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Activity Tracking Affordances: Identification and Instrument Development

Robert Rockmann
Neu-Ulm University of Applied Sciences, robert.rockmann@hs-neu-ulm.de

Heiko Gewald
Neu-Ulm University of Applied Sciences, heiko.gewald@hs-neu-ulm.de

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Completed Research Paper

Robert Rockmann
Neu-Ulm University of Applied Sciences
Center for Research on Service Sciences
Wileystr. 1, 89231 Neu-Ulm, Germany
robert.rockmann@hs-neu-ulm.de

Heiko Gewald
Neu-Ulm University of Applied Sciences
Center for Research on Service Sciences
Wileystr. 1, 89231 Neu-Ulm, Germany
heiko.gewald@hs-neu-ulm.de

Abstract

Activity tracking apps –such as Fitbit or Nike+ Running– are positioned to enhance people's motivation towards physical activity and healthy behavior. Though various 'motivational' features are incorporated, the effectiveness of these apps is often mixed raising concerns about the 'one-size-fits-all' applicability. To get a better understanding about the nature of using activity tracking apps, this paper employs the lens of affordances and identifies eight particular salient affordances in activity tracking: Self-Monitoring, Performance Analysis, Exercise Guidance, Rewards, Social Comparison, Watching Others, Social Recognition, and Self-Presentation. Moreover, this study develops a corresponding measurement instrument evaluated using q-sort methodology. Avenues for future research are highlighted involving the set of affordances and their instruments and practical implications are given.

Keywords: Self-tracking, activity tracking, affordances, scale development, q-sort

Introduction

In recent years, a rise of information technologies (IT) to promote positive changes in peoples' behavior can be observed. Particularly in the health context, physical activity tracking apps are gaining attention for their potentials to promote motivation and adherence to healthy behavior and physical activity (Hamari et al. 2014a; Orji and Moffatt 2018). There is a huge interest about the effectiveness of these applications for health promotion (Lupton 2016) especially as many people do not engage in physical activities as recommended by health guidelines (Sisson and Katzmarzyk 2008).

To induce motivation and positive attitude towards physical activity, many available activity tracking apps incorporate 'motivational' features, 'persuasive principles or 'gamified elements' (Hamari et al. 2014a; Orji and Moffatt 2018). Considered as "a promising new approach to health behavior change" (Johnson et al. 2016, p. 90), these frequently incorporated features involve setting goals and earning points for completing activity targets, receiving instructions but also social support and comparison functionalities (Lister et al. 2014).

However, scholars increasingly observe that the effectiveness of these functionalities is mixed, context-specific and varies among individuals raising concerns about the applicability of the 'one-size-fits-all' approach often employed (Hamari et al. 2014b; Seaborn and Fels 2015). As equally echoed in motivation theories, scholars increasingly become aware that differences of the users –such as motives and goals– must be taken into account when seeking to design effective persuasive features (Böckle et al. 2017; Hamari et al. 2014b; Kappen et al. 2017). Moreover, as vendors in the wearable and app marketspace of activity tracking face great competition, a thorough understanding how users interpret the incorporated features is seen as critical for success (Suh and Wagner 2017). As Leonardi

(2013, p. 571) puts it: *"it is the capabilities of the technology, just as much as the choices people make about how to use those capabilities, which explain the ultimate effects that technologies have."*

In information systems (IS) research, the concept of 'affordances' embarks the idea what people perceive when looking at an object – precisely, what the IT artefact may allow them to do (Gibson 1986; Markus and Silver 2008). As such, the affordance perspective allows to obtain a "concrete understanding of the uses of the technological artifact" (Tim et al. 2018, p. 4). Although different affordances have been identified in prior research, it is important to note that no single set of affordances is applicable for every technology (Markus and Silver 2008). Against this backdrop, it is important to identify the affordances that are particularly salient in the context of activity tracking. Moreover, as the concept of affordances is positioned as viable means to study 'effective uses' of a given system (Burton-Jones and Volkoff 2017), it is equally important to have corresponding, readily applicable and valid operational assessment instrument in place. Therefore, this research asks:

RQ1: What are the salient affordances of activity tracking systems?
RQ2: What are valid measurement scales for these affordances?

Based on these two questions, the aim of this paper is consequently two-fold. First, this paper aims to identify the affordances that are salient in activity tracking. To this end, this paper makes an effort to offer a synthesized affordance framework based on an integrative perspective of related concepts, anecdotal user stories gathered from published research as well as from nine user interviews. Second, for the identified affordances, this paper develops and evaluates corresponding measurement instruments by focusing on content validity using a q-sort in two rounds (n=7 and n=55) that resulted in sufficient validity of the scales. In sum, this paper contributes to research with a synthesis of affordances and content-valid measurement instruments which provide important research avenues.

The remainder of this paper is structured as follows. In the next section, background information on activity tracking is presented and the theory of affordances is introduced. Subsequently, we outline the methodological approach for the affordance identification. Then, we report the scale development and evaluation process resulting in a content-valid instrument. Lastly, avenues for application of these affordances to study activity tracking are outlined and practical implications are derived.

Background

Activity Tracking as Persuasive and Gamified Health System

In recent years, a steady increase of technologies aiming to persuade or motivate people towards beneficial behaviors can be observed (Hamari et al. 2014a). Though termed differently either traditionally as 'persuasive technology' or more recently as 'gamification', such concepts usually entail the vision to use a certain technology to reinforce, change or shape attitudes about an issue, object or action in a desirable direction (Fogg 2003; Hamari et al. 2014a; Oinas-Kukkonen and Harjumaa 2009). Amongst the many areas in which such technologies systems are deemed to be useful, especially the health area is seen as a promising avenue by motivating people towards more healthy behaviours (Oinas-Kukkonen and Harjumaa 2009).

A huge variety of prospective technological features have been proposed –termed either as 'persuasive design principles' (Oinas-Kukkonen and Harjumaa 2009), 'gamification elements' (Blohm and Leimeister 2013), or 'motivational affordances' (Hamari et al. 2014a; Zhang 2008)– that are considered to aid achieving the targeted outcomes. As pointed out by Bui et al. (2015), these separate concepts have a considerable overlap as gamification matches with persuasive principles. Those usually entail features such as immediate feedback about progress and success as well as goal-setting support with features like scores, badges, trophies, levels or challenges; support for social relatedness, social recognition, and social comparison trough features like leaderboards, rankings, competitions, or conversations; support for autonomy through granting user-choices towards goals and activities; etc. (cf. Blohm and Leimeister 2013; Johnson et al. 2016; Oinas-Kukkonen and Harjumaa 2009; Seaborn and Fels 2015). Application of these principles and features is seen as "a promising new approach to health behavior change" (Johnson et al. 2016, p. 90).

However, whilst much of the extant literature on persuasive and gamified literature reports positive outcomes, scholars increasingly note that the effectiveness is mixed and context specific – but also

varies among individuals (Böckle et al. 2017; Hamari et al. 2014b; Seaborn and Fels 2015). Hence, there are raising concerns about the applicability of the 'one-size-fits-all' approach of these features (Hamari et al. 2014b; Seaborn and Fels 2015). As equally echoed in motivation theories, scholars increasingly become aware that differences of the users –such as motives and goals– must be taken into account when seeking to design effective persuasive features (Böckle et al. 2017; Hamari et al. 2014b). Yet there is a notable lack of studies that address this interplay, as the majority of the available studies analyzed a given application holistically although several persuasive/gamified features have been incorporated (Hamari et al. 2014b).

Given that many of the available applications increasingly incorporate such features (Lister et al. 2014), it becomes important for both, research and practice, to better understand the relationship between user characteristics and features incorporated in order to understand how people interact with such applications, how they perceive the features, and what makes the application effective to achieve the desired outcomes. Thus, a concrete understanding about the potential uses of the technology and its features to aid target behaviors is needed. Against this backdrop, the concept of 'affordances' can be a viable approach as it relates the features of the IT artefact with the characteristics of the user.

Affordances

By considering both, the characteristics of the technology and that of the users, IS scholars increasingly consider the concept of affordances. Rooted in ecological psychology, the concept of affordances embarks the idea that actors directly perceive the actionable attributes of an object: what the object may allow them to do (Stoffregen 2003). The affordance concept entails the material properties of an object in relationship with the actor's goals and thus reflects the possibilities for action an object holds to an actor (Stoffregen 2003). In the IS context, the affordance perspective focuses on the action potentials of technologies (Tim et al. 2018), where affordances can be defined as "the possibilities for goal-oriented action afforded to specified user groups by technical objects" (Markus and Silver 2008, p. 622). Thus, distinct from solely considering the features of a technology –which are the designated functionalities built into the technology–, affordances consider the potential ways of using IT artefacts and features as perceived by an individual (Grgecic et al. 2015).

An affordance perspective, hence, focuses on the relationship between actors (i.e. users) and the material features of a technology and therefore allows to explain why the same technology may provide different affordances to different actors (Giermindl et al. 2017). Thus, affordances offer a "concrete understanding of the uses of the technological artifact" (Tim et al. 2018, p. 4) and are considered as a means to study effective IT use, where "effective use is that type of use that helps attain desired goals" (Burton-Jones and Volkoff 2017, p. 1). Recent research highlights the distinct lens affordances hold to study IT uses. For instance, it allows theorizing how IS use can fulfill basic psychological needs (Karahanna et al. 2017) and others found the lens particularly useful to understand why users do not engage with a given technology (Giermindl et al. 2017).

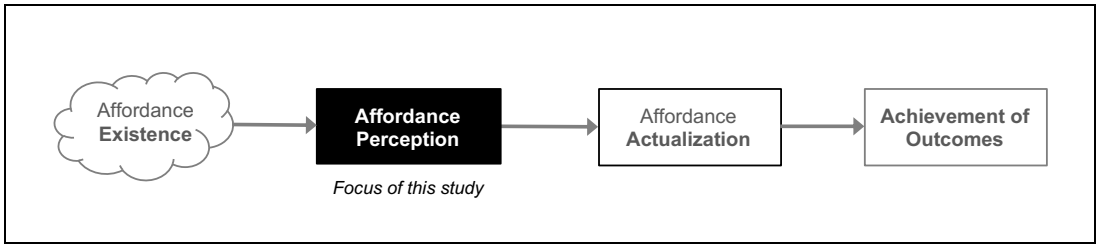

Figure 1. Framework for Studying Affordances

In IS research, there is agreement upon how affordances can be studied as a process consisting of four distinct phases that build upon another as depicted in Figure 1: affordance existence, affordance perception, affordance actualization, and effect or achievement of outcomes (Bernhard et al. 2013; Lehrig et al. 2017). *Affordance existence* refers to the theoretical (somewhat unlimited) space of options stemming out of the characteristics of the technology and the user (Bernhard et al. 2013; Lehrig et al. 2017). *Affordance perception* reflects the phase where a user becomes aware of an action

possibility (Bernhard et al. 2013; Lehrig et al. 2017). *Affordance actualization* denotes the actions taken by the user to take advantage of an affordance to achieve immediate concrete outcomes – i.e. the actual use of the technology for an action (Bernhard et al. 2013; Burton-Jones and Volkoff 2017; Lehrig et al. 2017; Strong et al. 2014). The *effect phase* considers the results out of the actualization process and thereby the outcomes gained from using IT in a particular way.

In this paper, we focus on the affordance perception phase as this phase is characterized by active involvement of the user and thus denotes the understanding the user has about the potentials for particular actions (Lehrig et al. 2017). This stage sets the baseline for the further phases concerning the actualization of affordances as well as its resulting effects. In this respect, it is important to note that due to the relational nature of affordances, multiple affordances can emerge out of an actor-material relationship. A chair, for instance, may not only a 'sitting' affordance but also a 'standing-on' affordance (Volkoff and Strong 2013). In the context of activity tracking apps, a leaderboard feature, for instance, may allow one person to compare its physical activity with that of others in order to increase self-insight, another person may find the purpose of a leaderboard to gain acknowledgement and respect of others for her/his activities or to increase its social status.

Extant literature exists that identified particular affordances for particular contexts, such as organizational (Treem and Leonardi 2013; Vaast and Kaganer 2013), private (Karahanna et al. 2017), and other social media uses (Bernardi 2016; Harindranath et al. 2015; Mesgari and Faraj 2012), service robots in hospitals (Mettler et al. 2017), electronic health record systems (Strong et al. 2014), or other particular systems (Volkoff and Strong 2013). Yet, as pointed out by Markus and Silver (2008), it is important to note that no single set of affordances will work for every technology.

Little is known about the affordances salient in activity tracking. Given the potentially different ways people how people can interpret and utilize the functionalities incorporated, it is important to identify the affordances salient in this context. We deem the affordance perspective as particularly useful as it holds great potentials to study why and how people interact with activity tracking systems and thus holds potential to study why and how the potential outcomes may occur. Against this backdrop, valid assessment instruments for these affordances are equally needed to aid empirical research.

Research Method

This paper seeks to identify the salient affordances of activity tracking and to develop according measurement items. Therefore, this section is divided into two parts. The first part describes our methodological approach to identify the affordances salient in the activity tracking context. The second part describes our efforts in developing and evaluating according measurement instruments.

Identification of Salient Affordances in Activity Tracking

As with any affordance-based study, the identification of salient affordances of a particular technology is an important and necessary step. This step is characterized as a qualitative inquiry as it is targeted at getting a thorough understanding about the (potential) purposes for which these apps and respective features incorporated are employed for (e.g. Mettler et al. 2017; Strong et al. 2014).

Our analysis was guided by prior approaches of affordance-based studies (Karahanna et al. 2017; Mettler et al. 2017) and thus informed by a variety of informational sources as outlined in Table 1. First, we took an integrative perspective on existing literature. Our analysis started by reviewing qualitative inquiries and anecdotal stories reported in prior literature in order to get a deep understanding how people interact with these systems. Then we sought to align these insights with existing concepts and terminology within the overlapping domains of 'gamification', 'persuasive systems' and 'motivational affordances' as well as with the wider theme of 'behaviour change techniques' (Bui et al. 2015). Second, we analysed vendor's marketing efforts (e.g., websites and press releases) how these apps and incorporated features are described and advertised. Additionally, nine interviews with actual activity tracking users were conducted.

Table 1. Example Sources for Affordance Identification

Area	Sources
Conceptual Underpinnings	• Gamification (Blohm and Leimeister 2013; Bui et al. 2015; Thiebes et al. 2014) • Persuasive System Design (Oinas-Kukkonen and Harjumaa 2009) • Motivational Affordances (Jung et al. 2010; Zhang 2008) • Social Media (Karahanna et al. 2017) • Behavior Change Techniques (Abraham and Michie 2008; Michie et al. 2011)
User Insights	• Nine interviews with actual users • Qualitative research and anecdotal user stories (e.g. Barratt 2017; Hafermalz et al. 2015; Hamari and Koivisto 2013; Sjöklint et al. 2015; Smith and Treem 2016; Yoganathan and Kajanan 2015; Zhang and Lowry 2016; Zhou et al. 2016)
Vendor Insights	• Feature lists and descriptions published on websites and press releases (e.g. Fitbit, Strava)

The integrative approach allowed us to qualitatively extract the main affordances and to align the terminology with existing concepts proposed in prior literature. As a result of this approach, eight affordances were identified that are salient in activity tracking apps. Table 2 entails these affordances, their corresponding definitions as well as examples of respective features. We outline these affordances in the following lines.

Table 2. Identified Salient Affordances in Activity Tracking

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 for 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
Self-Presentation	Possibility to create and communicate unique self-identity and image	Profile page, sharing/posting activities

Self-Monitoring. Self-monitoring denotes "the systematic observation and recording of target behaviors" (Baker and Kirschenbaum 1993, p. 377), is a key technique for behavior change (Abraham and Michie 2008) and therefore considered as important design principle for persuasive systems (Oinas-Kukkonen and Harjumaa 2009). Moreover, self-monitoring embodies the cornerstone of self-tracking practices that are "directed at regularly monitoring and recording, and often measuring, elements of an individual's behaviours or bodily functions" (Lupton 2016, p. 2). Thus, the self-monitoring affordance of activity tracking apps entails the possibility to systematically document and observe one's physical activity. In self-tracking, people seek to observe trends within their recordings whether they are making progress, to ensure themselves in maintaining their target behavior, but also to increase self-awareness about (un)healthy behavior (Barratt 2017; Lee and Drake 2013; Li et al. 2011; Sjöklint et al. 2015). Not surprisingly, functionalities directed at self-monitoring can be found in nearly all of the available health and fitness tracking apps (Lister et al. 2014).

Performance Analysis. Individuals engaging in self-tracking often perform sophisticated analyses on their recorded metrics in an attempt to get a deeper understanding about their behavior and performance (Gimpel et al. 2013). In the context of sports and performance, the comparison of data is of high centrality where performance analysis involves assessing performance indicators that reflect 'action variables' that define certain or all aspects of performance (Hughes and Bartlett 2002). Consequently, the performance analysis affordance reflects the possibility to systematically analyze and evaluate performance indicators.

Exercise Guidance. Many of the available health and fitness apps incorporate means in providing training and guidance to increase the physical ability of an individual in order to perform a target behavior by providing informational contents such as videos or tutorials (Lister et al. 2014). According to behavior change research, addressing one's abilities to engage in particular behavior is considered central to achieve long-term behavioral change (Michie et al. 2011) and providing instructions acts as important technique (Abraham and Michie 2008).

Rewards. Persuasive and gamified systems as well as activity tracking apps in particular increasingly incorporate 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). Equally, provision of contingent rewards has been proposed as behavior change technique (Abraham and Michie 2008). Therefore, the rewards affordance in such apps entails the possibility to obtain virtual/cognitive incentives for physical activity.

Social Comparison. Social comparison generally comprises the process of evaluating one's own abilities, opinions and behaviors by comparing those to that of others (Festinger 1954). Social comparison is increasingly considered as means to induce a social dimension into persuasive systems (Oinas-Kukkonen and Harjumaa 2009). It is thereby 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). As such, providing opportunities for social comparison is considered as a viable behavior change technique (Abraham and Michie 2008) and acts as form of motivation why people engage in sports, such as running a marathon (Markland and Ingledew 1997). Thus, the social comparison affordance entails the possibility to compare one's performance against others.

Watching Others. Watching and observing the content –in terms of activities– of others can be frequently found in social media settings (Karahanna et al. 2017; Lallmahomed et al. 2013). From a persuasive system perspective, this resonates with 'social learning' (Oinas-Kukkonen and Harjumaa 2009) or 'vicarious learning'. Here, it is argued that a person will be more motivated to perform a certain behavior if she/he can observe others performing the focal behavior and its outcomes (Oinas-Kukkonen and Harjumaa 2009). In activity tracking apps, activities of others are usually found in newsfeeds where most recent physical activities of friends are presented.

Social Recognition. Social recognition describes the social feedback users receive on their behaviors from other users (Hamari and Koivisto 2013), such as support, respect or approval (Lin and Bhattacherjee 2010). In sports context, gaining recognition from others is seen as a motif why people, for instance, are running a marathon (Masters et al. 1993). It is also considered as important behavior change technique (Abraham and Michie 2008).

Self-Presentation. Self-presentation generally refers to "the process by which individuals attempt to control the impressions others have of them" (Dominick 1999, p. 647). As many of the available apps have social network functionalities incorporated, profile pages for each user are usually created automatically. Within these profiles, people can enter personal information, including photos of themselves and recorded activities will be displayed. Other users can access these profile pages. Moreover, activities recorded will also appear in other users newsfeed. Accordingly, these social network functionalities support users in presenting one's activity as well as communicating one's identity and personality to others (Proudfoot et al. 2018). As such, the self-presentation affordance reflects the possibility with which users can reveal and present information of themselves, such as sport and exercise activities, to others as a means to create and present unique self-identities (Karahanna et al. 2017; Suh et al. 2017)

Development of Corresponding Affordance Measurement Instruments

According to the framework for studying affordances depicted in Figure 1, an empirical assessment of the perception of the affordances identified sets the baseline to study their actualization and potential outcomes. As, hence, corresponding measurement instruments are needed but not fully readily available in prior literature, measurements have to be adapted or newly developed and especially evaluated regarding their content validity (Haynes et al. 1995; MacKenzie et al. 2011).

Content validity denotes "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). Establishment of content validity ensures that items correctly represent the targeted construct and do not tap into variables outside the focal construct domain (Haynes et al. 1995). The practice of content validation is a "multimethod, quantitative and qualitative process" and aims 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, we followed the widely applied procedure of Moore and Benbasat (1991) involving 1) generation of items representing each construct and 2) assessment of content validity using q-sort.

Step 1: Item Development

Based on the identified and defined affordance constructs, the first step is generate a pool of items that represent the conceptual domain of each construct (MacKenzie et al. 2011). Items should be written in simple, specific and concise wordings in order to avoid ambiguity from early on (Podsakoff et al. 2012). As recommended in prior literature (Haynes et al. 1995; Nunnally 1978), our item development process was informed by a variety of sources, including reviews of the literature, deductions from the corresponding definitions, previous research, and interviews as presented above in our affordance identification approach (cf. Table 1). Additionally, an exploratory review of existing and related constructs and hence potentially adaptable measurement instruments was conducted.

Hereto, initial measurements for 'social comparison' and 'rewards' affordances were found in gamification literature (Suh et al. 2017; Suh and Wagner 2017) as well as instruments for 'social recognition' (Hamari and Koivisto 2013) that also appeared in the sports motivation context (Masters et al. 1993). These served as input, adjusted to our context and new items were additionally created to reevaluate these existing measures.

In line with prior affordance studies (Grgecic et al. 2015; Suh et al. 2017), each item was preceded by the stem *"The fitness tracking app offers me the possibility to …"*, items were conceptualized as reflective scales as well as readily measurable Likert-type scales (i.e. 'strongly disagree' to 'strongly agree'). With this approach, an initial pool of about 100 items spanning the eight proposed constructs were written in English. This pool was then discussed with two colleagues from our university who had sufficient domain knowledge (i.e. both were active activity tracking app users) and also had experience in measurement development. During this discussion, items were reworded to better reflect each underlying construct or dropped if ambiguous. As a result of this preliminary evaluation, the initial pool was reduced to 61 items that were then iteratively evaluated in two rounds of q-sort.

Step 2: Q-Sort

In the second step, a q-sort procedure ('card-sorting') was applied to evaluate the content validity at a larger scale (Moore and Benbasat 1991; Nahm et al. 2002). This method involves assigning the items developed to one of the proposed categories (i.e. the affordances). For each category, a label and definition is presented (e.g., 'self-monitoring: possibility to systematically document and observe one's sport behavior'). An additional 'ambiguous' category was added to prevent forcing respondents to assign problematic items. The pool of items is then presented in a random order to each participant, who is asked to assign each item to one of the categories which the item best reflects.

If an item is consistently placed within one category, it is considered to demonstrate 'convergent validity' with the construct and 'discriminant validity' with all other constructs (Moore and Benbasat 1991). To assess the reliability of the sorting, two metrics have been calculated: 1) a 'hit-ratio' that reflects the frequency of items correctly assigned to the target category and 2) levels of agreement between the raters (raw agreement and Kappa) (Moore and Benbasat 1991). Yet it must be noted that

a q-sort procedure is much more a qualitative analysis than a strict quantitative technique. Hence, q-sort method is often applied with small sample sizes. We conducted the sorting procedure in two rounds administered using an online tool ('OptimalSort').

Sorting Round 1. In the first sorting round, seven participants (colleagues and friends) were invited in order to gain an initial impression about the suitability and clarity of the items. The overall hit-ratio was 74%, interrater raw agreement was 62% and kappa was 0.57 indicating an overall 'moderating agreement' amongst the participants (Landis and Koch 1977). Major areas for improvement were 'self-monitoring' in relation to 'performance analysis' where placement ratios were 50% and 67% respectively as items were overlapping. Hence, ambiguous items were inspected and either reworded or dropped from the pool. This led to an optimized and reduced pool of 50 items.

Sorting Round 2. As we developed the scales in English from the beginning as means to prevent potential reliability issues stemming from translations in further studies (Hess et al. 2014), an external evaluation with participants from an English-speaking country was needed. Hence, in the second sorting round, 60 participants located in the United States (U.S.) were invited via Amazon Mechanical Turk (MTurk). MTurk is a crowdsourcing service that has gained attraction as viable and reliable source for empirical research (Sheehan and Pittman 2016) such as in IS research (e.g. Lowry et al. 2016). Especially when conducted with respondents from the U.S., MTurk provides reliable results with demographics comparable to the general population and lends statistical conclusions similar to those of regular consumer or student panels (Steelman et al. 2014). Though MTurk participants receive monetary compensation, they are not only motivated by monetary incentives but also by interest in research and fun in spending free time (Paolacci et al. 2010). Hence, an MTurk sampling may be no better or worse compared to other samples (Landers and Behrend 2015). As a means to ensure high response quality from MTurk respondents (Mason and Suri 2012), only participants located in the U.S., who had actual experience with or at least sufficient awareness of fitness tracking apps, were qualified as 'MTurk Masters', had at least 500 prior tasks approved and a lifetime approval rate of at least 95% were invited. To ensure further response quality, we included two instructed-item attention checks where respondents had to assign these items to a certain category.

Table 3. Card Sorting Results of the Second Round (n=55)

	Initial Set				**Purified Set**			
Constructs (Affordances)	*Items*	*Hit-Ratio*	*Raw Agreement*	*Kappa**	*Items*	*Hit-Ratio*	*Raw Agreement*	*Kappa**
Self-Monitoring	5	82.55%	71.02%	0.674	4	87.27%	77.15%	0.743
Performance Analysis	9	78.59%	66.26%	0.620	4	90.91%	83.35%	0.813
Guidance	7	81.30%	69.77%	0.660	4	90.00%	81.14%	0.788
Rewards	5	97.82%	95.65%	0.951	4	98.18%	96.36%	0.959
Social Comparison	7	89.61%	81.06%	0.787	4	93.64%	87.81%	0.863
Watching Others	6	80.61%	68.61%	0.647	4	87.27%	77.46%	0.746
Social Recognition	6	85.45%	73.45%	0.701	4	87.73%	77.19%	0.743
Self-Presentation	5	78.55%	65.23%	0.609	4	85.00%	72.66%	0.692
Total	**50**	**84.31%**	**73.28%**	**0.699**	**32**	**90.00%**	**81.64%**	**0.793**

** Kappa Interpretation (Landis and Koch 1977): > 0.01 'slight agreement; > 0.21 'fair agreement'; > 0.41 'moderate agreement'; > 0.61 'substantial agreement'; > 0.81 'almost perfect agreement'*

Based on this, 55 usable and valid response sets were obtained. Out of the 55 respondents, 49% were female and 51% male. The average age was 38.9 years (min: 23, max: 65). 51% are active users, 23.6% discontinued users and 25.5% are not active users yet indicated awareness of these apps. Respondents were aware of the most popular apps, including Fitbit (91%), Nike+ Running (42%), MapMyRun (35%) or Garmin Connect (24%). Hence, respondents had sufficient domain expertise.

In this round, almost all items have been assigned dominantly to their intended category as indicated by the overall 'hit-ratio' of 84% that ranged between 78% for 'self-presentation' and 97% for 'rewards' (cf. Table 3). Concerning the rater reliability, the overall raw agreement score was 73% and

ranged between 65% (for 'self-presentation') and 95% (for 'rewards'). In addition, the total interrater kappa was 0.699 which can be interpreted as 'substantial agreement' between the respondents (Landis and Koch 1977). Hence, the refinements of the items led to satisfactorily support for content validity.

Table 4. Final Measurement Instrument

Construct	Hits		Items	Related
The fitness tracking app offers me the possibility to …				
Self-Monitoring	96%	SM1	monitor my sport behavior	Newly developed
	78%	SM2	document information about my sport activities	
	85%	SM3	keep track of my exercise activities	
	89%	SM4	record my physical activities	
Performance Analysis	91%	PA1	run statistics on my trainings	Newly developed
	85%	PA2	examine performance metrics in detail	
	96%	PA3	perform statistical analysis of performance metrics	
	91%	PA4	statistically analyze my sport performance indicators	
Exercise Guidance	87%	EG1	get guidance how to better perform physical exercises	Newly developed
	93%	EG2	get taught how to improve my physical activity	
	91%	EG3	receive instructions while doing physical activity	
	89%	EG4	get supervised to reach my physical activity goals	
Rewards	98%	RE1	make my physical activity rewarded	(Suh et al. 2017; Suh and Wagner 2017)
	98%	RE2	get more rewards if I try harder	
	98%	RE3	obtain virtual rewards (badges, trophies) for my physical activity	
	98%	RE4	earn virtual rewards as a token for my efforts in physical activity	
Social Comparison	89%	SC1	compare my performance with the performance of others	(Suh et al. 2017; Suh and Wagner 2017)
	96%	SC2	compare myself with others regarding what I have accomplished in exercising	
	93%	SC3	find out how I am doing in exercise compared to what others have done	
	96%	SC4	compete with others	
Watching Others	91%	WO1	observe others who are performing physical activities	Newly developed
	87%	WO2	follow sport activities of other people	
	95%	WO3	keep an eye on other people's way of doing sports	
	76%	WO4	get inspired by how others do physical activity	
Social Recognition	87%	SR1	earn compliments from others for my physical activity	(Hamari and Koivisto 2013; Masters et al. 1993)
	87%	SR2	earn respect of others for my physical activity	
	91%	SR3	get recognized from others for my sport behavior	
	85%	SR4	get noticed by others for my physical activity	
Self-Presentation	87%	SP1	express myself as physically active person	(Proudfoot et al. 2018)
	85%	SP2	establish a preferred image of myself as physically active person	
	82%	SP3	present myself as physically active person	
	85%	SP4	project an image about myself as physically active person	

Scale Purification. In order to derive a parsimonious set of high quality measurements, the scales were purified aimed at final four items for each construct. Here, items that were assigned correctly by less than 61% were removed (Landis and Koch 1977) and those four items with best assignment ratios were selected. As a result of this purification process, 32 items were retained, the overall 'hit-ratio' increased to 90% ranging from 85% (for 'self-presentation') to 98% (for 'rewards'). The interrater raw agreement increased to 82% and kappa values increased to 0.793 reflecting 'substantial agreement'. As such, for the purified scale and items selected, we conclude that a high degree of construct validity and therefore potential reliability had been achieved (Moore and Benbasat 1991). The final measurement instrument is reported in Table 4.

Discussion

Positioned to promote healthy behavior, activity tracking apps incorporate various functionalities to motivate people towards physical activity. Yet research on activity tracking apps frequently reports either positive, mixed, or even adverse effects of using such systems (Hamari et al. 2014a; Hamari et al. 2014b; Orji and Moffatt 2018; Seaborn and Fels 2015). Hence, there are increasing concerns about the effectiveness of these apps as they are oftentimes studied as a whole without paying attention to the effectivities of particular features incorporated (Hamari et al. 2014b; Johnson et al. 2016). Equally, scholars are increasingly aware that the features may not provide 'one-size-fits-all' solutions (Seaborn and Fels 2015) and are not necessarily valued equally by all users (Hamari et al. 2014b).

Against this backdrop, this paper applied the concept of affordances (Gibson 1986; Markus and Silver 2008) and identified eight affordances particularly salient in activity tracking apps and developed but also evaluated corresponding measurement instruments. This paper, hence, makes two contributions to research: First, a synthesized set of activity tracking affordances and second, corresponding, pre-validated measurements. We suggest that these two aspects can greatly facilitate further research:

As outlined in the background, the lens of affordances provides a unique perspective how people interpret a technology in dependence upon their goals and, hence, provides a precise understanding of the technology's uses (Burton-Jones and Volkoff 2017; Tim et al. 2018). Given the inconclusive results about the effectiveness of these applications, we suggest that further research can now readily apply this perspective to overcome an overly feature-centric perspective, to study the outcomes and consequences of using activity tracking, but also to study user characteristics as a means to overcome the 'one-size-fits-all' approach.

Motivations are considered as important factors of information systems success (Jung et al. 2010). Scholars advocate the idea that systems should be designed in such way that users' motivations are leveraged by fulfilling diverse psychological, cognitive, social, and even emotional needs (Jung et al. 2010; Zhang 2008). As affordances highlight the important role of 'user goals', we suggest that the proposed affordances can be studied with complementary goal- and motivation- theories. Achievement Goal Theory (Maehr and Zusho 2009), for instance, posits that people approach certain contexts, such as sports, with mastery and performance goals. Whilst people with a mastery-approach orientation focus on developing and improving competence, performance-approach orientations focus on demonstrating one's performance and to exceed others. From this perspective, the identified affordances could be as 'mastery-oriented' (i.e. self-monitoring, performance analysis, exercise guidance, rewards) and 'performance-oriented' affordances (i.e. social comparison, watching others, social recognition, self-presentation) as suggested by Zhang and Lowry (2016). Other theories might be more suited to study particular affordances, such as Self-Determination Theory (Deci and Ryan 2000), Self-Efficacy Theory (Bandura 1997), Goal Setting Theory (Locke and Latham 2002), Social Comparison Theory (Festinger 1954), or Self-Presentation Theory (Baumeister and Hutton 1987).

In this respect, our content-valid measurement instrument can be readily used for these research avenues. Although the instrument is targeted to assess the 'affordance perception' stage, we tentatively suggest that the instrument also serves to study the 'affordance actualization' stage (i.e. actual use). By drawing on the concept of 'deep structure use' (Burton-Jones and Straub 2006), researchers may easily adapt our instruments. For instance, to assess the actualization of the 'social comparison' affordance, the instrument can be adapted to *'When I use the activity tracking app, I use features that allow me to compare my performance with the performance of others'*. Hence, the instrument developed and evaluated here can serve as the empirical underpinnings to study these affordances and their potential outcomes (cf. Figure 1). Thus, the instrument developed contributes to unique measurement instruments of the self-tracking context (Baumgart and Holten 2018; Gimpel et al. 2013). Yet, as activity tracking apps encompass functionalities that are also conceptually proposed in 'gamification' and 'persuasive system' literature (e.g. Blohm and Leimeister 2013; Oinas-Kukkonen and Harjumaa 2009; Zhang 2008) as well as in the social media context (e.g. Karahanna et al. 2017), we suggest that these related domains can likewise draw upon this instrument.

For practice, our research holds important implications. Given the competition vendors face in this market, the inconclusive findings about the effectiveness of the features incorporated, as well as the concerns about the 'one-size-fits-all' approach, designers, promoters and vendors are in need to possess a thorough understand about their target group. The affordance perspective sheds light on how

users interpret the functionalities and offers a more concrete understanding of their potential uses. The eight affordances identified in this research can help practice to understand how the features can be potentially interpreted by users. 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'. As such, the affordance perspective has been promoted as a viable means to develop user profiles (Mesgari et al. 2015) and we suggest that it can also help to create effective advertising messages. Our proposed measurement instrument can help to survey the target group and to weigh the selection of features that need to be incorporated but also to potentially to develop novel features allowing firms to gain a competitive advantage in the market space.

Notwithstanding the contributions this paper holds, one has to take into account its limitations. Although our affordance identification method was informed by a variety of informational sources for triangulation purposes, we acknowledge that our eight identified affordances may be based on subjective interpretation and others may weigh the salience of the affordances differently or may find additional affordances. Second, concerning the measurement instrument, we focused on establishing content validity – the first and crucial step in the development of new scales (MacKenzie et al. 2011). Although this step increases the potential validity and reliability in subsequent studies, it should be noted that construct reliability and validity must be accordingly evaluated as a next step involving a larger quantitative study (MacKenzie et al. 2011; Moore and Benbasat 1991). Hence, in line with above outlined further research avenues, studies may re-evaluate the proposed affordances and need to establish further confidence in the reliability and validity of the measurement instrument.

References

Abraham, C. and Michie, S. 2008. "A Taxonomy of Behavior Change Techniques Used in Interventions," *Health Psychology* (27:3), pp. 379–387.

Baker, R. C. and Kirschenbaum, D. S. 1993. "Self-monitoring may be necessary for successful weight control," *Behavior Therapy* (24:3), pp. 377-394.

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

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

Baumeister, R. F. and Hutton, D. G. 1987. "Self-Presentation Theory: Self-Construction and Audience Pleasing," in *Theories of Group Behavior,* B. Mullen and G.R. Goethals (eds.), New York, NY: Springer, pp. 71-87.

Baumgart, R. and Holten, R. 2018. "How Does Self-Tracking Go? A Research Model and Pre-Test," In: *Proceedings of the Hawaii International Conference on System Sciences*. Big Island.

Bernardi, R. 2016. "How Do Online Communities of Patients Aggregate on Twitter? An Affordance Perspective," In: *Proceedings of the International Conference on Information Systems*. Dublin, Ireland.

Bernhard, E., Recker, J. C., and Burton-Jones, A. 2013. "Understanding the Actualization of Affordances: A Study in the Process Modeling Context," In: *Proceedings of the International Conference on Information Systems*. Milan, Italy.

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.

Böckle, M., Novak, J., and Bick, M. 2017. "Towards Adaptive Gamification: A Synthesis of Current Developments," In: *Proceedings of the European Conference on Information Systems*. Guimarães, Portugal.

Bui, A., Veit, D., and Webster, J. 2015. "Gamification–A Novel Phenomenon or a New Wrapping for Existing Concepts?," In: *Proceedings of the International Conference on Information Systems*. Fort Worth.

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.

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.

Dominick, J. R. 1999. "Who do you think you are? Personal home pages and self-presentation on the World Wide Web," *Journalism & Mass Communication Quarterly* (76:4), pp. 646-658.
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. 1986. *The Ecological Approach to Visual Perception*. Mahwah, NJ: Lawrence Earlbaum.
Giermindl, L., Strich, F., and Fiedler, M. 2017. "Why do you NOT use the Enterprise Social Network? Analyzing Non-Users' reasons through the lens of Affordances," In: *Proceedings of the International Conference on Information Systems*. South Korea.
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.
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.
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.
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., 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*.
Harindranath, G., Bernroider, E. W. N., and Kamel, S. H. 2015. "Social Media and Social Transformation Movements: The Role of Affordances and Platforms," In: *Proceedings of the European Conference on Information Systems*. Münster.
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.
Hess, T. J., McNab, A. L., and Basoglu, K. A. 2014. "Reliability Generalization of Perceived Ease of Use, Perceived Usefulness, and Behavioral Intentions," *MIS Quarterly* (38:1), pp. 1-28.
Hughes, M. D. and Bartlett, R. M. 2002. "The use of performance indicators in performance analysis," *Journal of Sports Sciences* (20:10), pp. 739-754.
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.
Jung, J., Schneider, C., and Valacich, J. 2010. "Enhancing the Motivational Affordance of Information Systems: The Effects of Real-Time Performance Feedback and Goal Setting in Group Collaboration Environments," *Management Science* (56:4), pp. 724-742.
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. 2017. "The Needs-Affordances Features (NAF) Perspective for the Use of Social Media," *MIS Quarterly* (in press).
Lallmahomed, M. Z., Rahim, N. Z. A., Ibrahim, R., and Rahman, A. A. 2013. "Predicting different conceptualizations of system use: Acceptance in hedonic volitional context (Facebook)," *Computers in Human Behavior* (29:6), pp. 2776-2787.
Landers, R. N. and Behrend, T. S. 2015. "An inconvenient truth: Arbitrary distinctions between organizational, Mechanical Turk, and other convenience samples," *Industrial and Organizational Psychology* (8:2), pp. 142-164.
Landis, J. R. and Koch, G. G. 1977. "The Measurement of Observer Agreement for Categorical Data," *Biometrics* (33:1), pp. 159-174.
Lee, V. R. and Drake, J. 2013. "Digital Physical Activity Data Collection and Use by Endurance Runners and Distance Cyclists," *Technology, Knowledge and Learning* (18:1), pp. 39-63.
Lehrig, T., Krancher, O., and Dibbern, J. 2017. "How Users Perceive and Actualize Affordances: An Exploratory Case Study of Collaboration Platforms," In: *Proceedings of the International Conference on Information Systems*. Seoul, South Korea.

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.
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.
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.
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), pp. e9.
Locke, E. A. and Latham, G. P. 2002. "Building a Practically Useful Theory of Goal Setting and Task Motivation," *American Psychologist* (57:9), pp. 705-717.
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., 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.
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.
Markland, D. and Ingledew, D. K. 1997. "The measurement of exercise motives: Factorial validity and invariance across gender of a revised Exercise Motivations Inventory," *British Journal of Health Psychology* (2:4), pp. 361-376.
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.
Mason, W. and Suri, S. 2012. "Conducting behavioral research on Amazon's Mechanical Turk," *Behavior Research Methods* (44:1), pp. 1-23.
Masters, K. S., Ogles, B. M., and Jolton, J. A. 1993. "The development of an instrument to measure motivation for marathon running: The Motivations of Marathoners Scales (MOMS)," *Research Quarterly for Exercise and Sport* (64:2), pp. 134-143.
Mesgari, M. and Faraj, S. 2012. "Technology Affordances: The Case of Wikipedia," In: *Proceedings of the Americas Conference on Information Systems*. Seattle.
Mesgari, M., Okoli, C., and Ortiz de Guinea, A. 2015. "Affordance-based User Personas: A mixed-method Approach to Persona Development," In: *Proceedings of the Americas Conference on Information Systems*. Puerto Rico.
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), pp. 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.
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.
Nunnally, J. C. 1978. *Psychometric Theory*, (2 ed.). New York: McGraw-Hill.
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. 2018. "Persuasive technology for health and wellness: State-of-the-art and emerging trends," *Health Informatics Journal* (24:1), pp. 66-91.
Paolacci, G., Chandler, J., and Ipeirotis, P. G. 2010. "Running Experiments on Amazon Mechanical Turk," *Judgment and Decision Making* (5:5), pp. 411–419.

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.

Proudfoot, J. G., Wilson, D., Valacich, J. S., and Byrd, M. D. 2018. "Saving face on Facebook: privacy concerns, social benefits, and impression management," *Behaviour & Information Technology* (37:1), pp. 16-37.

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

Sheehan, K. and Pittman, M. 2016. *Amazon's Mechanical Turk for Academics: The HIT Handbook for Social Science Research*. Irvine, CA: Melvin & Leigh Publishing.

Sisson, S. and Katzmarzyk, P. 2008. "International prevalence of physical activity in youth and adults," *Obesity Reviews* (9:6), pp. 606-614.

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, 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.

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.

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., Cheung, C. M., Ahuja, M., and Wagner, C. 2017. "Gamification in the Workplace: The Central Role of the Aesthetic Experience," *Journal of Management Information Systems* (34:1), pp. 268-305.

Suh, A. and Wagner, C. 2017. "How gamification of an enterprise collaboration system increases knowledge contribution: an affordance approach," *Journal of Knowledge Management* (21:2), pp. 416-431.

Thiebes, S., Lins, S., and Basten, D. 2014. "Gamifying Information Systems-a Synthesis of Gamification Mechanics and Dynamics," In: *Proceedings of the European Conference on Information Systems*. Tel Aviv.

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.

Treem, J. W. and Leonardi, P. M. 2013. "Social media use in organizations: Exploring the affordances of visibility, editability, persistence, and association," *Annals of the International Communication Association* (36:1), pp. 143-189.

Vaast, E. and Kaganer, E. 2013. "Social media affordances and governance in the workplace: An examination of organizational policies," *Journal of Computer-Mediated Communication* (19:1), pp. 78-101.

Volkoff, O. and Strong, D. M. 2013. "Critical Realism and Affordances: Theorizing IT-Associated Organizational Change Processes," *MIS Quarterly* (37:3), pp. 819-834.

Yoganathan, D. and Kajanan, S. 2015. "Designing Fitness Apps Using Persuasive Technology: A Text Mining Approach," In: *Proceedings of the Pacific Asia Conference on Information Systems*. Singapore, Singapore.

Zhang, J. and Lowry, P. B. 2016. "Designing Quantified Self 2.0 Running Platform to Ensure Physical Activity Maintenance: The Role of Achievement Goals and Achievement Motivational Performance," In: *Proceedings of the Pacific Asia Conference on Information Systems*. Chiayi, Taiwan.

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

Zhou, Y., Kankanhalli, A., and Huang, K.-W. 2016. "Effects of Fitness Applications with SNS: How Do They Influence Physical Activity," In: *Proceedings of the International Conference on Information Systems*. Dublin, Ireland.