction.*

We further assume that the relatedness need satisfaction from social interactions is particularly strong for performance-oriented users. In general, performance goals are related to social goals of acceptance and status within a peer group meaning that performance-oriented persons have a stronger desire to form positive relationships with peers and to gain status within popular groups (Anderman and Anderman 1999). Literature suggests that a prior lack of belongingness causes individuals to adopt a performance goal (Anderman and Anderman 1999) suggesting that performance-oriented persons have neglected relatedness needs and hence stronger striving for social acceptance. In consequence, performance-oriented persons should benefit more from social interactions. Motivation research reports that athletes' flow experiences are caused in part by environments that satisfy their relatedness need – and this effect is particularly strong for athletes with a higher affiliation (Schüler and Brandstätter 2013). Furthermore, literature on peer acceptance and relationships in the PA context has shown that being physical competent brings about greater peer acceptance, social status and popularity (Allen 2003). Thus, performance-oriented users attempting these social interaction affordances seek to demonstrate their physical competencies and the recognitions, such as likes, gained from others are suggestive of being accepted by sports peers. For some, the virtual profile created within the motivational IS "tells you whether someone is serious or not" (Barratt 2017). As persons with social and affiliation motives to exercise are more likely to engage with social interaction affordances (James et al. 2019a), we assume that performance-oriented users' relatedness satisfaction excels from enactment of social interaction affordances.

For mastery-oriented users, in contrast, we do not expect additional gains in relatedness need satisfaction. Whereas we assume that performance-oriented users' relatedness need satisfaction excels due to their prior deficits in social belongingness, persons are more likely to adopt a mastery goal when their relatedness needs have been previously satisfied (Anderman and Anderman 1999; Janke et al. 2015). That is, adoption of mastery goals is less caused by relationship or other social goals but rather by skill development and improvement related motives (Anderman and Anderman 1999; White and Duda 1994). Since mastery-oriented persons' relatedness need should be hence already satisfied, the social interaction affordances' impacts on relatedness need satisfaction should remain neutral.

> ***H9(a/b):*** *The relationship between social affordance enactment and relatedness need satisfaction is moderated by users' goal orientations so that the relationship is* ***a)*** *stronger for users high in a performance goal orientation but* ***b)*** *neutral for users high in a mastery goal orientation.*

3.5 Controls

To control the relationships discussed so far, we consider a battery of potential alternative explanations for the net benefits gained as reported in prior motivation and motivational IS literature. Precisely, we control for demographic variables, including age (Kappen et al. 2017; Matallaoui et al. 2017) and gender (Bol et al. 2018; Koivisto and Hamari 2014). We further control for physical activity variables, including exercise self-efficacy (Wu et al. 2015) and levels of physical activity in terms of frequency (Zhou et al. 2017). Moreover, we control for system-relevant variables including months of using the system (Koivisto and Hamari 2014; Stragier et al. 2016), frequency and intensity of use (Burton-Jones and Straub 2006), and type of subscription (free vs. premium). Lastly, we control for social network-relevant variables including the number of users followed and followed by, network exposure (Hamari and Koivisto 2015; Zhou et al. 2017), and comparative evaluation (Blanton et al. 1999).

4 RESEARCH METHOD

4.1 Research Case: Strava

The developed model and hypotheses are tested with users of the popular physical activity tracking application named Strava. Strava (www.strava.com) was launched in 2009 and is available as web-based and mobile application. At the end of 2018, Strava reports a 36 million active userbase across 195 countries and a total of two billion uploaded activities with one million new users joining every 30 days and 15 million activities uploaded each week[19]. Strava offers the focal motivational affordances (self-quantification, exercise control, social) in its free version so that Strava users and hence participants can readily report their associated experiences and perceptions. Moreover, we opted for Strava as focal case as user stories indicate varying motivational impacts (see e.g., Barratt 2017; Smith 2017; Smith and Treem 2016).

Strava users can record and store their physical activity data with the mobile Strava application or synchronize their data from designated devices such as wearable fitness trackers or bicycle computers. These activity recordings usually entail their GPS-based route, time, heart rate, and additional activity metrics which users can utilize for self-monitoring purposes and for detailed performance analyses. For instance, Strava automatically compares the recorded metrics for identical activities (i.e., running the same route) visually displaying one's performance improvements. Users can also analyze their recorded metrics in detail such as by comparing heart rate by ascent or pace by mile. Exercise guidance is facilitated by Strava's training diary in which recorded activities are automatically entered providing an overview about one's activities over time. Moreover, while performing sports, users can also receive audio performance feedback from the mobile applications. Users can also take part in regular activity challenges, such as a 'May 10k' where users run ten km during the month and receive a badge as virtual reward. A particularly noteworthy feature of Strava is "segments." Segments are GPS-based

[19] Strava press release "Strava Upload Rate Surges 5X, Total Uploads Surpass 2 Billion" retrieved May, 7th 2019 from: https://blog.strava.com/press/strava-upload-rate-surges-5x-total-uploads-surpass-2-billion/

tracks, for example a steep part of a trail, created by Strava users. When a user is active on this particular segment, Strava uses this data and ranks a user's performance against others users' performance on this segment. Fastest users receive the "King of the Mountain" or "Queen of the Mountain" virtual trophy. Like in other social networks, users can also connect with other Strava users and follow their activities. Once connected, other users' activities are automatically displayed in one's newsfeed which they can comment or can give "kudos" enabling social comparisons and social recognitions.

4.2 Measurement Instrument

The measurement instrument of this study is depicted in the appendix. Whenever possible, we relied on established and content-valid measurement instruments of prior literature.

Items for the focal *affordances* were adapted from Rockmann and Gewald (2018) to the Strava context. The items were instructed by the stem *'When I use Strava, I use features that allow me …'* in order to assess enacted affordances of the Strava application (Burton-Jones and Straub 2006). Items for the *dispositional goal orientations*, mastery and performance goals, were taken from established psychology literature on Achievement Goal Theory (Conroy et al. 2003; Elliot and McGregor 2001). Respondents were instructed to think about their sports and exercises when responding to these items. To assess *basic psychological need satisfaction* in the three dimensions of autonomy, competence, relatedness, we relied on items of prior literature (Conroy et al. 2003; Elliot and McGregor 2001) and adapted them to our context by adding the stem *'When using the Strava,…'* before assessing the items. Lastly, items for our final dependent variable *perceived benefits* were developed for this study. To this end, we compiled a list of benefits associated with using a fitness app. A recent, in parallel developed study of Hassan et al. (2019), likewise developed such items and share high similarity with those developed for our study so that content validity for these items is further supported.

All items were assessed with Likert-7 type scales anchored on 'strongly disagree' to 'strongly agree' (affordances, goal orientations, and benefits) or 'very untrue' to 'very true' (psychological need satisfaction).

4.3 Sampling Strategy and Demographics

Respondents were recruited using an online panel provided by Amazon Mechanical Turk (MTurk). MTurk gained attraction as a viable and reliable source for empirical research (Jia et al. 2017) including IS research (e.g., Lowry et al. 2016) and motivational IS research in the physical activity context (e.g., James et al. 2019b; Pettinico and Milne 2017). Following recent guidelines on MTurk (Jia et al. 2017), responses were restricted to the United States as such responses provide reliable results similar to regular consumer panels (Steelman et al. 2014).

Our sampling strategy proceeded as follows. As we seek to understand the motivational impacts of using a motivational IS, only participants using Strava were allowed to take part in the survey. To filter out non-users, a screening question was incorporated asking about whether they are currently using Strava. Of the 624 persons opening the survey, 110 were accordingly directly terminated (resulting n=514). We recorded IP addresses as well as MTurk user IDs to ensure unique responses and removed 89 suspicious responses due to non-unique IP addresses and/or Worker IDs (resulting n=435). Assessment of the social affordances' impact requires that

participants are connected with other users in Strava (i.e., have 'followers'). 293 participants responded to our filter questions that they are connected with other users and 132 not which have been consequently dropped from the dataset. To further safeguarding data quality, we incorporated instructed response items as attention traps (Lowry et al. 2016) and removed those participants who have not answered correctly to at least one attention trap (James et al. 2019a; James et al. 2019b). Lastly, we dropped responses with more than five missing answers across the survey.

This final dataset (n=286) is characterized as follows: 60.4% are male and the average age is 32.4 years (SD 7.96 years). On average, participants use Strava already for 11.5 months (SD 14.1 months) and when it comes to sports, 63.3% use Strava 'often' or 'always'. Participants' number of followers in Strava is at a median of 16 followers. Asking about their general frequency of performing sports, 78.4% answered with 'several times a week' or 'almost every day'. Although official demographic data of Strava are not available, the sample's characteristics adhere to studies assessing Strava or comparable applications (Hamari et al. 2018; Higgins 2016; Stragier et al. 2018).

4.4 Preliminary Analyses

We used Structural Equation Modeling with Partial Least Squares (PLS) to analyze the data using the software SmartPLS 3.2.8 (Ringle et al. 2015).

4.4.1 Measurement Instrument

We conceptualized the three affordances (i.e. self-quantification, exercise control, social interaction) as well as 'growth need satisfaction' as higher-order constructs which are represented by the specific lower-order constructs as visualized in Figure 5 (Edwards 2001; Wright et al. 2012). Technically, these are second-order reflective, first-order reflective constructs (Hair et al. 2014). For their construction, we followed the suggested two-step approach by first obtaining the latent variable scores of the lower-order construct that are used as the manifest variables of the higher-order construct in the second step (Hair et al. 2014). Details are provided in the appendix.

Construct	CR	AVE	1	2	3	4	5	6	7	8
1 Self-quantification	0.932	0.874	0.935							
2 Exercise control	0.850	0.739	0.331	0.860						
3 Social interaction	0.918	0.848	0.307	0.674	0.921					
4 Mastery goal	0.860	0.672	0.629	0.448	0.451	0.820				
5 Performance goal	0.907	0.765	0.211	0.512	0.698	0.450	0.874			
6 Growth satis.	0.920	0.853	0.676	0.404	0.378	0.663	0.277	0.923		
7 Relatedness satis.	0.869	0.689	0.508	0.429	0.544	0.563	0.416	0.580	0.830	
8 Benefits	0.920	0.658	0.709	0.461	0.423	0.667	0.308	0.649	0.657	0.811

Table 4. Measurement model evaluation

Accordingly, we evaluated the measurement model for validity and reliability as follows (Table 4). Indicator reliability was achieved as all item loadings are greater than 0.707 (0.781–0.892) and are significant ($p<0.001$). Construct reliability was achieved as values for Composite

Reliability (CR) and for Average Variance Extracted (AVE) are above 0.7 and 0.5. Construct reliability is further supported by values for Cronbach's Alpha between 0.760 and 0.859. Discriminant validity is supported as 1) each item loads highest on its designated construct, and 2) as the Fornell-Larcker criterion is fulfilled given that the inter-variable correlations are smaller than the root of the corresponding AVE as demonstrated in the diagonal lines (Chin 1998).

4.4.2 Common Method Bias

Common method bias (CMB) can be of concern when relying on self-reported data obtained through a single method (Podsakoff et al. 2003). To mitigate the potential influence a priori, we stressed anonymity, the academic purpose of the survey, that there are no wrong or right answers, and randomized item ordering (Podsakoff et al. 2003). We performed a series of tests to observe the potential influence of CMB, in particular Harman's single factor test (Harman 1976), assessment of the correlation matrix (Pavlou et al. 2007), collinearity assessment (Kock 2017), and the Unmeasured Latent Method Construct (ULMC) technique (Liang et al. 2007; Williams et al. 2003). None of these tests gave indications that CMB is of concern (see appendix for details).

4.5 Structural Model Analysis

Given the adequateness of the measurement model's properties, we analyzed the structural model and the interaction effects for hypotheses testing. Analysis involved assessment of the coefficient of determination (R^2) as well as assessment of the path coefficients including their strengths, significance levels, and effect sizes (f^2).

Our analyses started with the model including the twelve control variables related to demographics (age, gender), physical activity (frequency of physical activity, exercise self-efficacy), system use (experience in months, frequency of use, intensity of use, subscription type), and user's social network (number of followers, number of followed others, network exposure, comparative evaluation). Because none of these control variables exerted a significant influence on the dependent variable net benefits, we removed the control variables from further analyses to keep the model parsimonious (see Appendix for full results).

We proceeded by analyzing the main effects model (i.e., without moderating effects). Results are presented in Figure 6). The three affordances explain jointly 49.8% in growth need satisfaction and social affordances additionally explain 29.6% of the variance in relatedness need satisfaction. Growth need satisfaction and relatedness need satisfaction, in consequence, explain 54.0% of the variance in net benefits reported. Moreover, all relationships are significant at least 10% level and in assumed direction so that the results support all main effect relationships hypothesized (i.e., H1a/b, H2, H4, H6, H8).

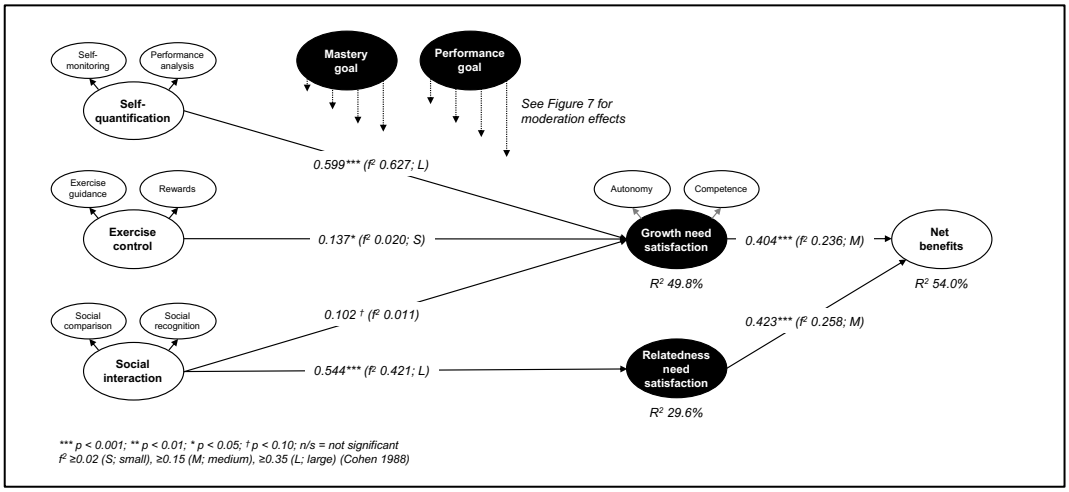

Figure 6. Structural model results

4.6 Mediation Analysis

Moreover, we performed mediation analyses to examine whether growth need satisfaction and relatedness need satisfaction mediate the impact of the affordances on net benefits. We found a partial mediating effect for self-quantification affordances and control affordances on net benefits via growth need satisfaction. For the social affordances, we found full mediation effect via growth need satisfaction and relatedness need satisfaction.

4.7 Moderation Analysis

Having analyzed and confirmed the main effects (i.e., direct relationships) of our proposed model, we investigated the assumed moderating effects of user's mastery and performance goal orientations for the relationships between the affordances and need satisfactions. To this end, we developed a series of models for each of our moderating hypotheses. Significant interactions are plotted in Figure 7 to aid interpretation (Aiken and West 1991). Detailed statistics are reported in the appendix.

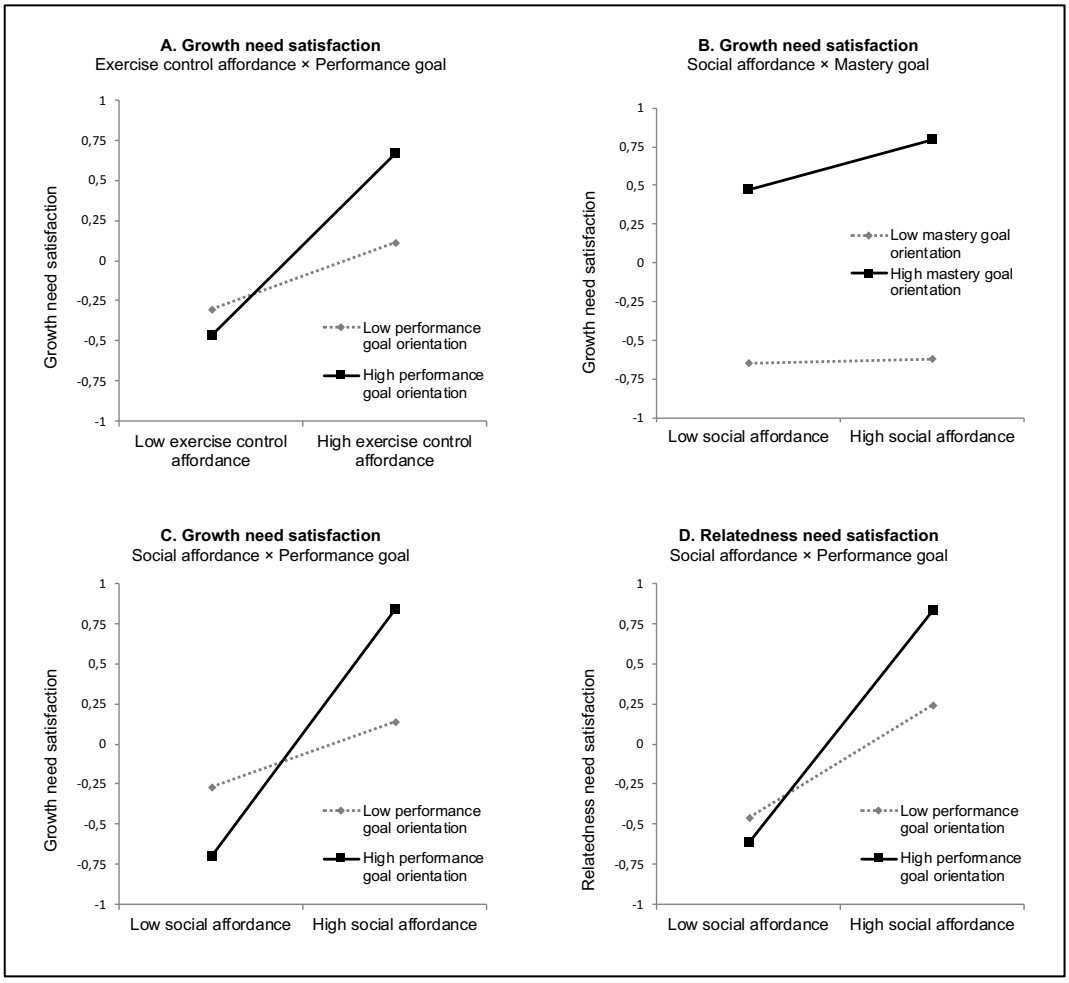

Figure 7. Moderating effects

5 DISCUSSION

This research was motivated by the lack of physical activity prevailing in many societies (WHO 2018a) and the inconclusive picture of the motivational effectiveness of motivational IS reported in the literature (Koivisto and Hamari 2019). To better understand the motivational benefits people report from using such IS, we focused on the core elements of motivational IS – the 'motivational affordances' (Zhang 2008). Two gaps in the literature were identified: the psychological processes underlying the motivational affordances' impacts and how inter-individual motivational differences account for variations in these processes. To fill these gaps, we utilized motivation-theoretical underpinnings of Self-determination Theory (Ryan and Deci 2017) and Achievement Goal Theory (Ames 1992; Nicholls 1989) to develop a research model that explains how users' motivational benefits emerge from the enacted motivational affordances. Based on an empirical study with 286 users supporting most arguments developed, this research contributes to motivational IS literature by 1) explicating the psychological processes underlying the motivational affordances and 2) interpersonal variations due to individual differences. Below, we outline our specific contributions.

5.1 Contributions to Research and Theory

Prior literature concerned with the motivational outcomes of motivational IS sometimes reported conflicting results reporting positive, neutral, or even adverse effects. Scholars frequently pointed at an inhibited understanding of the motivational IS due to 1) lacking focus on the particular affordances, 2) underlying motivational mechanisms, and 3) role of individual, motivational differences. This paper took upon these gaps and derives according contributions to research and theory (Figure 8) that we discuss in the following lines.

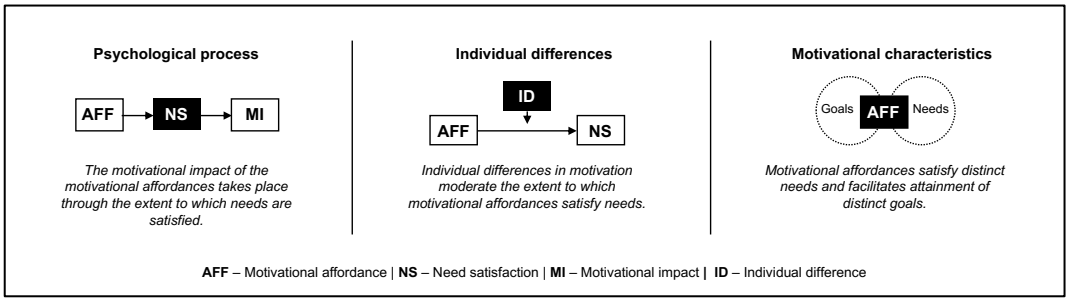

Figure 8. Research contributions

5.1.1 Psychological Processes Underlying Motivational Affordances

Previous research investigating the impacts of motivational affordances analyzed different consequences such as subjective well-being (James et al. 2019a; James et al. 2019b), perceived benefits (Hassan et al. 2019), or continued use (Hassan et al. 2019; Suh 2018). In consequence, however, literature draws different, sometimes even opposing conclusions about the motivational impacts for each affordance. Self-quantification affordances, for example, were found to be related to subjective well-being in one study (James et al. 2019b) but unrelated in another study (James et al. 2019a). As such, the underlying processes how affordances affect motivational outcomes is not well understood and scholars consequently call for analyzing the motivational processes and mechanisms through which motivational IS produce the anticipated impacts (Koivisto and Hamari 2019). Processes linking affordances with outcomes investigated in the literature so far involve the impacts on IS-related perceptions (i.e., usefulness and enjoyment beliefs) (Suh 2018) or the type of feedback (i.e., informational, social, affective) users obtain from the affordances (Hassan et al. 2019). This research, in contrast, elaborated upon a core assumption underlying motivational affordances: the support of users' motivational needs (Zhang 2008). Although scholars take upon this key tenet in linking motivational affordances with a particular outcome (James et al. 2019b; Suh 2018), there is scarce empirical evidence how these affordance actually support motivational needs (Xi and Hamari 2019).

As discussed, this paper theorizes distinct linkages between the individual affordances and the specific needs for autonomy, competence, and relatedness. Depending on the extent to which these three needs are satisfied, users realize higher motivational benefits from their fitness tracking technology use, as represented by reported enhancements in physical activity motivation and behavior. Moreover, when considering basic psychological need satisfaction as the antecedent, a multitude of alternative explanations (e.g., demographics, exercise self-efficacy, activity levels, usage experience) have no significant effect on these actualized motivational benefits; this, in turn, strengthens the finding that psychological need satisfaction is a core motivational mechanism promoting the benefits. With these results, this dissertation

responds to the call to identify the underlying psychological processes with which these affordances exert motivational impacts (Koivisto and Hamari 2019).

In consequence, we posit that any neglect of such underlying processes might result in otherwise inconclusive associations between particular motivational affordances and outcomes. Incorporation of the need satisfaction process, on the other hand, brings researchers into the position to link the motivational affordances with a brought variety of motivational outcomes. Our contention is grounded in the key tenets of SDT and the vast amount of empirical evidence that has shown how satisfaction of these three needs mediates the motivational impact of the social environment and hence accounts for a broad variety of motivational outcomes at different levels (Ryan and Deci 2017)

5.1.2 Moderating Role of Inter-Individual Motivational Differences

Besides the psychological processes underlying the motivational impacts of the motivational affordances, we also explain and provide evidence that the motivational effectiveness is contingent upon inter-individual motivational differences. Whilst it is well-known that persons are individually motivated, pursuing their behaviors for different reasons and for different goals, prior research often neglected the role of inter-individual motivational differences when studying various phenomena related to motivational IS. Scholars consequently called for considerations of the individual differences. The few studies incorporating this personal aspect examined how individual differences in motivations and goals result in enactment of particular motivational affordances (James et al. 2019a; Stragier et al. 2018) or in varying importance users assign to these affordances (Hamari et al. 2018). Less well understood is, however, whether –and if so how and why– such inter-individual differences influence the motivational impacts of the motivational affordances (despite a first indication in James et al. 2019b). This missing understanding might be an additional cause of the inconclusive results about the motivational IS reported in prior literature. Hence, a gap in research concerning the inter-individual differences in the affordance-outcome relationships was identified which limits our understanding as to whether certain affordances provide more or less motivational benefits for certain users.

Our research contributes with a theoretical explanation of how motivational goals of the users moderate the relationship between enacted affordances and need satisfaction. Because users are differently motivated and differ in the goals pursued (e.g., mastery and performance), not all motivational affordances have the same motivational impact for every user. Rather, each motivational affordance supports the attainment of particular goal and users enacting those motivational affordances that correspond with their goal, the likelihood of goal attainment increases and optimal motivational outcomes emerge. This theoretical approach essentially follows a 'person-situation interaction' logic (Diener et al. 1984) that responds to the call of Nacke and Deterding (2017).

We extend motivational IS research on the role of individual differences. Whereas prior research found that individual differences in motivations and goals influence the perception and enactment of motivational affordances (Hamari et al. 2018; James et al. 2019a; Stragier et al. 2018), our research differs as that it reveals that the motivational impacts of the enacted motivational affordances are also vary because of these inter-individual differences. Whilst our first contributions added to knowledge concerning the underlying psychological processes, our second contributions further enhances this knowledge by explaining and revealing inter-individual differences.

5.1.3 Motivational Characteristics of the Motivational Affordances

The theoretical concept of motivational affordances (Zhang 2008) is at the core of motivational IS. As discussed, however, the motivational effectiveness of motivational affordances is not well understood (Hamari et al. 2014a; Hamari et al. 2014b; Koivisto and Hamari 2019). Analyzing the motivational impacts of the motivational affordances inherently requires an understanding about the motivational nature of the motivational affordances. The literature on motivational IS posits that motivational affordances center on supporting "one's motivational needs" (Zhang 2008, p. 145). However, an identification of the motivational need supported by motivational affordances is missing so far.

This research conceptually identifies the needs and goals each motivational affordance targets (see Table 3) and provides supporting empirical evidence. Motivation literature, in particular SDT, posits that optimal motivational outcomes emerge to the extent a person's need for autonomy, competence, and relatedness are satisfied. Following this, we mapped each motivational affordance against the need for autonomy and competence (growth needs) as well as relatedness and empirically validated these specific associations. In similar vein, we also identified the goals each motivational affordance is most likely to facilitate. To this end, we used two goals that are established in the motivational literature, namely mastery goals (competence development) and performance goals (competence demonstration) (Ames 1992; Nicholls 1989). Using this distinction, we mapped each motivational affordance accordingly. The empirical study illustrates both the theoretical and empirical utility of the two goal dimensions. In consequence, scholars are now better equipped with a deeper understanding about the motivational characteristics of the motivational affordances, in particular the needs they most likely satisfy and the goals they most likely facilitate. Thereby, further research can make according predictions and arguments revolving the motivational affordances.

5.2 Implications for Practice

Designing effective motivational IS demands sufficient awareness and incorporation of motivational psychology (Koivisto and Hamari 2019). The results of this paper provide implications for providers and users to achieve the anticipated benefits of fitness tracking technology use.

Vendors of fitness tracking technology face intense competition in the market and hence need to possess a distinct understanding of the motivational effects of the incorporated motivation affordances and about their target group to develop fitness tracking technology that fulfills its expectations. Because individuals have different physical activity goals, they require individualized 'motivational environments' that fit their exercise-relevant goals. This paper provides the patterns between the users' goals, corresponding affordances and resulting motivational effects which facilitates the understanding of distinct user-profiles and assists in the development and invention of motivational affordances. The results also suggest that these affordances might be dynamically adjusted according to the goal orientations of the users to provide optimal motivational environments. For instance, for users with a strong performance goal orientation, those features should be brought to the fore, which provide means to compare and compete with others. Thereby, vendors need to consider the motivational processes underlying feature use so that features should be designed in such a way that they satisfy the psychological needs for autonomy, competence, and relatedness. The developed mapping above provides guidance for vendors on how to target each psychological need.

For users, this paper suggest that users can create their individual motivating environment by selecting and engaging with those affordances that best fit their personal goals. Although results suggest that using the self-monitoring affordances is motivating and beneficial for all users, exercise controlling features, such as virtual rewards, and social interaction features are particularly motivating for users with a strong performance goal orientation.

5.3 Limitations and Further Research

As with any empirical studies, we need to acknowledge certain limitations in our study that, however, provide fruitful avenues for further research.

Adverse effects of motivational information systems. In this paper, we applied a positive view on fitness tracking technology. That is, we sought to understand how the motivational affordances promote increased motivation and physical activity (i.e., perceived benefits) via satisfaction of the three basic psychological needs – autonomy, competence, and relatedness. However, anecdotal user stories and scholars provide indications about potentially adverse motivational effects, including demotivation, overuse, cheating, or peer pressure (Barratt 2017; Schmidt-Kraepelin et al. 2019). To this end, SDT points also at need thwarting (Ryan and Deci 2017) which could be readily integrated into the theoretical approach and model developed here.

Additional motivational outcomes. In similar vein, our study focused on one specific outcome of fitness use, namely increased motivation and physical activity (i.e. net benefits). However, there are additional outcomes that need to be studied, including well-being outcomes like subjective vitality as recently studied in the fitness app context (James et al. 2019a; James et al. 2019b). However, BPNT suggests that need satisfaction mediates important motivation outcome variables. Adhering to this line of thought, we believe that these outcomes can be readily integrated into the theoretical approach and model developed here.

Additional motivation-relevant individual differences. In this paper, we paid attention to fitness app users' achievement goal orientations. We focused on two dimensions: mastery and performance goals. Recent advancements in AGT tend to suggest a further distinction between an approach and avoidance dimensions resulting in an 2x2 achievement goal framework. Following this distinction, we applied an approach dimension of these goals. An avoidance perspective could yield additional insights. Moreover, given our theoretical frame of AGT, we also need to acknowledge other potential goals and motives fitness app users follow which could yield additional insights such as goal specifity as applied by Hamari et al. (2018) or the self-determination continuum as applied by James et al. (2019b).

Additional user differences and zoom-in. Our study provides an overview on the relationships between affordances, individual differences, psychological mediators and outcomes. However, our theoretical approach neglects further important details such as network structures and size, etc.

In addition, different stages of usage experience; affordance usage, need satisfaction, and outcomes may vary in their influence based on the physical activity experience (i.e. athletes vs. beginners), or fitness app system experience (Stragier et al. 2016).

Different demographical user groups and contexts. Our methodological approach is narrowed to the single research context of fitness apps and Strava in particular. As outlined in the sample characteristics, the data consists of quite active fitness app users and physically active individuals aged around 30 years. Children and older adults may differ in their fitness app use.

Long-term assessment, changes in affordance use and goal pursuit. In this paper, we applied a cross-sectional survey. Several scholars call for long-term investigations to better understand the effectiveness of motivational systems (Stepanovic and Mettler 2018). This raises the interesting question how individuals adapt themselves to the motivational affordances. On the one hand, fitness app users may adjust their affordance selection and use over time. On the other hand, fitness app users may adopt a different goal orientation. In this study, we considered achievement goal orientations as dispositional tendencies of the individual. Yet achievement goal orientations can also be situational and be influenced by the goal structure in which one engages. Hence, further research can investigate how users adapt their affordance sets and/or their goal orientations and how these adaptations in turn shape variations in motivational outcomes gained.

APPENDIX

Measurement Instrument

The measurement instrument of this study is depicted below. Whenever possible, we relied on established and content-valid measurement instruments of prior literature.

Items for the focal *affordances* were adapted from Rockmann and Gewald (2018) to the Strava context. The items were instructed by the stem *'When I use Strava, I use features that allow me …'* in order to assess enacted affordances of the Strava application (Burton-Jones and Straub 2006). Items for the *dispositional goal orientations*, mastery and performance goals, were taken from established psychology literature on Achievement Goal Theory (Conroy et al. 2003; Elliot and McGregor 2001). Respondents were instructed to think about their sports and exercises when responding to these items. To assess *basic psychological need satisfaction* in the three dimensions of autonomy, competence, relatedness, we relied on items of prior literature (Conroy et al. 2003; Elliot and McGregor 2001) and adapted them to our context by adding the stem *'When using the Strava,…'* before assessing the items. Lastly, items for our final dependent variable *perceived benefits* were developed for this study. To this end, we compiled a list of benefits associated with using a fitness app. A recent, in parallel developed study of Hassan et al. (2019), likewise developed such items and share high similarity with those developed for our study so that content validity for these items is further supported.

All items were assessed with Likert-7 type scales anchored on 'strongly disagree' to 'strongly agree' (affordances, goal orientations, and benefits) or 'very untrue' to 'very true' (psychological need satisfaction)

Construct	Item		Source
Affordances		*When I use Strava, I use features that allow me …*	
Self-monitoring	SM1	… to monitor my sport behavior.	(Rockmann and Gewald 2018)
	SM2	… to document information about my sport activities.	
	SM3	… to keep track of my exercise activities.	
	SM4	… to record my physical activities.	
Performance analysis	PA1	… to run statistics on my trainings.	
	PA2	… to examine performance metrics in detail.	
	PA3	… to perform statistical analysis of performance metrics.	
	PA4	… to statistically analyze my sport performance indicators.	
Exercise guidance	EG1	… to get guidance how to better perform physical exercises.	
	EG2	… to get taught how to improve my physical activity.	
	EG3	… to receive instructions while doing physical activity.	
	EG4	… to get supervised to reach my physical activity goals.	
Rewards	RW1	… to make my physical activity rewarded.	
	RW2	… to get more rewards if I try harder.	
	RW3	… to obtain virtual rewards (badges, trophies) for my physical activity.	
	RW4	… to earn virtual rewards as a token for my efforts in physical activity.	

Social comparison	SC1	… to compare my performance with the performance of others.	
	SC2	… to compare myself with others regarding what I have accomplished in exercising.	
	SC3	… to find out how I am doing in exercise compared to what others have done.	
	SC4	… to compete with others.	
Social recognition	SR1	… to earn compliments from others for my physical activity.	
	SR2	… to earn respect of others for my physical activity.	
	SR3	… to get recognized from others for my sport behavior.	
	SR4	… to get noticed by others for my physical activity.	
Goal orientations			
Mastery goal orientation	MG1	It is important to me to perform as well as I possibly can.	(Conroy et al. 2003; Elliot and McGregor 2001)
	MG2	I prefer challenging goals so that I'll improve a great deal.	
	MG3	I'm willing to take on a difficult challenge if it helps me reach my goals.	
Performance goal orientation	PG1	It is important for me to perform better than others.	
	PG2	It is important to me to do well compared to others.	
	PG3	To be honest, I really like to prove my abilities to others.	
Psychological needs		*When using Strava, …*	
Autonomy satisfaction	AUT1	I feel free to choose how I do my physical activities.	(Chen et al. 2015; Gunnell et al. 2013)
	AUT2	I feel free to make my own decisions for the way I'm doing sports.	
	AUT3	I feel like I am the one who decides what physical activities I do.	
Competence satisfaction	COM1	I feel confident that I can do sports well.	
	COM2	I feel capable at what I do.	
	COM3	I feel competent to achieve my exercise goals.	
Relatedness satisfaction	REL1	I feel connected to the people who I interact with.	
	REL2	I feel I share a common bond with other users.	
	REL3	I feel a sense of camaraderie with other users I'm connected with.	
Motivational outcomes			
Perceived benefits	BEN1	Using Strava has helped me being physically active.	Self-developed
	BEN2	I gained motivation to exercise from using Strava.	
	BEN3	Using Strava has helped me to achieve my goals.	
	BEN4	Strava has helped me to improve my sports performance.	
	BEN5	Using Strava makes my sport more enjoyable.	
	BEN6	In sum, Strava is of benefit for my sports.	

Table 5. Measurement instrument

Hierarchical Component Models

In line with James et al. (2019a; 2019b), we applied hierarchical component models (HCM; also called 'higher-order constructs') for the classes of motivational affordances enacted. In general,

HCM are constructs at a higher level of abstraction where a multidimensional 'higher-order' (also termed 'second-order') construct is developed consisting of 'lower-order' (also termed 'first-order') constructs (Hair et al. 2014). For instance, the construct 'self-quantification affordances' is a higher-order construct consisting of 'self-monitoring' and 'performance analysis' lower-order constructs. Application of HCM allows to enhance model parsimony as the number of variables and relationships are reduced but also prevents collinearity and discriminant validity issues when the constructs are otherwise highly correlated (Hair et al. 2014). The same arguments apply to the higher-order construct 'growth need satisfaction' consisting of the lower-order constructs 'autonomy need satisfaction' and 'competence need satisfaction' as also argued by motivation literature (Hagger et al. 2006; Ntoumanis 2005; Standage et al. 2005).

Operationally, we followed the procedure described in Hair et al. (2014) to develop the according hierarchical component models. We followed the 'reflective-reflective' type of HCM as the corresponding lower-order constructs are all conceptualized with reflective measurements and because the corresponding lower-order constructs are highly correlated, the higher-order constructs are also measured with a reflective model (Hair et al. 2014). Operational development of HCM proceeds in two steps (Hair et al. 2014).

The first step is the extraction of the latent variables scores for the lower-order constructs (e.g., 'self-monitoring' and 'performance analysis') which afterwards serve as the indicators for the higher-order construct (e.g., 'self-quantification affordance). Hereto, the lower-order constructs are developed as usual and an additional higher-order construct is created to which *all* indicators of the underlying lower-order constructs are jointly assigned (i.e., repeated indicators approach).

In the second step, the higher-order construct is modeled within the structural model and utilizes the just extracted latent variables scores as its indicators (Hair et al. 2014). These higher-order constructs are then evaluated like regular constructs meaning that construct reliability and validity must be ensured. According validation is described in the main article.

Common Method Bias Evaluation

Common method bias (CMB) can be of concern when relying on self-reported data, particularly when data for dependent and independent variables are obtained from the same source, from the same context, and/or using the same method (Podsakoff et al. 2003). Despite having incorporated several means to mitigate the influence of CMB during data collection, we performed a series of analyses to observe the influence of CMB in the data as presented in the following. These analyses were conducted using the manifest variables of all first-order latent variables.

Harman's single factor test. First, we ran Harman's single factor test (Harman 1976). In this test, all items of the model are entered into an exploratory factor analysis and the unrotated factor solution is analyzed. According to this test, a substantial amount of CMB is present when only one factor emerges or when one general factor accounts for the majority of the variance (Podsakoff et al. 2003). In our case, this test revealed a non-single factor structure and only 11.99% of the variance is explained by a single factor which is not the majority. Despite its widespread application in the literature, however, the suitability of Harman's single factor to reliably detect the presence of CMB has been strongly contested (Aguirre-Urreta and Hu 2019; Schwarz et al. 2017).

Correlation of latent variables. Second, we examined the correlation matrix as proposed by Pavlou et al. (2007). According to this test, extremely high correlations ($r > 0.9$) are an indicator of CMB. In our data, we did not observe such high correlations as the highest correlation is 0.743. Moreover, this correlation appeared for 'self-monitoring' and 'performance analysis' construct which serve as lower-order dimensions of the higher-order 'self-quantification affordance'.

Collinearity assessment. Third, we performed a *collinearity assessment* as suggested by Kock (2017). In this test, the variance inflation factors (VIF) for all latent variables are observed. VIF values above 3.3 would be an indication of CMB. In our data, such high values are not the case.

Unmeasured Latent Method Construct (ULMC) technique. Fourth, we applied the ULMC technique (Williams et al. 2003) in PLS as per Liang et al. (2007). This test involves the creation of a latent variable that represents a "method effect" and which is entered into the structural model (Liang et al. 2007; Richardson et al. 2009; Schwarz et al. 2017; Williams et al. 2003). This method effect construct consists of all indicators (i.e., assessed items) of the study (Schwarz et al. 2017). Moreover, all indicators are additionally transformed into single-item constructs. Then, the respective influence of the theoretical construct is compared to the influence of the method effect factor. In our data, the resulting ratio of 1:403 is much smaller compared to prior research (e.g., 1:42 in Liang et al. 2007).

In sum, the results of the tests performed do not indicate that CMB is of great concern in our data.

Structural Model Results Including Control Variables

Path	Path coefficient	T-value	Effect size	Support
Growth need satisfaction (R^2 49.8% / R^2 adjusted 49.3%)				
Quantified-self affordance → Growth need satisfaction	0.599	10.940***	0.627 (large)	**Yes**
Exercise control affordance → Growth need satisfaction	0.137	1.985*	0.020 (small)	**Yes**
Social affordance → Growth need satisfaction	0.102	1.800†	0.011	**Yes**
Relatedness need satisfaction (R^2 29.6% / R^2 adjusted 29.4%)				
Social affordance → Relatedness need satisfaction	0.544	11.597***	0.421 (large)	**Yes**
Net benefits (R^2 56.5% / R^2 adjusted 54.2%)				
Growth need satisfaction → Net benefits	0.366	5.691***	0.174 (medium)	**Yes**
Relatedness need satisfaction → Net benefits	0.417	5.853***	0.204 (medium)	**Yes**
Controls:				
Age → Net benefits	0.018	0.516 (n/s)	–	No
Gender → Net benefits	-0.041	1.013 (n/s)	–	No
Sports frequency → Net benefits	-0.019	0.433 (n/s)	–	No
Exercise self-efficacy → Net benefits	0.060	1.026 (n/s)	–	No
Subscription type (free, premium, n/a) → Net benefits	0.000	0.009 (n/s)	–	No
Frequency of use → Net benefits	0.086	1.282 (n/s)	–	No
Intensity of use → Net benefits	-0.010	0.170 (n/s)	–	No

System experience in months → Net benefits	0.078	1.419 (n/s)	–	No
Number following → Net benefits	0.053	0.538 (n/s)	–	No
Number followers → Net benefits	0.033	0.397 (n/s)	–	No
Network exposure → Net benefits	-0.044	0.706 (n/s)	–	No
Comparative evaluation → Net benefits	0.007	0.140 (n/s)	–	No
*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.10; n/s = not significant f^2 ≥0.02 (S; small), ≥0.15 (M; medium), ≥0.35 (L; large) (Cohen 1988)				

Table 6. Full model results including control variables

Moderation Analyses

Because moderation effects are usually small, a conservative interpretation for f2 is 0.005 ('small'), 0.01 ('medium'), and 0.025 ('large') (Kenny 2015). Results are depicted below.

	Model	Path	Effect size	Support
H3a	**Quantified-self affordance × Mastery goal → Growth need satisfaction**			
	Quantified-self affordance → Growth need satisfaction	0.436***	0.242 (medium)	
	Mastery goal → Growth need satisfaction	0.394***	0.209 (medium)	
	Quantified-self affordance × Mastery goal → Growth need satisfaction	0.024 (n/s)	–	No
H3b	**Quantified-self affordance × Performance goal → Growth need satisfaction**			
	Quantified-self affordance → Growth need satisfaction	0.650***	0.747 (large)	
	Performance goal → Growth need satisfaction	0.129**	0.209 (small)	
	Quantified-self affordance × Performance goal → Growth need satisfaction	0.031 (n/s)	–	No
H5a	**Exercise control affordance × Mastery goal → Growth need satisfaction**			
	Exercise control affordance → Growth need satisfaction	0.130*	0.536 (large)	
	Mastery goal → Growth need satisfaction	0.609***	0.025 (small)	
	Exercise control affordance × Mastery goal → Growth need satisfaction	0.027 (n/s)	–	No
H5b	**Exercise control affordance × Performance goal → Growth need satisfaction**			
	Exercise control affordance → Growth need satisfaction	0.386***	0.139 (small)	
	Performance goal → Growth need satisfaction	0.099 (n/s)	–	
	Exercise control affordance × Performance goal → Growth need satisfaction	0.178***	0.065 (large)	**Yes**
H7a	**Social affordance × Mastery goal → Growth need satisfaction**			
	Social affordance → Growth need satisfaction	0.088 †	0.011	
	Mastery goal → Growth need satisfaction	0.636***	0.560 (large)	
	Social affordance × Mastery goal → Growth need satisfaction	0.073 †	0.012 (medium)	**Yes**
H7b	**Social affordance × Performance goal → Growth need satisfaction**			
	Social affordance → Growth need satisfaction	0.448***	0.141 (small)	
	Performance goal → Growth need satisfaction	0.067 (n/s)	–	
	Social affordance × Performance goal → Growth need satisfaction	0.284***	0.170 (large)	**Yes**
H9a	**Social affordance × Mastery goal → Relatedness need satisfaction**			

	Social affordance → Relatedness need satisfaction	0.358***	0.173 (medium)	
	Mastery goal → Relatedness need satisfaction	0.408***	0.222 (medium)	
	Social affordance × Mastery goal → Relatedness need satisfaction	0.026 (n/s)	–	No
H9b	**Social affordance × Mastery goal → Relatedness need satisfaction**			
	Social affordance → Relatedness need satisfaction	0.538***	0.224 (medium)	
	Performance goal → Relatedness need satisfaction	0.107 (n/s)	–	
	Social affordance × Performance goal → Relatedness need satisfaction	0.185***	0.080 (large)	**Yes**
*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.10; n/s = not significant Direct f^2 ≥0.02 (S; small), ≥0.15 (M; medium), ≥0.35 (L; large) (Cohen 1988) Moderation f^2 ≥0.005 (S; small), ≥0.01 (M; medium), ≥0.025 (L; large) (Kenny 2015)				

Table 7. Moderation Effects

REFERENCES

Aguirre-Urreta, M. I. and Hu, J. 2019. "Detecting Common Method Bias: Performance of the Harman's Single-Factor Test." *ACM SIGMIS Database: the DATABASE for Advances in Information Systems* (50:2), pp. 45-70.

Aiken, L. S. and West, S. G. 1991. *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.

Alahäivälä, T. and Oinas-Kukkonen, H. 2016. "Understanding persuasion contexts in health gamification: A systematic analysis of gamified health behavior change support systems literature." *International Journal of Medical Informatics* (96), pp. 62-70.

Allen, J. B. 2003. "Social Motivation in Youth Sport." *Journal of Sport and Exercise Psychology* (25:4), pp. 551-567.

Allen, J. B. and Hodge, K. 2006. "Fostering a Learning Environment: Coaches and the Motivational Climate." *nternational Journal of Sports Science & Coaching* (1:3), pp. 261-277.

Ames, C. 1984. "Achievement attributions and self-instructions under competitive and individualistic goal structures." *Journal of Educational Psychology* (76:3), pp. 478-487.

Ames, C. 1992. "Classrooms: Goals, structures, and student motivation." *Journal of Educational Psychology* (84:3), pp. 261-271.

Anderman, L. H. and Anderman, E. M. 1999. "Social Predictors of Changes in Students' Achievement Goal Orientations." *Contemporary Educational Psychology* (24:1), pp. 21-37.

Appleton, P. R., Ntoumanis, N., Quested, E., Viladrich, C., and Duda, J. L. 2016. "Initial validation of the coach-created Empowering and Disempowering Motivational Climate Questionnaire (EDMCQ-C)." *Psychology of Sport and Exercise* (22), pp. 53-65.

Babar, Y., Chan, J., and Choi, B. 2018. ""Run Forrest Run!": Measuring the Impact of App-Enabled Performance and Social Feedback on Running Performance." In: *Proceedings of the International Conference on Information Systems*, San Francisco.

Baker, R. C. and Kirschenbaum, D. S. 1993. "Self-monitoring may be necessary for successful weight control." *Behavior Therapy* (24:3), pp. 377-394.

Barratt, P. 2017. "Healthy competition: A qualitative study investigating persuasive technologies and the gamification of cycling." *Health & Place* (46), pp. 328-336.

BBC. 2018. "John Hancock adds fitness tracking to all policies." Retrieved September 21st, 2018 from https://www.bbc.com/news/technology-45590293

Best, A. 2016. “Self-Tracking: Ärzte und Versicherungen erwarten hohes Potenzial.” Retrieved April 24th, 2017 from http://www.healthrelations.de/self-tracking/

Biddle, S., Wang, C. J., Kavussanu, M., and Spray, C. 2003. “Correlates of Achievement Goal Orientations in Physical Activity: A Systematic Review of Research.” *European Journal of Sport Science* (3:5), pp. 1-20.

Blanton, H., Buunk, B. P., Gibbons, F. X., and Kuyper, H. 1999. “When Better-Than-Others Compare Upward: Choice of Comparison and Comparative Evaluation as Independent Predictors of Academic Performance.” *Journal of Personality and Social Psychology* (76:3), pp. 420-430.

Blohm, I. and Leimeister, J. M. 2013. “Design of IT-Based Enhancing Services for Motivational Support and Behavioral Change.” *Business & Information Systems Engineering* (5:4), pp. 275-278.

Bol, N., Helberger, N., and Weert, J. C. 2018. “Differences in mobile health app use: A source of new digital inequalities?” *The Information Society* (34:3), pp. 183-193.

Bortoli, L., Bertollo, M., and Robazza, C. 2009. “Dispositional goal orientations, motivational climate, and psychobiosocial states in youth sport.” *Personality and Individual Differences* (47:1), pp. 18-24.

Brunel, P. 1999. “Relationship between achievement goal orientations and perceived motivational climate on intrinsic motivation.” *Scandinavian Journal of Medicine Science in Sports* (9:6), pp. 365-374.

Burton-Jones, A. and Straub, D. W. J. 2006. “Reconceptualizing System Usage: An Approach and Empirical Test.” *Information Systems Research* (17:3), pp. 228-246.

Burton-Jones, A. and Volkoff, O. 2017. “How Can We Develop Contextualized Theories of Effective Use? A Demonstration in the Context of Community-Care Electronic Health Records.” *Information Systems Research* (28:3), pp. 468-489.

Butler, R. 1992. “What Young People Want to Know When: Effects of Mastery and Ability Goals on Interest in Different Kinds of Social Comparisons.” *Journal of Personality and Social Psychology* (62:6), pp. 934-943.

Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., and Mouratidis, A. 2015. “Basic psychological need satisfaction, need frustration, and need strength across four cultures.” *Motivation and Emotion* (39:2), pp. 216-236.

Chin, W. W. 1998. “The Partial Least Squares Approach to Structural Equation Modeling,” in *Modern Methods for Business Research,* G.A. Marcoulides (ed.). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers, pp. 295-336.

Choe, E. K., Lee, N. B., Lee, B., Pratt, W., and Kientz, J. A. 2014. “Understanding Quantified-Selfers' Practices in Collecting and Exploring Personal Data.” In: *Proceedings of the ACM Conference on Human Factors in Computing Systems*, Toronto: ACM, pp. 1143-1152.

Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*. Mahwah, NJ: Lawrence Erlbaum.

Conroy, D. E., Elliot, A. J., and Hofer, S. M. 2003. “A 2x2 Achievement Goals Questionnaire for Sport: Evidence for Factorial Invariance, Temporal Stability, and External Validity.” *Journal of Sport and Exercise Psychology* (25:4), pp. 456-476.

Coutinho, S. A. and Neuman, G. 2008. “A model of metacognition, achievement goal orientation, learning style and self-efficacy.” *Learning Environments Research* (11:2), pp. 131-151.

Cury, F., Famose, J. P., and Sarrazin, P. 1997. “Achievement goal theory and active search for information in a sport task.” In: *Proceedings of the IX World Congress in Sport Psychology*, R. Lidor and M. Bar-Eli (eds.), Netanya, Israel, pp. 218-220.

Deci, E. L. and Ryan, R. M. 1985a. “The General Causality Orientations Scale: Self-Determination in Personality.” *Journal of Research in Personality* (19:2), pp. 109-134.

Deci, E. L. and Ryan, R. M. 1985b. *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum Press.

Deci, E. L. and Ryan, R. M. 1987. "The Support of Autonomy and the Control of Behavior." *Journal of Personality and Social Psychology* (53:6), pp. 1024-1037.

Deci, E. L. and Ryan, R. M. 2000. "The "what" and" why" of goal pursuits: Human needs and the self-determination of behavior." *Psychological Inquiry* (11:4), pp. 227-268.

Deci, E. L. and Ryan, R. M. 2012. "Motivation, Personality, and Development Within Embedded Social Contexts: An Overview of Self-Determination Theory," in *The Oxford Handbook of Human Motivation,* R.M. Ryan (ed.). New York: Oxford University Press, pp. 85-107.

Deterding, S., Dixon, D., Khaled, R., and Nacke, L. 2011. "From Game Design Elements to Gamefulness: Defining "Gamification"." In: *Proceedings of the International Academic MindTrek Conference*: ACM, pp. 9-15.

Diefenbach, S. 2018. "Positive Computing – a powerful partnership between positive psychology and interactive technology. A discussion of potential and challenges." *Journal of Positive Psychology and Wellbeing* (2:1), pp. 1-22.

Diener, E., Larsen, R. J., and Emmons, R. A. 1984. "Person × Situation Interactions: Choice of Situations and Congruence Response Models." *Journal of Personality and Social Psychology* (47:3), pp. 580-592.

Duda, J. L. 2013. "The conceptual and empirical foundations of Empowering Coaching™: Setting the stage for the PAPA project." *International Journal of Sport and Exercise Psychology* (11:4), pp. 311-318.

Duda, J. L. and Appleton, P. R. 2016. "Empowering and Disempowering Coaching Climates: Conceptualization, Measurement Considerations, and Intervention Implications," in *Sport and Exercise Psychology Research,* M. Raab, P. Wylleman, R. Seiler, A.-M. Elbe and A. Hatzigeorgiadis (eds.). San Diego: Academic Press, pp. 373-388.

Duda, J. L. and Ntoumanis, N. 2003. "Correlates of achievement goal orientations in physical education." *International Journal of Educational Research* (39:4-5), pp. 415-436.

Dweck, C. S. and Leggett, E. L. 1988. "A Social-Cognitive Approach to Motivation and Personality." *Psychological Review* (95:2), pp. 256-273.

Edwards, J. R. 2001. "Multidimensional Constructs in Organizational Behavior Research: An Integrative Analytical Framework." *Organizational Research Methods* (4:2), pp. 144-192.

Elliot, A. J. and McGregor, H. A. 2001. "A 2×2 Achievement Goal Framework." *Journal of Personality and Social Psychology* (80:3), pp. 501-519.

Elliot, A. J., McGregor, H. A., and Gable, S. 1999. "Achievement goals, study strategies, and exam performance: A mediational analysis." *Journal of Educational Psychology* (91:3), pp. 549-563.

Emmons, R. A., Diener, E., and Larsen, R. J. 1986. "Choice and Avoidance of Everyday Situations and Affect Congruence: Two Models of Reciprocal Interactionism." *Journal of Personality and Social Psychology* (51:4), pp. 815-826.

Festinger, L. 1954. "A theory of social comparison processes." *Human Relations* (7:2), pp. 117-140.

Fogg, B. 2003. *Persuasive Technology: Using Computers to Change What We Think and Do*. San Francisco, CA: Morgan Kaufmann.

Gibson, J. J. 1977. "The Theory of Affordances," in *Perceiving, Acting, and Knowing,* R.E. Shaw and J. Bransford (eds.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Giddens, L., Leidner, D., and Gonzalez, E. 2017. "The Role of Fitbits in Corporate Wellness Programs: Does Step Count Matter?" In: *Proceedings of the Hawaii International Conference on System Sciences*.

Gimpel, H., Nißen, M., and Görlitz, R. 2013. "Quantifying the Quantified Self: A Study on the Motivation of Patients to Track Their Own Health." In: *Proceedings of the International Conference on Information Systems*, Milan, Italy.

Gunnell, K. E., Crocker, P. R., Wilson, P. M., Mack, D. E., and Zumbo, B. D. 2013. "Psychological need satisfaction and thwarting: A test of basic psychological needs theory in physical activity contexts." *Psychology of Sport and Exercise* (14:5), pp. 599-607.

Guthold, R., Stevens, G. A., Riley, L. M., and Bull, F. C. 2018. "Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants." *The Lancet Global Health* (6:10), pp. e1077-e1086.

Hagger, M. S., Chatzisarantis, N. L., and Harris, J. 2006. "From Psychological Need Satisfaction to Intentional Behavior: Testing a Motivational Sequence in Two Behavioral Contexts." *Personality and Social Psychology Bulletin* (32:2), pp. 131-148.

Hair, J. F. J., Hult, G. T. M., Ringle, C., and Sarstedt, M. 2014. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Sage Publications.

Hamari, J., Hassan, L., and Dias, A. 2018. "Gamification, quantified-self or social networking? Matching users' goals with motivational technology." *User Modeling and User-Adapted Interaction* (28:1), pp. 35-74.

Hamari, J. and Koivisto, J. 2013. "Social Motivations To Use Gamification: An Empirical Study Of Gamifying Exercise." In: *Proceedings of the European Conference on Information Systems*, Utrecht.

Hamari, J. and Koivisto, J. 2015. ""Working out for likes": An empirical study on social influence in exercise gamification." *Computers in Human Behavior* (50), pp. 333-347.

Hamari, J., Koivisto, J., and Pakkanen, T. 2014a. "Do Persuasive Technologies Persuade? - A Review of Empirical Studies." In: *Proceedings of the International Conference on Persuasive Technology*, pp. 118-136.

Hamari, J., Koivisto, J., and Sarsa, H. 2014b. "Does Gamification Work? — A Literature Review of Empirical Studies on Gamification." In: *Proceedings of the Hawaii International Conference on System Sciences*.

Harackiewicz, J. M., Barron, K. E., Carter, S. M., Lehto, A. T., and Elliot, A. J. 1997. "Predictors and Consequences of Achievement Goals in the College Classroom: Maintaining Interest and Making the Grade." *Journal of Personality and Social psychology* (73:6), pp. 1284-1295.

Harackiewicz, J. M. and Elliot, A. J. 1993. "Achievement Goals and Intrinsic Motivation." *Journal of Personality and Social Psychology* (65:5), pp. 904-915.

Harman, H. H. 1976. *Modern Factor Analysis*. Chicago: University of Chicago Press.

Hassan, L., Dias, A., and Hamari, J. 2019. "How motivational feedback increases user's benefits and continued use: A study on gamification, quantified-self and social networking." *International Journal of Information Management* (46), pp. 151-162.

Higgins, J. P. 2016. "Smartphone Applications for Patients' Health and Fitness." *The American Journal of Medicine* (129:1), pp. 11-19.

Hodge, K. and Gucciardi, D. F. 2015. "Antisocial and prosocial behavior in sport: The role of motivational climate, basic psychological needs, and moral disengagement." *Journal of Sport and Exercise Psychology* (37:3), pp. 257-273.

Ickes, W., Snyder, M., and Garcia, S. 1997. "Personality Influences on the Choice of Situations," in *Handbook of Personality Psychology,* R. Hogan, J. Johnson and S. Briggs (eds.). San Diego: Academic Press, pp. 165-195.

Jagacinski, C. M., Madden, J. L., and Reider, M. H. 2001. "The Impact of Situational and Dispositional Achievement Goals on Performance." *Human Performance* (14:4), pp. 321-337.

James, T. L., Deane, J. K., and Wallace, L. 2019a. "An application of goal content theory to examine how desired exercise outcomes impact fitness technology feature set selection." *Information Systems Journal* (29:5), pp. 1010-1039.

James, T. L., Wallace, L., and Deane, J. K. 2019b. "Using Organismic Integration Theory to Explore the Associations Between Users' Exercise Motivations and Fitness Technology Feature Set Use." *MIS Quarterly* (43:1), pp. 287-312.

Janke, S., Nitsche, S., and Dickhäuser, O. 2015. "The role of perceived need satisfaction at work for teachers' work-related learning goal orientation." *Teaching and Teacher Education* (47), pp. 184-194.

Jia, R., Steelman, Z. R., and Reich, B. H. 2017. "Using Mechanical Turk Data in IS Research: Risks, Rewards, and Recommendations." *Communications of the Association for Information Systems* (41:1), pp. 301-318.

Jõesaar, H., Hein, V., and Hagger, M. S. 2011. "Peer influence on young athletes' need satisfaction, intrinsic motivation and persistence in sport: A 12-month prospective study." *Psychology of Sport and Exercise* (12:5), pp. 500-508.

Johnson, D., Deterding, S., Kuhn, K.-A., Staneva, A., Stoyanov, S., and Hides, L. 2016. "Gamification for health and wellbeing: A systematic review of the literature." *Internet Interventions* (6), pp. 89-106.

Kappen, D. L., Mirza-Babaei, P., and Nacke, L. E. 2017. "Gamification through the Application of Motivational Affordances for Physical Activity Technology." In: *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY 2017)*, Amsterdam, NL.

Karahanna, E., Xu, S. X., and Zhang, A. N. 2018. "The Needs–Affordances–Features Perspective for the Use of Social Media." *MIS Quarterly* (42:3), pp. 737-756.

Karapanos, E., Gouveia, R., Hassenzahl, M., and Forlizzi, J. 2016. "Wellbeing in the Making: Peoples' Experiences with Wearable Activity Trackers." *Psychology of Well-Being* (6:4), pp. 1-17.

Kenny, D. A. 2015. "Moderation." Retrieved March 20th, 2018 from http://davidakenny.net/cm/moderation.htm

Kerner, C. and Goodyear, V. A. 2017. "The motivational impact of wearable healthy lifestyle technologies: a self-determination perspective on Fitbits with adolescents." *American Journal of Health Education* (48:5), pp. 287-297.

Kock, N. 2017. "Common Method Bias: A Full Collinearity Assessment Method for PLS-SEM," in *Partial Least Squares Path Modeling: Basic Concepts, Methodological Issues and Applications,* H. Latan and R. Noonan (eds.). Cham, Switzerland: Springer, pp. 245-257.

Koivisto, J. and Hamari, J. 2014. "Demographic differences in perceived benefits from gamification." *Computers in Human Behavior* (35), pp. 179-188.

Koivisto, J. and Hamari, J. 2019. "The rise of motivational information systems: A review of gamification research." *International Journal of Information Management* (45), pp. 191-210.

Li, I., Dey, A., and Forlizzi, J. 2010. "A stage-based model of personal informatics systems." In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*: ACM, pp. 557-566.

Li, I., Dey, A. K., and Forlizzi, J. 2011. "Understanding my data, myself: supporting self-reflection with ubicomp technologies." In: *Proceedings of the International Conference on Ubiquitous Computing*, Bejing: ACM, pp. 405-415.

Liang, H., Saraf, N., Hu, Q., and Xue, Y. 2007. "Assimilation of Enterprise Systems: The Effect of Institutional Pressures and the Mediating Role of Top Management." *MIS Quarterly* (31:1), pp. 59-87.

Lin, C. P. and Bhattacherjee, A. 2010. "Extending technology usage models to interactive hedonic technologies: a theoretical model and empirical test." *Information Systems Journal* (20:2), pp. 163-181.

Linnenbrink, E. A. 2005. "The Dilemma of Performance-Approach Goals: The Use of Multiple Goal Contexts to Promote Students' Motivation and Learning." *Journal of Educational psychology* (97:2), pp. 197-213.

Linnenbrink, E. A. and Pintrich, P. R. 2001. "Multiple goals, multiple contexts: The dynamic interplay between personal goals and contextual goal stresses," in *Motivation in learning contexts: Theoretical advances and methodological implications.,* S. Volet and S. Järvelä (eds.). Elmsford, NY, US: Pergamon Press, pp. 251-269.

Lowry, P. B., Zhang, J., Wang, C., and Siponen, M. 2016. "Why Do Adults Engage in Cyberbullying on Social Media? An Integration of Online Disinhibition and Deindividuation Effects with the Social Structure and Social Learning Model." *Information Systems Research* (27:4), pp. 962-986.

Lupton, D. 2016. *The Quantified Self*. Malden, MA: Polity Press.

Markus, M. L. and Silver, M. S. 2008. "A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole's Concepts of Structural Features and Spirit." *Journal of the Association for Information Systems* (9:10/11), pp. 609-632.

Matallaoui, A., Koivisto, J., Hamari, J., and Zarnekow, R. 2017. "How effective is "exergamification"? A systematic review on the effectiveness of gamification features in exergames." In: *Proceedings of the Hawaii International Conference on System Sciences*.

Mekler, E. D., Brühlmann, F., Tuch, A. N., and Opwis, K. 2017. "Towards understanding the effects of individual gamification elements on intrinsic motivation and performance." *Computers in Human Behavior* (71), pp. 525-534.

Murayama, K. and Elliot, A. J. 2009. "The Joint Influence of Personal Achievement Goals and Classroom Goal Structures on Achievement-Relevant Outcomes." *Journal of Educational Psychology* (101:2), pp. 432–447.

Nacke, L. E. and Deterding, C. S. 2017. "The maturing of gamification research." *Computers in Human Behavior* (71), pp. 450-454.

Newton, M. and Duda, J. L. 1999. "The interaction of motivational climate, dispositional goal orientations, and perceived ability in predicting indices of motivation." *International Journal of Sport Psychology* (30:1), pp. 63-82.

Ng, J. Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., and Williams, G. C. 2012. "Self-Determination Theory Applied to Health Contexts: A Meta-Analysis." *Perspectives on Psychological Science* (7:4), pp. 325-340.

Nicholls, J. G. 1989. *The Competitive Ethos and Democratic Education*. Cambridge, MA: Harvard University Press.

Ntoumanis, N. 2001a. "Empirical links between achievement goal theory and self-determination theory in sport." *Journal of Sports Sciences* (19:6), pp. 397-409.

Ntoumanis, N. 2001b. "A self-determination approach to the understanding of motivation in physical education." *British Journal of Educational Psychology* (71:2), pp. 225-242.

Ntoumanis, N. 2005. "A Prospective Study of Participation in Optional School Physical Education Using a Self-Determination Theory Framework." *Journal of Educational Psychology* (97:3), pp. 444-453.

Ntoumanis, N., Edmunds, J., and Duda, J. L. 2009. "Understanding the coping process from a self-determination theory perspective." *British Journal of Health Psychology* (14:2), pp. 249-260.

OECD. 2017. "Health at a Glance 2017: OECD Indicators." Retrieved September 20th, 2018 from http://dx.doi.org/10.1787/health_glance-2017-en

Oinas-Kukkonen, H. and Harjumaa, M. 2009. "Persuasive Systems Design: Key Issues, Process Model, and System Features." *Communications of the Association for Information Systems* (24), pp. 485-500.

Orji, R. and Moffatt, K. 2016. "Persuasive technology for health and wellness: State-of-the-art and emerging trends." *Health Informatics Journal* (24:1), pp. 66-91.

Park, Y. and Park, S. W. 2017. "Goal orientations and social comparison: The role of different motivations in affiliation preferences." *Motivation and Emotion* (41:5), pp. 617-627.

Pavlou, P. A., Liang, H., and Xue, Y. 2007. "Understanding and Mitigating Uncertainty in Online Exchange Relationships: A Principal-Agent Perspective." *MIS Quarterly* (31:1), pp. 105-136.

Peng, W., Lin, J.-H., Pfeiffer, K. A., and Winn, B. 2012. "Need satisfaction supportive game features as motivational determinants: An experimental study of a self-determination theory guided exergame." *Media Psychology* (15:2), pp. 175-196.

Peters, D., Calvo, R. A., and Ryan, R. M. 2018. "Designing for Motivation, Engagement and Wellbeing in Digital Experience." *Frontiers in Psychology* (9:797), pp. 1-15.

Pettinico, G. and Milne, G. R. 2017. "Living by the numbers: understanding the "quantification effect"." *Journal of Consumer Marketing* (34:4), pp. 281-291.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., and Podsakoff, N. P. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies." *Journal of Applied Psychology* (88:5), pp. 879–903.

Rapp, A., Hopfgartner, F., Hamari, J., Linehan, C., and Cena, F. 2019. "Strengthening gamification studies: Current trends and future opportunities of gamification research." *International Journal of Human-Computer Studies* (127), pp. 1-6.

Reeve, J. 2005. *Understanding Motivation and Emotion*, (4th ed.). New York: John Wiley & Sons, Inc.

Reeve, J. and Deci, E. L. 1996. "Elements of the Competitive Situation That Affect Intrinsic Motivation." *Personality and Social Psychology Bulletin* (22:1), pp. 24-33.

Régner, I., Escribe, C., and Dupeyrat, C. 2007. "Evidence of Social Comparison in Mastery Goals in Natural Academic Settings." *Journal of Educational Psychology* (99:3), pp. 575-583.

Reinboth, M., Duda, J. L., and Ntoumanis, N. 2004. "Dimensions of Coaching Behavior, Need Satisfaction, and the Psychological and Physical Welfare of Young Athletes." *Motivation and Emotion* (28:3), pp. 297-313.

Richardson, H. A., Simmering, M. J., and Sturman, M. C. 2009. "A Tale of Three Perspectives: Examining Post Hoc Statistical Techniques for Detection and Correction of Common Method Variance." *Organizational Research Methods* (12:4), pp. 762-800.

Ringle, C. M., Wende, S., and Becker, J.-M. 2015. "SmartPLS 3." Boenningstedt: SmartPLS GmbH.

Rockmann, R. and Gewald, H. 2018. "Activity Tracking Affordances: Identification and Instrument Development." In: *Proceedings of the Pacific Asia Conference on Information Systems*, Yokohama, Japan.

Ryan, R. M. 1982. "Control and Information in the Intrapersonal Sphere: An Extension of Cognitive Evaluation Theory." *Journal of Personality and Social Psychology* (43:3), pp. 450-461.

Ryan, R. M. and Deci, E. L. 2000. "Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being." *American Psychologist* (55:1), pp. 68-78.

Ryan, R. M. and Deci, E. L. 2017. *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. New York, NY: The Guilford Press.

Ryan, R. M., Rigby, C. S., and Przybylski, A. 2006. "The motivational pull of video games: A self-determination theory approach." *Motivation and Emotion* (30:4), pp. 344-360.

Sagiv, L. and Schwartz, S. H. 2000. "Value priorities and subjective well-being: Direct relations and congruity effects." *European Journal of Social Psychology* (30:2), pp. 177-198.

Sailer, M., Hense, J. U., Mayr, S. K., and Mandl, H. 2017. "How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction." *Computers in Human Behavior* (69), pp. 371-380.

Sardi, L., Idri, A., and Fernández-Alemán, J. L. 2017. "A systematic review of gamification in e-Health." *Journal of Biomedical Informatics* (71), pp. 31-48.

Schmidt-Kraepelin, M., Thiebes, S., Baumsteiger, D., and Sunyaev, A. 2018. "State Of Play: A Citation Network Analysis Of Healthcare Gamification." In: *Proceedings of the European Conference on Information Systems*, Portsmouth.

Schmidt-Kraepelin, M., Thiebes, S., Stepanovic, S., Mettler, T., and Sunyaev, A. 2019. "Gamification in Health Behavior Change Support Systems - A Synthesis of Unintended Side Effects." In: *Proceedings of the International Conference on Wirtschaftsinformatik*, Siegen, Germany.

Schüler, J. and Brandstätter, V. 2013. "How basic need satisfaction and dispositional motives interact in predicting flow experience in sport." *Journal of Applied Social Psychology* (43), pp. 687-705.

Schwarz, A., Rizzuto, T., Carraher-Wolverton, C., Roldán, J. L., and Barrera-Barrera, R. 2017. "Examining the Impact and Detection of the "Urban Legend" of Common Method Bias." *ACM SIGMIS Database: the DATABASE for Advances in Information Systems* (48:1), pp. 93-119.

Seaborn, K. and Fels, D. I. 2015. "Gamification in theory and action: A survey." *International Journal of Human-Computer Studies* (74), pp. 14-31.

Sheldon, K. M., Abad, N., and Hinsch, C. 2011. "A Two-Process View of Facebook Use and Relatedness Need-Satisfaction: Disconnection Drives Use, and Connection Rewards It." *Journal of Personality and Social Psychology* (100:4), pp. 766-775.

Sjöklint, M., Constantiou, I., and Trier, M. 2015. "The Complexities of Self-Tracking - An Inquiry into User Reactions and Goal Attainment." In: *Proceedings of the European Conference on Information Systems*, Münster, Germany.

Smith, N., Quested, E., Appleton, P. R., and Duda, J. L. 2017. "Observing the coach-created motivational environment across training and competition in youth sport." *Journal of Sports Sciences* (35:2), pp. 149-158.

Smith, N., Tessier, D., Tzioumakis, Y., Fabra, P., Quested, E., Appleton, P., Sarrazin, P., Papaioannou, A., Balaguer, I., and Duda, J. L. 2016. "The relationship between observed and perceived assessments of the coach-created motivational environment and links to athlete motivation." *Psychology of Sport and Exercise* (23), pp. 51-63.

Smith, W. R. 2017. "Communication, Sportsmanship, and Negotiating Ethical Conduct on the Digital Playing Field." *Communication & Sport* (5:2), pp. 160-185.

Smith, W. R. and Treem, J. 2016. "Striving to Be King of Mobile Mountains: Communication and Organizing Through Digital Fitness Technology." *Communication Studies* (68:2), pp. 135-151.

Song, H., Kim, J., Tenzek, K. E., and Lee, K. M. 2013. "The effects of competition and competitiveness upon intrinsic motivation in exergames." *Computers in Human Behavior* (29:4), pp. 1702-1708.

Standage, M., Duda, J., and Ntoumanis, N. 2003a. "Predicting motivational regulations in physical education: the interplay between dispositional goal orientations, motivational climate and perceived competence." *Journal of Sports Sciences* (21:8), pp. 631-647.

Standage, M., Duda, J. L., and Ntoumanis, N. 2003b. "A Model of Contextual Motivation in Physical Education: Using Constructs From Self-Determination and Achievement Goal Theories to Predict Physical Activity Intentions." *Journal of Educational Psychology* (95:1), pp. 97-110.

Standage, M., Duda, J. L., and Ntoumanis, N. 2005. "A test of self-determination theory in school physical education." *British Journal of Educational Psychology* (75:3), pp. 411-433.

Statista. 2018. "eServices Report 2018 – Fitness." Retrieved July 23th, 2018 from https://de.statista.com/statistik/studie/id/36673/dokument/fitness-outlook/

Steelman, Z. R., Hammer, B. I., and Limayem, M. 2014. "Data Collection in the Digital Age: Innovative Alternatives to Student Samples." *MIS Quarterly* (38:2), pp. 355-378.

Stepanovic, S. and Mettler, T. 2018. "Gamification applied for health promotion: does it really foster long-term engagement? A scoping review," *Proceedings of the European Conference on Information Systems*, Portsmouth.

Stragier, J., Abeele, M. V., Mechant, P., and De Marez, L. 2016. "Understanding persistence in the use of Online Fitness Communities: Comparing novice and experienced users." *Computers in Human Behavior* (64), pp. 34-42.

Stragier, J., Vanden Abeele, M., and De Marez, L. 2018. "Recreational athletes' running motivations as predictors of their use of online fitness community features." *Behaviour & Information Technology* (37:8), pp. 815-827.

Suh, A. 2018. "Sustaining the Use of Quantified-Self Technology: A Theoretical Extension and Empirical Test." *Asia Pacific Journal of Information Systems* (28:2), pp. 114-132.

Suh, A., Wagner, C., and Liu, L. 2015. "The Effects of Game Dynamics on User Engagement in Gamified Systems." In: *Proceedings of the Hawaii International Conference on System Sciences*, pp. 672-681.

Swan, M. 2013. "The Quantified Self: Fundamental Disruption in Big Data Science and Biological Discovery." *Big Data* (1:2), pp. 85-99.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., and Ryan, R. M. 2012. "Exercise, physical activity, and self-determination theory: a systematic review." *International Journal of Behavioral Nutrition and Physical Activity* (9:1), pp. 1-30.

Tim, Y., Pan, S. L., Bahri, S., and Fauzi, A. 2018. "Digitally enabled affordances for community-driven environmental movement in rural Malaysia." *Information Systems Journal* (28:1), pp. 48-75.

Treasure, D. and Roberts, G. 1998. "Relationship between female adolescents' achievement goal orientations, perceptions of the motivational climate, belief about success and sources of satisfaction in basketball." *International Journal of Sport Psychology* (29:3), pp. 211-230.

Vallerand, R. J. 1997. "Toward a Hierarchical Model of Intrinsic and Extrinsic Motivation." *Advances in Experimental Social Psychology* (29), pp. 271-360.

van Roy, R. and Zaman, B. 2018a. "Need-supporting gamification in education: An assessment of motivational effects over time." *Computers & Education* (127), pp. 283-297.

van Roy, R. and Zaman, B. 2018b. "Unravelling the ambivalent motivational power of gamification: A basic psychological needs perspective." *International Journal of Human-Computer Studies* (127), pp. 38-50.

Vansteenkiste, M., Ryan, R. M., and Deci, E. L. 2008. "Self-Determination Theory and the Explanatory Role of Psychological Needs in Human Well-Being," in *Capabilities and Happiness,* L. Bruni, F. Comim and M. Pugno (eds.). Oxford, UK: Oxford University Press, pp. 187–223.

Velez, J. A., Ewoldsen, D. R., Hanus, M. D., Song, H., and Villarreal, J. A. 2018. "Social Comparisons and Need Fulfillment: Interpreting Video Game Enjoyment in the Context of Leaderboards." *Communication Research Reports* (35:5), pp. 424-433.

Whipple, T. 2018. "Quitters' day puts new year's resolutions to the test." Retrieved 2018-07-09 from https://www.thetimes.co.uk/article/quitters-day-puts-new-year-s-resolutions-to-the-test-29mr0vn3g

White, S. A. and Duda, J. L. 1994. "The relationship of gender, level of sport involvement, and participation motivation to task and ego orientation." *International Journal of Sport Psychology* (25:4), pp. 4-18.

WHO. 2018a. "Global action plan on physical activity 2018–2030: more active people for a healthier world." Retrieved September 20th, 2018 from http://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf

WHO. 2018b. "WHO and Google Fit announcement." Retrieved September 20th, 2018 from http://www.who.int/behealthy/digital-health/promoting-health-in-the-21st-century

Williams, L. J., Edwards, J. R., and Vandenberg, R. J. 2003. "Recent advances in causal modeling methods for organizational and management research." *Journal of Management* (29:6), pp. 903-936.

Wright, R. T., Campbell, D. E., Thatcher, J. B., and Roberts, N. 2012. "Operationalizing Multidimensional Constructs in Structural Equation Modeling: Recommendations for IS Research." *Communications of the Association for Information Systems* (30:1), pp. 367-412.

Wu, Y., Kankanhalli, A., and Huang, K.-w. 2015. "Gamification in Fitness Apps: How Do Leaderboards Influence Exercise?" In: *Proceedings of the International Conference on Information Systems*, Fort Worth, Texas.

Xi, N. and Hamari, J. 2019. "Does gamification satisfy needs? A study on the relationship between gamification features and intrinsic need satisfaction." *International Journal of Information Management* (46), pp. 210-221.

Zhang, P. 2007. "Toward a Positive Design Theory: Principles for Designing Motivating Information and Communication Technology," in *Designing Information and Organizations with a Positive Lens,* M. Avital, R. Bolland and D. Cooperrider (eds.). Emerald Group Publishing Limited, pp. 45-74.

Zhang, P. 2008. “Motivational Affordances: Reasons for ICT Design and Use.” *Communications of the ACM* (51:11), pp. 145-147.

Zhang, X. and Venkatesh, V. 2018. “From Design Principles to Impacts: A Theoretical Framework and Research Agenda.” *AIS Transactions on Human-Computer Interaction* (10:2), pp. 105-128.

Zhou, Y., Kankanhalli, A., and Huang, K.-w. 2017. “Predicting Exercise Behavior in Fitness Applications: A Multi-Group Study.” In: *Proceedings of the International Conference on Information Systems*, Seoul.

Paper XI

Don’t Hurt Me... No More?

An Empirical Study on the Positive and Adverse Motivational Effects in Fitness Apps

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Proceedings of the *European Conference on Information Systems* 2019.

https://aisel.aisnet.org/ecis2019_rp/90

Paper XII

If You Are Happy and Don't Know IT: Continuance?

Analyzing Emotion Carry-over Effects in Activity Tracking Continuance Decisions

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Proceedings of the *Pacific Asia Conference on Information Systems* 2018.

https://aisel.aisnet.org/pacis2018/238

This paper received the AIS SIG Health Best Paper Award under the Junior Scholar category in 2019.

Appendix

Publications

PUBLICATIONS

Conference Proceedings (Peer Reviewed)

Rockmann, R. and Gewald, H. 2019. “Individual Fitness App Use: The Role of Goal Orientations and Motivational Affordances.” In: *Proceedings of the Americas Conference on Information Systems*, Cancún, México.

Rockmann, R. 2019. “Don’t Hurt Me… No More? An Empirical Study on the Positive and Adverse Motivational Effects in Fitness Apps.” In: *Proceedings of the European Conference on Information Systems*, Stockholm, Sweden.

Rockmann, R. and Maier, C. 2019. “On the Fit in Fitness Apps: Studying the Interaction of Motivational Affordances and Users’ Goal Orientations in Affecting the Benefits Gained.” In: *Proceedings of the International Conference on Wirtschaftsinformatik*, Siegen, Germany.

Rockmann, R. and Gewald, H. 2018. “Activity Tracking Affordances: Identification and Instrument Development.” In: *Proceedings of the Pacific Asia Conference on Information Systems*, Yokohama, Japan.

Rockmann, R. and Gewald, H. 2018. “How Do IT-related Traits Drive the Internet Use of Mature Adults? The Interplay of Curiosity and Control.” In: *Proceedings of the Hawaii International Conference on Systems Sciences*, Waikoloa, Hawaii.

Rockmann, R., Gewald, H., and Haug, M. 2018. “Equal Access for Everyone? A Digital Divide Cascade for Retired Senior Citizens.” In: *Proceedings of the European Conference on Information Systems*, Portsmouth, United Kingdom.

Rockmann, R., Salou, T., and Gewald, H. 2018. “If You Are Happy and DON’T Know IT: Continuance? Analyzing Emotion Carry-Over Effects in Activity Tracking Continuance Decisions.” In: *Proceedings of the Pacific Asia Conference on Information Systems*, Yokohama, Japan.

Rockmann, R. and Gewald, H. 2017. “Older Adults’ Use of Online Health Information – Do They Even Try?” In: *Proceedings of the Hawaii International Conference on Systems Sciences*, Waikoloa, Hawaii.

Rockmann, R. and Gewald, H. 2017. “Is IT What You Make out of IT? On Affordances, Goals, and Positive and Negative Consequences in Activity Tracking.” In: *Proceedings of the International Conference on Information Systems*, Seoul, South Korea.

Gewald, H. and Rockmann, R. 2016. “Mature Adults' Use of Digital Health Services - The Role of Prior Computer Experience on eHealth Adoption.” In: *Proceedings of the International Conference on Information Resources Management*, Cape Town, South Africa.

Gewald, H. and Rockmann, R. 2016. “Digital Services for the Aging Society: The Impact of Previous Workplace Privileges on Mature Adults’ Use of the Internet.” In: *Proceedings of the International Conference on Digital Society and eGovernments*, Venice, Italy.

Rockmann, R. and Gewald, H. 2016. "Technology-Mediated Health Activities: An Exploratory Study on Older Adults." In: *Proceedings of the Americas Conference on Information Systems*, San Diego, United States.

Rockmann, R. and Gewald, H. 2016. "The Role of Cognitive Age as Predictor of Individual Differences and Use of E-Health by the Elderly." In: *Proceedings of the European Conference on Information Systems*, İstanbul, Turkey.

Schulz, T., Rockmann, R., and Weeger, A. 2016. "Service Composition in Networks – Towards a Typology of Intermediaries." In: *Proceedings of the Americas Conference on Information Systems*, San Diego, United States.

Rockmann, R., Weeger, A., and Gewald, H. 2015. "Elderly People in eHealth: Investigating Internet Self-Efficacy and the Role of Occupational Internet Usage." In: *Proceedings of the Americas Conference on Information Systems*, Puerto Rico, United States.

Rockmann, R., Weeger, A., and Gewald, H. 2015. "IT Capabilities and Organizational Utilization of Public Cloud Computing." In: *Proceedings of the European Conference on Information Systems*, Münster, Germany.

Rockmann, R., Weeger, A., and Gewald, H. 2014. "Identifying Organizational Capabilities for the Enterprise-Wide Usage of Cloud Computing." In: *Proceedings of the Pacific Asia Conference on Information Systems*, Chengdu, China.

Workshop Papers (Peer Reviewed)

Brune, P. and Rockmann, R. 2018. "Towards An Application Architecture For A Smart Online Service Network Platform For The Elderly." In: *Proceedings of the International Workshop on Adults Use of Information and Communication Technologies in Healthcare*, Lund, Sweden.

Haug, M., Gewald, H., and Rockmann, R. 2018. "Grandma's New Tablet – The Role of Mobile Devices in Trying to Innovate in IT." In: *Proceedings of the International Workshop on Adults Use of Information and Communication Technologies in Healthcare*, Lund, Sweden.

Rockmann, R. and Gewald, H. 2016. "Examining Older Adults' Enhanced Use of eHealth." In: *Proceedings of the International Workshop on Adults Use of Information and Communication Technologies in Healthcare*, London, United Kingdom.

Rockmann, R. and Gewald, H. 2015. "Elderly People in eHealth: Who Are They?" In: *Proceedings of the International Workshop on Adoption and Usage of Information and Communication Technologies in Healthcare by the Elderly*, Berlin, Germany.

Rockmann, R. and Gewald, H. 2015. "The Effect of Previous Work Experience on eHealth Adoption of the Elderly." In: *Workshop on Health IT and Economics*, Washington, D.C.

Book Chapters

Rockmann, R., Gewald, H., and Brune, P. 2019. "Gesundheitsbezogene IT-Nutzung im Altersübergang – Ursachen und Auswirkungen individueller Differenzen." In: Der Altersübergang als Neuarrangement von Arbeit und Leben: Kooperative Dienstleistungen für das Alter(n) in Vielfalt. W. Schneider and S. Stadelbacher (eds.). Wiesbaden: Springer Fachmedien Wiesbaden, pp. 177-198.