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INSIGHTS INTO PERSONAL ICT USE: UNDERSTANDING CONTINUANCE AND DISCONTINUANCE OF WEARABLE SELF-TRACKING DEVICES

by

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INSIGHTS INTO PERSONAL ICT USE: UNDERSTANDING CONTINUANCE AND DISCONTINUANCE OF WEARABLE SELF-TRACKING DEVICES

Research paper

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Abstract

Wearable self-tracking devices become increasingly common in our society and reflect the trend towards the digitized individual. However, little is known what drives the continuance and discontinuance usage of such devices. To empirically analyze factors leading to continuance and discontinuance of wearable self-tracking device usage, we develop a conceptual model based on established post-adoption concepts and the dual-factor theory. We validate it by applying structural equation modeling on collected survey data among 357 self-tracking users. Whereas previous research focuses on predicting continuance intentions, our results reveal discontinuance to be another decisive determinant of usage behavior. Additionally, we provide insights into factors driving continuance and discontinuance intentions and derive practical implications for producers. Our results advance the theoretical discourse on IS post-adoption behavior in a personal ICT context.

Keywords: Self-tracking, quantified-self, wearable computing, information systems continuance, information systems discontinuance, technology use, personal ICT.

1 Introduction

Self-tracking, life-logging, quantified-self, personal analytics, and personal informatics are terms for the current trend in personal information and communication technology (ICT) to collect and analyze specific features of life on a regular basis through mobile and wearable digital devices (Lupton, 2014a). Self-tracking devices are placed in the category of wearable electronics and/or multi-sensor platforms in the field of the Internet of Things (Swan, 2012). These devices can take the shape of smartwatches, wristband sensors, wearable sensor patches, artificial reality-augmented glasses, brain computer interfaces, or wearable body metric textiles (Swan, 2012). They enable the individual to capture daily activities, exercises, vital parameters, disease symptoms, or nutrition, among others (Gimpel et al., 2013; Pantzar and Ruckenstein, 2015). Next to an increasing interest in self-tracking devices from an academic point of view, we also observe a surge of interest in practice. Even though the private collection and analysis of one's personal data is not a completely new phenomenon (e.g., handwritten data or with Excel charts), the topic becomes vibrant again due to new technologies, decreasing sensor sizes, and increasing smartphone usage, all of which enable the user to do this practice in a much more convenient way (Gimpel et al., 2013; Lupton, 2014b). Major players in the consumer electronic market, such as Apple, Google and Microsoft, as well as specialized producers, such as fitbit or

Jawbone, launched their own wearable self-tracking devices (e.g., Apple Watch, Android Wear, Microsoft Band, Fitbit Charge and Jawbone UP) and start to build up software and hardware ecosystems around them. It is expected that the shipment of self-tracking devices will grow from 102 million units in 2016 to more than 224 million units in 2020 (IDC, 2016).

The first generation of self-tracking devices (e.g. the Nike Fuelband) can be seen as products that generate revenues at the point of sale only and solely run tracking and analyzing software, which is provided by the device producer in an enclosed ecosystem. Hence, in terms of direct revenue generation for the specific product through a particular customer, it is not important how long the customer uses the device after the initial adoption (however, in terms of brand reputation and rebuy intention, an ongoing use is aspired). Additionally, due to the closed ecosystem, the collected self-tracking data is of limited value since it provides insights for the self-tracking users but does not allow service enhancements for users by new and traditional third-party providers.

In contrast, the second generation of self-tracking devices (e.g. the Apple Watch) resembles a platform for an entirely new and open ecosystem of applications and services for new and traditional third-party providers, which can create additional value beyond the pure tracking and analysis of data for the user and revenue for themselves over time (e.g., personalized sport and fitness support, dynamic health-insurances, and digital health-care support) (Lupton, 2014a). These applications and services have in common that the associated business and service models rely on the continuous supply with data recorded by the basic technology – the wearable self-tracking device. Consequently, for the success of these applications and services, it is necessary that the self-tracking device is used regularly and continuously after the initial adoption.

Regular and ongoing usage can be predicted by continuance factors but also inhibited by discontinuance factors. While such factors have been investigated in post-acceptance models (e.g. Bhattacherjee, 2001; Furneaux and Wade, 2011, 2017; Recker, 2014, 2016), these models do not fully account for the domain of wearable self-tracking devices placed in the personal ICT context and were not synthesize in one comprehensive dual-factor model that considers both types of important determinants of usage behavior at the same time. Therefore, by identifying the determinants that promote and inhibit continuous use behavior, we want to answer the following research question:

RQ: What determines continuance and discontinuance behavior of wearable self-tracking devices?

Concerning the adoption research stream, much research has focused on the initial acceptance of information systems (IS), especially in a business IS context. Also, in the post-acceptance phase useful contributions on continuance use in a consumer context were published by Bhattacherjee (2001) and Limayem et al. (2007), whereas Recker (2016) focused on discontinuance in a business IS context. However, theoretical post-acceptance research with a focus on continuance and discontinuance intention in a personal ICT context is still scarce and will be the focus of this study:

Adoption phase	**Business IS context**	**Personal ICT context**
Initial acceptance	Out of scope	Out of scope
Post-acceptance Continuance	Out of scope	**Focus of the study**
Post-acceptance Discontinuance	Out of scope	

Table 1: Focus of the study

While previously developed models focus on either continuance or discontinuance, we aim at combining both facets in our study because they influence human behavior by initiating or preventing human actions. Therefore, based on what we learn from existing theoretical approaches, we deductively derive a conceptual model to answer our research question. To this end, we develop a set of 12 hypotheses that we empirically evaluate using survey data collected from 357 self-tracking users and by applying structural equation modeling. Overall, we aim at advancing the theoretical understanding in the field of personal ICT usage and particularly (dis)continuance research as well as at providing practical implications for producers and third-party application developers in the self-tracking industry.

2 Theoretical Foundations

2.1 Wearable Self-Tracking Devices

Wearable self-tracking devices can be assigned to the category of personal ICT (together with smartphones and tablet computers) since they are mobile (used on the users wrist), are adopted by individuals for their own personal usage and enable users to engage in various activities with one device (Hong and Tam, 2006; Scheepers and Middleton, 2013). In the specific self-tracking domain, the literature basis is continuously growing. Gimpel et al. (2013) identified five motivational factors which explain the individual's activity of self-tracking, while Sjöklint et al. (2015) investigated how individuals use self-tracking devices and how they cope with personal data provided in everyday life. Furthermore, Pfeiffer et al. (2016) examined consumer acceptance factors of self-tracking devices, whereas Baumgart and Wiewiorra (2016) analyzed what motivations to start self-tracking drive different self-tracking activities and what role self-control plays on the self-tracking behavior. Regarding the considered type of devices, technology acceptance research was conducted for wearable devices in general (Spagnolli et al., 2014; Yang et al., 2016), smartwatches (Chuah et al., 2016; Kim and Shin, 2015) as well as fitness-trackers (Sol and Baras, 2016). These results in the context of self-tracking and wearable devices serve as a promising basis for our research project.

2.2 Continuance and Discontinuance

Previous research extensively analyzes the adoption of IS, most often relying on the technology acceptance model (TAM) (Davis, 1989), the innovation diffusion theory (Moore and Benbasat, 1989) as two prominent theories in this area. Subsequent research extending the original TAM by additional factors converged in the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) and its extension (UTAUT2) (Venkatesh et al., 2012). The latter theories put forth additional adoption determinants, such as social influence or hedonic motivation. While these acceptance models made important contributions to the understanding of the initial technology adoption, they only provide limited insights into the post-acceptance phase (Sorgenfrei et al., 2014). For instance, Kim and Malhotra (2005) showed that applying the untailored TAM does not capture the actual processes involved in continued usage behavior or discontinuance. Furthermore, Karahanna et al. (1999) showed how the behavioral intentions for IT adoption and usage are influenced very differently.

Looking at this discrepancy, Bhattacherjee (2001) opens up the domain of post-acceptance theories by arguing based on the expectation confirmation theory that satisfied consumers will continue with IS usage while dissatisfied consumers will discontinue. He zeroes in on continuance aspects and suggests that usage is driven by the continuance intention which in turn is influenced by the satisfaction with and the perceived usefulness of the IS. Several empirical studies were carried out to identify relevant factors explaining usage. Petter et al. (2008) provide a summary of 21 studies in which use behavior and other IS success-related variables are explained by only a few different factors on the individual level, among them perceived usefulness. They show that *no* factor has strong literature support for explaining usage behavior. Therefore, only focusing on continuance aspects seems to be insufficient to understand usage behavior.

To understand usage behavior more comprehensively, we also need to understand factors preventing specific actions from taking place. By using theory of planned behavior or protection motivation theory as basis, previous research suggests that, similar to the continuance behavior, discontinuance decisions are also based on formed intentions (Turel, 2016; Furneaux and Wade, 2017). Furneaux and Wade (2011) are the first in the discontinuance domain, and they also focus on the business domain. They reason that discontinuance is determined by (1) change forces such as environment or system shortcomings as well as by (2) continuance inertia, e.g., system embeddedness or investments into it. Although all of those factors are relevant for organizations, only some of them seem to be applicable in a personal ICT discontinuance decision process. On the individual level, Recker (2014, 2016) conceptualizes IS discontinuance in an individual's working environment and suggests several factors

based on past works on technology use (perceived ease of use, perceived usefulness, perceived work impediment) and status quo bias (perceived inertia and perceived sunk costs), all of which influence the formation of the continuance and discontinuance intentions.

At this point, it is important to understand that continuance and discontinuance intentions are not considered to be one bipolar construct, but rather dual-factored constructs similar to the motivation-hygiene theory (Herzberg, 1959, 1966) or the enabler inhibitor concept (Cenfetelli, 2004). They are two independent parts with different determinants. For example, the occurrence of an error in a system increases the intention to discontinue the use of a system. However, the absence of this error does not necessarily build up the intention to continue using the system. Yet, both sides are relevant for understanding the reasons driving people's usage behavior. Adoption models can benefit from a separate view on both intention perspectives, by giving a deeper clarification on how well the continuance and the discontinuance intentions can be explained by antecedent factors and on how important their respective influence is on the actual usage. Current research on dual-factor theory has been conducted in various contexts such as enablers and inhibitors of technology usage (Cenfetelli and Schwarz, 2011; Recker, 2016), trust and distrust (Lewicki et al., 1998), and satisfaction and dissatisfaction (Herzberg, 1966).

To understand usage behavior in more detail, new research projects focusing on a particular research context with contextual variables may also valuably extend generic theories with a more refined picture of determinants and their strengths (Alvesson and Kärreman, 2007; Johns, 2006; Venkatesh et al., 2012). To illustrate this point in the case of personal ICT and self-tracking, devices collecting data on people's well-being, health and fitness may raise concerns, whether those data are shared with third parties, e.g. an insurance company. Thus, trust placed in the manufacturer to not share information may play an important role in the individual's decision-making process to use a self-tracking device or not. The idea of contextual factors suggests that variables explaining behavior differ from case to case and offers an additional possible explanation as to why Petter et al. (2008) find no strong support in the literature for any relationship explaining use behavior on the individual level.

Since previous research in a personal ICT context is scarce and not specifically carried out with the aim to explain wearable self-tracking use behavior and particularly (dis)continuance in the post-acceptance phase, we propose a comprehensive theoretical dual-factor model, including relevant factors from related literature, which we will explain subsequently.

3 Hypothesis Development

Having introduced previous research on continuance and discontinuance of IS usage behavior, we will now explain the different constructs and proposed relationships to analyze use in the context of wearable self-tracking devices. The context of wearable self-tracking devices refers to smartwatches (with sophisticated self-tracking functions) and wristband sensors, such as fitness trackers. Furthermore, our definition covers not only the hardware, but also the software and the associated ecosystem.

3.1 Use as well as Continuance and Discontinuance Intentions

IS continuance, IS continuance behavior, or IS continuous usage can be described as "behavioral patterns reflecting continued use of a particular IS" (Limayem et al., 2007, p. 707). As a form of behavior, it results from a consciously built intention and is not a one-time outcome but rather a behavior that is caused by a cycle of repeating or changing situations in which an individual intendedly or automatically uses the IS until the individual decides to discontinue (Limayem et al., 2007). To intendedly using the system, the user builds up a continuance intention (CI), which basically reflects all factors driving a person towards the conscious choice to continue the use. Analogous to the continuance intention, the discontinuance intention (DI) reflects all factors that lead to an individual's conscious choice to stop using an IS. For clarification purposes, however, we stress that discontinuance does not comprise the stopping of the activity (e.g., running) within which the self-tracking device was used, nor discontinuance as a result of substitution for a similar product. In this first step, we particularly focus

on factors linked to the self-tracking device that may lead an individual to discontinue using the device at all (while continuing the actual activity, e.g., running). Our proposed relationships are based on the theory of planed behavior (Ajzen, 1985) and the theory of reasoned action (Fishbein and Ajzen, 1975) in which several beliefs form intentions that ultimately result in behavior. Thus, we posit:

H1: Continuance intention is positively related to use.

H2: Discontinuance intention is negatively related to use.

3.2 Status Quo Bias

Continuance intentions are influenced by the status quo bias (Recker, 2014) which reflects "people's preference for maintaining their current status or situation" (Kim and Kankanhalli, 2009, p. 569). The wish to remain in the status quo can result from an individual cost–benefit analysis and psychological factors (Lee and Joshi, 2016). The first can be the outcome from people perceiving disadvantages of change or discontinuance to be greater than the advantages (Samuelson and Zeckhauser, 1988). In the context of self-tracking devices, discontinuance would generate little advantages, except that users save the negligible effort of equipping and using it. However, since self-tracking devices collect data over time, particularly a change or discontinuance would (usually) result in a loss of the accumulated information and be perceived as a disadvantage. Additionally, users of self-tracking devices often find themselves within an ecosystem or community around their device or its brand, sharing experience and information. Stopping the use of the particular self-tracking device would also lead to losing the connection to this ecosystem or community. Drawing on the concept of loss aversion as a psychological theory in the area of human decision making (Kahneman and Tversky, 1979), even minor goal-unrelated losses due to changing from the current situation to another could be perceived as larger than they actually are and as a result, people try to avoid them. Since that losses are perceived larger than gains in value perception, people prefer to remain in the status quo (Kim and Kankanhalli, 2009). This leads to a will to continue the use and is referred to as cognitive-based inertia (PCBI) (Recker, 2014). Thus, we posit:

H3: Perceived cognitive-based inertia has a positive effect on the continuance intention.

Considering different types of inertia, individuals can also form attachments to routines or systems by affection, strengthening the individual's status quo bias (Polites and Karahanna, 2012). This results from the individual being comfortable and happy with the system or even when pleasure is taken in its usage, leading to a positive emotional bond (Polites and Karahanna, 2012; Lin et al., 2015). They introduce this type of inertia as affective-based inertia (PABI). Since individuals consciously pursue actions with a positive contribution to their lives, the affective-based inertia raises individuals' continuance intentions of the associated actions. In the case of self-tracking devices, the affective-based inertia is formed during extensive every-day usage. Hence, we posit:

H4: Perceived affective-based inertia has a positive effect on the continuance intention.

Next to inertia, Recker (2014) identifies another economic phenomenon that leads an individual to remain in the status quo, the evaluation of transition costs in comparison to sunk costs. The construct perceived sunk costs (PSC) is defined as "comparison of transition costs such as time and effort of adapting to a new situation versus the time and effort already invested in learning to use the existing system" (Recker, 2014, p. 5). Transition costs are especially relevant in the case of switching to another system or routine. However, within the context of self-tracking devices, neither continuance nor discontinuance creates transition costs. Though, this does not apply to sunk costs, because after an investment is made, an individual wants to draw as much benefit as possible from the investment (due to the money, time, and effort already invested), even when the individual can partially regain the financial investment by reselling the device. That consequently creates a status quo bias with the intention to continue using the current system (Kim and Kankanhalli, 2009), regardless of whether reasons for discontinuance are present (Polites and Karahanna, 2012). The extent to which an individual wants to retain the status quo depends on the individual's perception of the investment. Thus, we posit:

H5: Perceived sunk costs have a positive effect on the continuance intention.

3.3 Social Influence

Social influence in a consumer context is defined as "the extent to which consumers perceive that important others (e.g., family and friends) believe they should use a particular technology" (Venkatesh et al., 2012, p. 159). While social influence has been referred to using the terms subjective norm, social factors, and image in previous research (e.g., Ajzen, 1991; Moore and Benbasat, 1991; Thompson et al., 1991), Venkatesh et al. (2003, p. 451) argue that "each of these constructs contains the explicit or implicit notion that the individual's behavior is influenced by the way in which others will view them as a result of having used the technology". Image is defined as "the degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat, 1991, p. 195). Consumer technology, such as mobile devices, may be regarded as a symbol for fashion and wealth if the diffusion of the technology is not yet substantial (Sarker and Wells, 2003). Individuals therefore adopt the technology to increase their self-importance (Lu et al., 2005). We argue that consumer technology, such as self-tracking devices, are highly personal mobile devices, which are mostly worn visibly daylong and therefore also function as a technology to increase one's self-importance. Furthermore, subjective norm refers to "the perceived social pressure to perform or not to perform the behavior" (Ajzen, 1991, p. 188). Because self-tracking devices offer a new and unfamiliar way to collect and analyze highly personal data, we argue that this practice may lead to a strong formation of opinion and controversial discussion of one's social group concerning the use.

While social influence is often discussed within the acceptance literature, it has not been considered so far in the continuance and discontinuance literature. This may be because research shows that social influence decreases with a growing experience with the technology (Venkatesh et al., 2003; Venkatesh and Morris, 2000). In contrast, we argue that for vibrant and controversial new technologies, such as self-tracking devices, social influence by one's social group does not just occur within the acceptance phase but continuously, and can change the intended effective direction due to new circumstances (e.g., negative news about the device manufacturer). We further propose dividing social influence into two separate variables – positive and negative social influence. It seems reasonable to argue that the absence of a positive social influence is not naturally leading to an increased discontinuance intention. However, we expect that a negative social influence of one's social group affects the perception whether to use a certain technology and therefore influences the discontinuance intention. Hence, we define positive social influence (PSI) as the extent to which personal ICT users perceive that important others believe they should continue to use a particular technology and negative social influence (NSI) as the extent to which personal ICT users perceive that important others believe they should discontinue to use a particular technology and posit:

H6: Positive social influence has a positive effect on the continuance intention.

H7: Negative social influence has a positive effect on the discontinuance intention.

3.4 System Characteristics

Following Recker's (2016) line of reasoning, we assume that users distinguish between system characteristic advantages and disadvantages of an IS. In terms of system characteristic advantages, the two variables perceived usefulness (PU) and perceived ease of use (PEOU) are widely accepted within the IS acceptance research stream. Initially used and defined by Davis (1985, 1989) for his technology acceptance model (TAM) as "the degree to which a person believes that using a particular system would enhance his or her job performance" (PU) and "the degree to which a person believes that using a particular system would be free of effort" (PEOU), both variables have been used in extensions of TAM and alternative IS acceptance models (Davis, 1989, p. 320) . While PU and PEOU are the main antecedents in the acceptance stage, it seems plausible at first to argue that both variables also influence the continuance decision (Bhattacherjee, 2001).

While PU has been considered in several previous studies (Recker, 2014; Bhattacherjee, 2001; Limayem et al., 2007; Recker, 2016), the integration of PEOU should be discussed in more detail. Referring to empirical studies, Bhattacherjee (2001) discards PEOU from his expectation-confirmation

model of IS continuance, following the line of reasoning that it becomes non-significant in the post-acceptance stage. This is due to the fact that users gain experience with a system and resolve their PEOU concerns. Similarly, Venkatesh et al. (2003, p. 450) within their Unified Theory of Acceptance and Use of Technology (UTAUT) state that the effort expectancy, which is defined "as the degree of ease associated with the use of the system", becomes non-significant when the technology is used extensively and sustainably. We follow the line of reasoning of Bhattacherjee (2001) and Venkatesh et al. (2003) and therefore do not include PEOU in our model. By transferring PU into the self-tracking context, we redefine PU as the degree to which a person believes that using a self-tracking device would enhance his or her personal living condition. We argue that data that is regularly and continuously collected by a self-tracking device, shared with the associated ecosystem, and analyzed by the user, can contribute positively to one's well-being, fitness, and/or health. As long as this circumstance is believed by a user, PU will have a positive effect on the continuance intention. Hence, we posit:

H8: Perceived usefulness has a positive effect on the continuance intention.

Concerning the system characteristic disadvantages, Recker (2016) includes in his model a variable called perceived work impediment, which is defined as "the individual assessment of system use in terms of a detriment to work task performance due to a need to comply with the ineffectual requirements of system use". For a deeper understanding of which specific system characteristic disadvantages influence the discontinuance intention in a personal ICT context, we transfer perceived work impediment into perceived routine constraints. In addition, we adapt two variables from Furneaux and Wade (2011) which seem suitable in a personal ICT context – system unreliability and system capability shortcomings – and finally include the variable trust, since in a holistic view of hardware, software and ecosystem it also reflects a system characteristic (Mayer et al., 1995; Mayer and Davis, 1999).

System reliability is defined as "the extent to which a system can be counted on to perform its intended tasks" (Furneaux and Wade, 2011, p. 582) . They hypothesized that a reduced system reliability leads to an increased replacement intention due to the fact that the continued use of an unreliable system is seen as a risk to the business (Furneaux and Wade, 2011). We adapt this hypothesis to the personal ICT context of self-tracking, arguing that an unreliable system (SU) (e.g., unreliable measurement of data) frustrates the user and therefore effects the discontinuance intention positively. We further assume that it is thereby not important whether the unreliable data measurement is caused by a software or a hardware defect. We posit:

H9: System unreliability has a positive effect on the discontinuance intention.

System capability shortcomings (SCS) is defined as "a limitation in the functionality of an IS that undermines its ability to meet individual needs" (Furneaux and Wade, 2011, p. 582). In our case, it refers to the perceived shortcomings of the self-tracking device and relate to the individual user's needs in terms of software, hardware, and the associated ecosystem. For instance, the self-tracking system may not be compatible to the individual's preferred smartphone application or may not be supported by the smartphone's operating system. Another shortcoming might be, when the collected data cannot be shared with one's social group due to an incompatibility with the ecosystem. We posit that capability shortcomings of the self-tracking system ultimately contribute to an individual's intention to discontinue using the device. Thus, we posit:

H10: System capability shortcomings are positively related to the discontinuance intention.

Work impediment is defined as "the individual perception of system use as a detriment to work task performance" (Recker, 2016, p. 48). We transfer the construct to the individual's private domain, rename it to perceived routine constraints (PRC) and define it as the individual assessment of system use in terms of a detriment to routine performance due to a need to comply with the ineffectual requirements of system use. While Recker (2016) referred to work impediments in general, we relate it to the private domain and zero in on the perceived constraints on an individual's daily routines due to the compliance with the requirements of a self-tracking device. For instance, the self-tracking system may disturb individual routines such as wearing specific clothes, such as suits. We posit:

H11: Perceived routine constraints are positively related to the discontinuance intention.

Trust (T) is defined as "the intention to accept vulnerability to a trustee based on positive expectations of his or her actions" (Colquitt et al., 2007, p. 909) and is significantly influenced by the trustworthiness of the trustee (Colquitt et al., 2007), which in this case is the company operating the IS. Perceived trustworthiness includes the three dimensions *ability*, *benevolence*, and *integrity* of the trustee (Mayer et al., 1995). Mayer and Davis (1999) posit that the relative importance of each of these three dimensions changes depending on specific situations in which any of facets may be more salient compared to the other facets. Ability refers to "that group of skills, competencies, and characteristics that allow a party to have influence within some domain", benevolence is "the extent to which a trustee is believed to want to do good to the trustor, aside from an egocentric profit motive", while integrity is "the trustor's perception that the trustee adheres to a set of principles that the trustor finds acceptable" (Mayer and Davis, 1999, p. 124). Related to self-tracking devices, the construct thus comprises the ability of the self-tracking service provider to continuously protect the individual's data, continuous take actions in the individual's best interest and integrative behavior. We suggest that trust is an important factor because the service provider continuously gathers and analyzes data from the individual that is highly sensitive. If trust diminishes as judged by the individual user, we argue that this perception contributes to a discontinuance intention. We posit:

H12: Trust is negatively related to the discontinuance intention.

4 Research Method

We choose quantitative-empirical methods to validate the conceptual model because they allow for a statistical generalization on the basis of results "representative of the whole population at a lower cost than collecting the data for the whole population" (Saunders et al., 2009, p. 144). Subsequently, we crafted a survey instrument. We began this process by using mostly existing measurement items as an initial operationalization that we subjected to a card sorting process to improve the validity and reliability of our final measurement instrument. Ultimately, we collected empirical data using our survey instrument and analyzed it using structural equation modeling (Straub, 1989; Urbach and Ahlemann, 2010).

4.1 Construct Operationalization

We used established and validated measures for our measurement instrument wherever possible to increase its validity (e.g. DeLone and McLean, 2003). We often adapted the items such that the self-tracking device as the focus of our study is centrally reflected in each of the statements. Each of the item statements was measured with a seven-point Likert scale (Likert, 1932) between (1 = I do not at all agree; 7 = I do fully agree). All constructs are measured reflectively. To further enhance the convergent and discriminant validity of our instrument, we decided to conduct a card sorting exercise (Moore and Benbasat, 1991) using an online tool. A group of five IS researchers was asked to assign the randomized items to their respective constructs. As a result of item assignments and additional qualitative feedback, we decided to revise the phrasing of items to increase the clarity.

4.2 Data Collection

We collected data by administrating our survey instrument to *current active users* of wearable self-tracking devices (e.g smartwatchtes or fitness trackers), which means that the users already own and still use their device for the purpose of fitness, health or well-being tracking. Users who do not yet own or already stopped using their devices were excluded from the survey because they do not have a current perception about the determinants of continuance and discontinuance as actual users have and would therefore distort the results. Further, personal and voluntary usage is assumed but not ensured, since we did not account for users who were encouraged by third parties such as physicians or fitness trainers. Respondents who indicated, subsequent to the introduction page of the online questionnaire, that they are not active users of a self-tracking device, were excluded from participating in the online questionnaire. To gather our data from respondents, we circulated the invitation message to participate

in our study in online social networks (e.g., weblogs, Facebook wall postings, Facebook groups, and Twitter), online business networks (e.g., Xing and LinkedIn), and the e-learning system of the authors' university. We decided in favor of openly circulating our invitation to allow for a snowball effect within the social media. Overall, we received 680 responses. After excluding incomplete and non-plausible answers (323 responses), we analyzed the remaining 357 responses. As we circulated the invitation for participation anonymously, we cannot determine a response rate. We controlled for the variables gender, age, income, country of origin, educational achievement, computer skills, used self-tracking device type, self-tracking device usage time, technical enthusiasm and health consciousness. The survey was filled out by 78 female and 272 male respondents. 7 preferred to not report on their gender. The average age was 28 with an average monthly income between 3,000 and 4,000 US Dollars after taxes. The average time of usage for the self-tracking devices was 18 months. 272 used a smart-watch, 78 activity trackers, 3 another form and 4 gave no input. More than half of the sample group sees itself as proficient in computer skills or better and is interested in trying out new technical devices (technical enthusiasts). 66 contain a degree on the tertiary level (e.g. bachelor or master) while 276 contain a secondary degree (e.g. high school diploma). 3 stated to have no degree, 12 gave no input on this matter. 283 agreed or strongly agreed regarding actively taking care of their health. 52 agreed to some extent, 8 neither agreed nor disagreed, 7 disagreed to some extent, 2 disagreed and 5 gave no information in this matter. We gathered 134 responses from the United States, 91 from Germany, 26 from Australia, 21 from United Kingdom, 12 from Canada, 7 from Netherlands, 5 from Belgium, and 45 from 28 other countries. 17 gave no input in this matter.

5 Data Analysis and Results

We tested the hypotheses and measurement properties with the structural equation modeling (SEM) approach partial least squares (PLS) (Chin, 1998; Wold, 2004) using the software SmartPLS (Ringle et al., 2015). We decided in favor of PLS for the data analysis because PLS has advantageous characteristics in comparison to covariance-based approaches (e.g., comparatively complex research models, high quantity of indicators and not very established measures) (Fornell and Bookstein, 1982; Chin and Newsted, 1999). Adhering to the validation guidelines of Lewis et al. (2005), Straub et al. (2004), and Urbach and Ahlemann (2010), we tested the reflective measurement model in terms of unidimensionality, internal consistency reliability, indicator reliability, convergent validity, and discriminant validity.

Unidimensionality describes how the measurement items of a latent construct's property reflect only the respective construct better compared to other variables (Gerbing and Anderson, 1988). We tested for unidimensionality by conducting an exploratory factor analysis (EFA) using SPSS 24 and selected the principle component analysis in combination with the Varimax rotation and the Kaiser normalization. While the conceptual model includes 13 constructs, the EFA only suggested 12 factors on the basis of the empirical data. Continuance intention and discontinuance intension both load on one factor which is not surprising because the items of both constructs are reversed. All other items only load on their respective factor with coefficients of at least 0.607, thus exceeding the threshold of 0.600 which is deemed high (Gefen and Straub 2005).

We evaluated *internal consistency reliability* using Cronbach's alpha (CA) and composite reliability (CR). Both the values for CA and CR of all constructs exceed the threshold of 0.7 (Nunnally and Bernstein, 1994) in Table 2, suggesting a high degree of internal consistency reliability.

Convergent validity assesses the extent to which an item positively correlates with other items of the same construct. We evaluated the average variance extracted, suggested by Fornell and Larcker (1981). As shown in Table 2, the AVE value of each of the constructs exceeds 0.5, indicating that the variance caused by measurement errors are lower compared to the construct's variances.

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Continuance intention	0.965	0.977	0.935
Discontinuance intention	0.971	0.981	0.945
Use	0.894	0.926	0.758
Negative social influence	0.958	0.967	0.854
Perceived affective based inertia	0.915	0.937	0.749
Perceived cognitive based inertia	0.939	0.960	0.890
Perceived routine constraints	0.877	0.907	0.662
Perceived sunk costs	0.801	0.881	0.711
Perceived usefulness	0.857	0.903	0.701
Positive social influence	0.959	0.973	0.924
System capability shortcomings	0.735	0.871	0.773
System unreliability	0.871	0.919	0.791
Trust	0.897	0.929	0.765

Table 2. Assessment of the Measurement Model

Indicator reliability shows to what degree a variable is consistent with its respective measure. A construct's reliability is determined independently from other constructs. We performed a confirmatory factor analysis (CFA) using SmartPLS. With the exception of the third item of the system capability shortcomings scale (SCS3) and the fifth item of positive social influence (PSI5) which we subsequently dropped, all loadings in our model exceed the threshold of 0.708, showing that the corresponding constructs explain more than 50% of the variance of an item. We evaluated the significance of the indicator loadings with the bootstrapping procedure with 10,000 resamples. All loadings were significant at the 0.01 level.

Discriminant validity assesses the extent to which a construct truly differs from other constructs of the conceptual model. To evaluate discriminant validity, we assessed the items' cross-loadings and the Fornell-Larcker criterion. Regarding the cross loadings, each item should show the highest loading on the construct with which it is theoretically related in comparison to other constructs (Chin, 1998). Therefore, we surmise that interchangeability of the indicators between the different constructs is not given. To support this point further, we analyzed the difference between the square roots of the AVE obtained for every single construct and the interconstruct correlation. This method demands the constructs to explain more of the variance in their own indicators compared to the variances they share with other constructs (Fornell and Larcker, 1981). In the context of this study, the square root of the AVE for every single construct is larger than their interconstruct correlations (see Table 3), which offers further indication for sufficient dissimilarity of the constructs.

	CI	DI	USE	NSI	PABI	PCBI	PRC	PSC	PU	PSI	SCS	SU	T
CI	0.967												
DI	-0.810	0.972											
USE	0.488	-0.476	0.871										
NSI	-0.228	0.254	-0.092	0.924									
PABI	0.621	-0.534	0.524	-0.166	0.865								
PCBI	0.127	-0.097	0.061	0.017	0.146	0.943							
PRC	-0.349	0.343	-0.225	0.216	-0.259	0.053	0.814						
PSC	0.164	-0.096	0.129	0.002	0.189	0.052	0.081	0.843					
PU	0.688	-0.573	0.448	-0.220	0.576	0.012	-0.262	0.272	0.837				
PSI	0.252	-0.195	0.133	0.055	0.282	0.078	0.039	0.175	0.341	0.961			
SCS	-0.230	0.247	-0.208	0.109	-0.313	0.024	0.211	0.016	-0.282	-0.159	0.879		
SU	-0.290	0.291	-0.283	0.116	-0.387	0.025	0.224	-0.029	-0.297	-0.048	0.533	0.889	
T	0.338	-0.246	0.240	-0.221	0.390	0.140	-0.135	0.109	0.353	0.145	-0.162	-0.201	0.875

Table 3: Fornell-Larcker Criterion

Turning to our results, we found support for 9 out of our 12 hypotheses. Our model explains 55.5% of the variance of the continuance intention, 21.7% of the variance of the discontinuance intention, and 25.7% of the variance of the usage. To set these values in perspective, research in IS usage typically achieves around 30% explanatory value (Meister and Compeau, 2002). All beta coefficients, the corresponding significant levels and R-squares are summarized in Table 4.

Independent variables	Dependent variables	Beta coefficients	P-values	R^2
Continuance intention	**Use**	**0.298**	**0.001*** **	0.257
Discontinuance intention	**Use**	**-0.235**	**0.014***	
Perceived affective based inertia	**Continuance intention**	**0.324**	**0.000*** **	0.555
Perceived cognitive based inertia	**Continuance intention**	**0.076**	**0.019***	
Perceived sunk costs	Continuance intention	-0.038	0.240ns	
Perceived usefulness	**Continuance intention**	**0.515**	**0.000*** **	
Positive social influence	Continuance intention	-0.015	0.440ns	
Negative social influence	**Discontinuance intention**	**0.146**	**0.006****	0.217
Perceived routine constraints	**Discontinuance intention**	**0.243**	**0.000*** **	
System capability shortcomings	Discontinuance intention	0.077	0.319ns	
System unreliability	**Discontinuance intention**	**0.150**	**0.018***	
Trust	**Discontinuance intention**	**-0.138**	**0.010****	
* significant at p < .050; ** significant at p < .010; *** significant at p < .001				

Table 4: Results

6 Discussion

In line with existing theory (Limayem et al., 2007), our results show that the continuance intention strongly predicts the use of a wearable self-tracking device. In addition, we also found evidence for discontinuance intention as a significantly negative determinant of use in accordance with our conceptualization on the basis of the motivation-hygiene theory (Herzberg, 1959). Continuance intention reflects factors based on positive beliefs, which facilitate continued use behavior by increasing user satisfaction (Thong et al., 2006; Sorgenfrei et al., 2014; Recker, 2016). In contrast, hygiene factors can cause dissatisfaction – but not satisfaction –, conceptualized as discontinuance intention which reflects factors based on negative beliefs (Recker 2016). For example, the presence of system unreliability fosters a discontinuance intention, whereas its absence does not contribute to the formation of a continuance intention. Accordingly, we contribute to the extension of the post-acceptance research stream by showing that a dual-factor conceptualization of continuance and discontinuance intentions helps explaining the use of self-tracking devices in a personal ICT context. Further, from a practical point of view, the significant negative influence of the discontinuance intention on use (β: -0.235) shows manufacturers that they should not only consider factors fostering continuance intention but also consider in their product development what factors lead to a user's discontinuance intention and minimize them.

Examining the status quo bias variables, our results only show strong support for the relationship between perceived affective based inertia and the continuance intention. As the influence of perceived cognitive based inertia on the continuance intention is comparably weak (β: 0.076), we reject the hypothesis. Additionally, the influence of sunk cost on the continuance intention is found to be not significant. To explain the results partially deviating from our conceptualization, we suggest that affective based inertia involves a positive emotional bond, and that a user wants to retain positive emotional contributions to his or her life, which are generated by the use of a self-tracking device. Manufacturers could therefore capitalize on this effect by including features, such as the personalization of the user interface. In contrast, the loss of quantifiable but emotionless assets, such as collected information, invested time, or money, seems to be negligible in this context. This explanation aligns with the find-

ings of Yu and Dean (2001) who investigated the role of emotional satisfaction in contrast to cognitive satisfaction on customer loyalty. They showed that emotional satisfaction has a stronger impact on customer loyalty than the cognitive satisfaction.

Concerning the social influence, we found support for the effect of negative social influence on the discontinuance intention, but no support for positive social influence on the continuance intention. By separating social influence into a positive and a negative dimension, we advance the current discourse. The definition and operationalization of positive social influence is identical to the established construct of social influence that has been proven to be relevant in the acceptance phase for wearable self-tracking devices (Pfeiffer et al., 2016). A possible explanation for our divergent findings might be that, in a post-adoption context, the potential loss of reputation within one's social group that disagrees with the use of a self-tracking device has a greater impact than the support of the use. In the case of positive social influence, the social group of a user is merely supporting the initial decision to adopt a self-tracking device, hence the user matches the expectation of his social group. On the other side, negative social influence is in contrast with the initial decision of the user to use the self-tracking device, therefore it could force the user to reconsider his or her decision to use the device to meet his or her social group expectations. With this in mind, producers of wearable self-tracking devices should invest in ongoing marketing and service to avoid negative voices.

Furthermore, focusing on the system characteristics, we found support for perceived usefulness, system unreliability, perceived routine constraints, and trust. The strong support for the influence of perceived usefulness on continuance intention was confirmed in our data as hypothesized because the variable is well established in this field of research and was proven to have a significant influence in various contexts (e.g. Venkatesh et al., 2003; Venkatesh et al., 2012; Davis, 1989; Limayem et al., 2007; Recker, 2016; Bhattacherjee, 2001; Davis, 1985). We also found weak support for the influence of the system unreliability on the discontinuance intention. The results are in contrast to Furneaux and Wade (2011) who tested the reverse variable system reliability in an organizational context and found no support for their hypothesis. The different results could be explained with the distinct research contexts. We suggest that, while organizations often have IT-service departments and service contracts with their vendors to solve reliability issues, within the personal ICT context it is nowadays expected that a consumer technology is working reliable and accurate since users do often not have the knowledge, time, or will for troubleshooting. Hence, it is important for producers of self-tracking devices to update their devices regularly to prevent reliability problems.

Further, we found strong support for the influence of our newly developed variable perceived routine constraints on the discontinuance intention. Considering the nature of a self-tracking device that is worn and used almost permanently, our results show the need for these kinds of technology to integrate seamlessly into the daily routines of the user to avoid the emergence of a discontinuance intention. Hence, during the development phase of the hardware, software and surrounding eco-system, the focus should be in particular on the overall usability of the devices. Finally, trust has a negative impact on the discontinuance intention, suggesting that users value a trustworthy vendor of a self-tracking device, when their highly sensitive data is gathered and analyzed. While previous studies already confirmed in various contexts that trust into the vendor is an important factor (e.g. Gefen et al., 2003; Suh and Han, 2002; Wang et al., 2003), we show that it is also important within the post-acceptance phase in the domain of self-tracking devices and should therefore receive high attention by producers of wearable self-tracking devices.

Finally, our results did not confirm the hypothesized influence of system capability shortcomings on the discontinuance intention, in contradiction to the results of Furneaux and Wade (2011). While it seems plausible that an information system is expected to fulfill its requirements continuously, we explain the diverging results with the research context of our study. In the personal ICT context, users are nowadays able to anticipate the majority of potential shortcomings already during the acceptance phase before the wearable self-tracking device is actually bought (e.g. with reviews or hands-on tests). Hence, they are able to choose a device with zero or negligible shortcomings for themselves or are willing to accept potential shortcomings. Consequently, producers of wearable self-tracking devices should ensure that their products fulfill the major requirements already on release since their potential

customers already form a product opinion before the release of subsequent software and firmware updates.

7 Conclusion

We set out to deductively build up and test a conceptual model with which we aim to explain an individual's continuous and discontinuance intention to use wearable self-tracking devices in a personal ICT context. While research on the continuance and discontinuance of individual-level IS usage is yet scarce, our study is one of the first that further explores this promising path and suggests a validated and comprehensive dual-factor model in the personal ICT context. Our study makes two significant contributions to the theoretical discourse. First, we show that hygiene factors (such as system unreliability, perceived routine constraints, trust and negative social influence by one's social group) determine the conscious formation of a discontinuance intention. Second, our results also show that the continuance intention is determined by the perceived usefulness and affective-based inertia.

Besides our promising results, we acknowledge the following limitations. Firstly, due to the chosen distribution channels, our sample group consists mainly of self-tracking enthusiasts which is why we cannot exclude a potential selection bias. A future broader validation of our model should ensure a sample group consisting of more ordinary self-tracking device users. Secondly, in terms of the trade-off between the width and the depth of a model, we decided in favor of a broad model because we deem a validated broad model more valuable in the early stages of a research domain. Succeeding research may then narrow down the focus on specific aspects and consider possible differences of groups segmentations (e.g. self-tracking device type, gender, age, etc.).

Conclusively, focusing on the theoretical implications of our study, our proposed model is one of the first to combine the research on continuance and discontinuance in a comprehensive model, therefore building the basis for future research. Furthermore, by focusing our research on the field of self-tracking, we transfer the current research of post-acceptance use into the personal ICT context. Concerning the practical implications, producers of self-tracking devices and developers of third-party applications and services, especially with a focus on healthcare, well-being and fitness, get a deeper understanding which positive and negative factors concerning self-tracking devices are important for customers and lead to a continuance or discontinuance intention. In detail, to generate a continuous intention, it is not only important to develop hardware, software, and an associated ecosystem that customers perceive to be useful but also enjoyable to use, all of which ultimately forms a positive emotional bond. Possible measures could be the development of visually appealing devices with adaptable styles (Pfeiffer et al., 2016) or gamification elements which challenge the user to sustain his or her achievements or to reach new goals. In contrast, to inhibit the formation of a discontinuance intention, self-tracking device developers should ensure that the device does not only provide the expected features but also interacts seamlessly with the user. Hence, when designing the hardware and software, factors such as used materials and visual appearance as well as software usability and interaction should be considered to minimize the disturbance of the user's daily routines as much as possible.

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