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DESIGNING QUANTIFIED-SELF 2.0 RUNNING PLATFORM TO ENSURE PHYSICAL ACTIVITY MAINTENANCE: THE ROLE OF ACHIEVEMENT GOALS AND ACHIEVEMENT MOTIVATIONAL AFFORDANCE

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Abstract:

With the rapid development of wearable technologies, people can nowadays easily track and record their health-related information—particularly their athletic performance. The quantified-self 2.0 (QS 2.0) movement encourages running website or mobile application users to share their athletic information with other online community members to ensure the sustainable use of the technology and the maintenance of physical activity. However, the health literature claims that health behavior maintenance is difficult because it is easy for people to give up on the regular physical exercise during the maintenance stage, considering the unforeseen barriers and temptations that may occur in the long term. Drawing upon a motivational affordance perspective and the achievement goal theory (AGT), this theory-based manuscript provides design principles for QS 2.0 running platforms, with the purpose to increase users' physical activity maintenance (PAM). Additionally, we propose a conceptual model explaining the underlying mechanism in terms of how these affordance design principles serve as the sources of two kinds of achievement goals, namely mastery goals and performance goals, which has distinct roles in determining users' longitudinal exercise performances.

Keywords: wearable device, quantified-self, running platforms, physical activity maintenance, motivational affordance, achievement goal, mastery goal, performance goal

1. INTRODUCTION

Wearable technologies (or wearable devices) are miniaturized electronic devices that can be worn by consumers (e.g., smart watches and smart bands), often with a purpose of tracking information related to health and fitness (Zhang et al. 2015). Along with increasing healthcare costs and individuals' growing concerns on their health conditions, wearable devices are now widely used as health monitoring tools in people's daily lives to record their athletic performances (e.g., measurements relating to running and other sports) and vital signs (e.g., body temperature, heart rate, and blood pressure) (Pantelopoulos & Bourbakis 2010; Zhang et al. 2015). According to Rackspace (2013), about 61% and 73% of people in the United Kingdom and in the United States, respectively, found wearable devices to be important for their healthcare management. The market value of wearable devices, which was only about $6.3 million in 2010, is expected to grow to about $12.6 billion by 2018 (Statista 2014).

The widespread use of wearable technology and the ease of gathering athletic performance have led to the concept of "quantified-self." The quantified-self movement advocates that online running platforms (including running websites and running mobile apps) should take full use of the data points recorded by wearable devices to quantify consumers' health conditions by visualizing these inputs in a user-friendly interface to provide timely and accurate feedback and suggestions for consumers' health behaviors (Swan 2009). This idea has quickly evolved into a quantified-self 2.0 (QS 2.0) movement supported by online health communities that encourage their users to exchange their quantified healthcare data with other social networking members (Swan 2012). For instance, in the Fitbit QS 2.0 community (www.fitbit.com), users who participate in the same activity group can view each other's physical exercise performance on a leaderboard, thus encouraging users to compete with each other to achieve higher health performance. In QS 2.0 running platforms, users can also make friends with others to exchange their health-related experience and to seek suggestions in terms of their health behavior (e.g., doing more exercise and controlling blood pressure). The existing literature has shown that participating in such running platforms has a significant positive influence on users' health-seeking behaviors (Kamel Boulos & Wheeler 2007). For instance, Maryea (2014) suggests that the social interaction among community members of the running platform successfully motivates users to engage in more physical exercise and improve their overall health. According to Wang (2012), adopting the Fitbit running platforms leads to more than a 40 percent increase in longitudinal physical exercise performance.

However, QS 2.0 running platforms face great challenges, as there is a lack of sustainable use of wearable devices and some of the running platforms have lost subscribers. According to a recent industrial report, about one-third of wearable device and the associated running platform users typically stop using the technology within six months (Ledger & McCaffrey 2014). Another survey found that more than half of the wearable device wearers and running platform users stopped using these healthcare technologies within a few months because they lost interest in them or don't have the willpower to stick on PAM (Hammond 2014). Evidence from the health literature explains why the sustainable use of such QS 2.0 running platforms is a great challenge. According to the National Institutes of Health (2015), the maintenance of health behavior can be very difficult in the context of weight loss, physical exercise, smoking cessation, and so forth. The lack of will power and self-efficacy is an important reason why

that people do not maintain physical exercise, despite their strong intention to seek for good health (Schwarzer 2008). Longitudinal athletic performance requires not only that people have a keen interest and strong intention when initiating a health behavior, but they must also have a strong willpower and longitudinal goals to sustain the behavior over time (Rothman et al. 2004).

The theory of health action process approach (HAPA) suggests that there is a huge *intention-behavior gap* between the intention to maintain health behavior and the actual effort spent in health-enhancing behaviors (e.g., doing physical activities) and avoiding health-compromising behaviors (e.g., smoking) (Schwarzer 2008). Despite the strong willingness to engage in good health behavior, people often "do not behave in accordance with their intentions [because] …unforeseen barriers could emerge, or people might give in to temptations" (Schwarzer 2008, p. 1). HAPA suggests there is "a distinction between (a) pre-intentional processes that lead to a behavioral intention, and (b) post-intentional volition processes that lead to the actual health behavior" (Schwarzer 2008, p. 1). Particularly, planning and maintenance self-efficacy, rather than health behavioral intention, are two of the most crucial factors determining behavior maintenance. For these reasons, better designs of running platforms to ensure sustained engagement in the post-intentional process are crucial for the long-term success of these platforms.

Until now, little research has examined the key factors and the underlying mechanisms for the sustainable use of such QS 2.0 running platforms—especially the key issues with the intentions-behaviors chasm in this context. Drawing on the AGT, this study identifies two kinds of achievement goals, namely mastery goals and performance goals, which can influence users' sustained efforts in the post-intentional phase and their longitudinal performances (Ames 1992; Dweck 1986). *Mastery goals* are related with developing one's ability and completing tasks, whereas *performance goals* are related with demonstrating high ability to others. One of the research propose of this study is to examine the roles of these two achievement goals in determining the post-intentional predictors of PAM.

Finally, little information system (IS) literature has provided theory-based design principles for QS 2.0 running platforms to better support users' achievement goals and design their websites and applications to support the continued engagement of users. As noted by Evers et al. (2003), one of the major weaknesses of the current designs of online healthcare communities and systems is that few of them are based on theory. To address this research gap, our study aims to provide theory-driven design approaches for running platforms to support achievement goals, based on the motivational affordance design principles.

Summarizing the above theoretical gaps and research motivations, we propose our research questions as follows:

- How can two kinds of achievement goals (i.e., mastery goals and performance goals) influence the post-intentional phase of PAM?
- What are the motivational affordances QS 2.0 running platforms should have to support users' achievement goals and PAM?

To address these two research questions, our essay and subsequent theoretical model roots its foundation in the AGT to explain the different influence of mastery goals and performance goals in determining longitudinal effects of PAM. We then introduce a motivational affordance perspective to propose six kinds of motivational affordances that QS 2.0 running platforms should have and list the existing design examples that support motivational affordance. In the hypotheses development section, we propose a

conceptual model to explain how motivational affordance of running platforms can support users achievement goals and further influence the post-intentional phase of PAM. Finally, we briefly discuss our proposed research design and data collection procedures, and then introduce our plan for completing the research.

2. THEORETICAL BACKGROUND

2.1 Achievement goal theory

Achievement goal theory (AGT), also termed as goal orientation theory, is originally proposed in education research to understand students' motivations of learning and predict the learning outcomes (Ames 1992; Dweck 1986). AGT then is further extended to explain various kinds of achievement behaviors, such as classroom learning, doing physical exercise (Biddle et al. 2003; Standage et al. 2003) and job performance of employee (Janssen & Van Yperen 2004). According to AGT, in these achievement context, behaviors can be viewed as "purposeful, intentional, and directed toward the attainment of certain goals" (Meece et al. 2006, p. 490), and the goals or achievement motivations can be briefly described as "developing or demonstrating high rather than low ability" (Nicholls 1984, p. 328).

AGT specifies two types of achievement goals that drives achievement-related behaviors, namely, mastery goals (i.e., task-involved goals) and performance goals (i.e., ego involved goals) (Ames 1992; Maehr & Zusho 2009; Nicholls 1984). *Mastery goals* are defined as the focuses on "developing one's abilities, mastering a new skill, [and] trying to accomplish something challenging," whereas *performance goals* refers to the focuses on "demonstrating high ability relative to others, striving to be better than others, and using social comparison standards to make judgments of ability and performance" (Meece et al. 2006, p. 490).

In the context of QS 2.0 running platform, we argue that both these two types of achievement goals exist. Individual users has mastery goals such as completing pre-set daily exercise tasks and learning new physical activity skills through regular exercise, while they have performance goals of achieving better physical activity performances than others or obtaining higher ranking in a leaderboard (Duda 1989). In the hypotheses development part, we will discuss the different influences of mastery and performances goals on PAM.

2.2 Motivational climate created by motivational affordances of running platform

From the perspective of AGT, literature on PAM has explored the environmental factors that support individuals' achievement goals. They propose the concept of *motivational climate* to describe the extent to which the context or social environment of individuals can support their achievement motivations of individuals during PAM (Kavussanu & Roberts 1996; Kuczka & Treasure 2005). Consistent with AGT, *mastery motivational climate* refers to the degree to which the environment provides specific environmental cues that support mastery goals. To increase mastery motivational climate, the context should "encourage effort, learning, mastery of the task, and participation" (Kavussanu & Roberts 1996, p. 265). Performance motivational climate is defined as the degree to which the environment provides

specific environmental cues that support performance goals. According to Kavussanu and Roberts (1996, p. 265), to support performance goals, the environment should emphasize "interpersonal competition, normative feedback, public evaluation, and social comparison." Notably, mastery and performance motivational climates are not the opposite of each other; instead, they can coexist as certain contexts can involve specific environmental cues that make salient both mastery and performance goals.

Constructs	Operational definitions	Existing design examples
Perceived affordance for task accomplishment	The perceived ability of the website / mobile app that informs the user about their achievement when they complete certain physical activity tasks and reach certain milestones.	• Daily task setting • Badges when reach milestones • Timely feedback or exercise report
Perceived affordance for learning	The perceived extent to which the website / mobile app supports learning knowledge and skills related with doing physical activity.	• Q&A webpages • Articles teaching exercise skills • Online forum for experience sharing
Perceived affordance for task autonomy	The perceived extent to which the platform provides users with the ability to have their personalized ways of using the platform according to their free will (Lickerman 2012).	• Personalized exercise program and schedule • Personalized privacy settings for disclosing athletic information

Table 1. Mastery motivational affordances of QS 2.0 running platforms

Constructs	Operational definitions	Existing design examples
Perceived affordance for self-presentation	The perceived extent to which the website / mobile app enables users to present "themselves to others regarding their identities" (Kamel Boulos & Wheeler 2007, p. 45).	• Export / share your performance • Friends can view your badges / performance • Title, level, avatar or identifier
Perceived affordance for social comparison	The perceived extent to which the website / mobile app supports users to evaluate their health performance by comparing themselves with other people.	• Leaderboard • Group ranking • Compete with other users
Perceived affordance for leadership	The perceived extent to which the website / mobile app enable users to perceive themselves as people that holds a dominant or superior position within the user community and experience as role models.	• Leaderboard • Level and status: e.g. team leader, outstanding members

Table 2. Performance motivational affordances of QS 2.0 running platforms

Corresponding to the concept of motivational climate in the physical context, we introduce the concept of motivational affordance to capture the ability of QS 2.0 running platform that support users' achievement motivations. According to Zhang (2008, p. 145), *affordance* is defined as "the actionable

properties between an object and an actor." If the technological affordance is perceived, IT users will "take actions that may satisfy certain needs" (Zhang 2008, p. 145). Specifically, *achievement motivational affordance* refers to the degree to which an IT artifact can support users' achievement motivations or goals. Zhang (2008, p. 146) proposed ten design principles for motivational affordance, and six of them are directly related with achievement motivations, namely: "[e]nable the creation of self-identity and promote self-presentation", "[d]esign optimal challenges for users to achieve", "[p]rovide timely and positive feedback", "[f]acilitate communication and interactions among users", "[r]epresent a social bond among users", and "[f]acilitate users' desire to influence others".

We refer to these design principles to propose six achievement motivational affordances that healthcare technology should have, and categorize them as three mastery motivational affordances and three performance motivational affordances, as shown in Table 1 and Table 2.

3. RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

Here, we propose a conceptual research model as shown in Figure 1. In the first two hypotheses, we identify two crucial post-intentional factors suggested by HAPA as the direct predictors of PAM. In the third and fourth hypotheses, we illustrate the roles of achievement goals in determining users' planning and maintenance self-efficacy. We finally discuss how can motivational affordances of QS 2.0 running platform influence users achievement goal structures, in the fifth and sixth hypotheses.

3.1 Post-intentional predictors of PAM

Health literature suggests that intention is not a good predictors of PAM, because various unforeseen barriers (e.g., too busy) and temptations (e.g., feeling lazy) may occur after one initiating health behaviors (Schwarzer 2008). Instead, the theory of HAPA suggest that two factors that reflecting the post-intentional phase, namely planning and maintenance self-efficacy, is crucial in determining PAM. Planning helps to establish the standards for action and create crucial cues for self-monitoring (Sniehotta et al. 2005). With detailed planning, even when individuals have the willingness to suspend regular exercise for a while, they can rely on self-regulatory action to stick with the pre-set plans. *Maintenance self-efficacy* refers to people's beliefs about their capability to "sustain the behavior regardless of barriers specific to the maintenance period" (Luszczynska & Sutton 2006, p. 315). Such barriers and temptations may preventing individuals' continuous efforts on health behavior. With higher maintenance self-efficacy, individuals respond more "confidently with more effort, and prolonged persistence" to overcome these unforeseen difficulties (Sniehotta et al. 2005, p. 146). We hypothesize:

H1: Planning is positively associated with physical activity maintenance.

H2: Maintenance self-efficacy is positively associated with physical activity maintenance.

3.2 The influence of mastery goals and performance goals on the post-intentional phase

According to AGT, mastery goals and performance goals have different influences on task planning and sustained efforts. Mastery goals are associated with adaptive patterns of behavioral and psychological outcomes such as adaptive motivation, emotional well-being, and cognitive engagement, whereas performance goals have been associated with maladaptive behavioral patterns(Linnenbrink 2005).

Treasure and Roberts (1995) also suggested that mastery goal is a strong predictor of peoples' perceived behavioral control. Hence, it is more likely for people with higher mastery goals and lower performance goals to develop cognitive strategies such as self-monitoring and self-regulation to ensure sustained efforts, which are embodied in their pre-set regular exercise plan (Pintrich 2000). Hence, we hypothesize:
H3(a): Mastery goal has a positive influence on planning.
H3(b): Performance goal has a negative influence on planning.

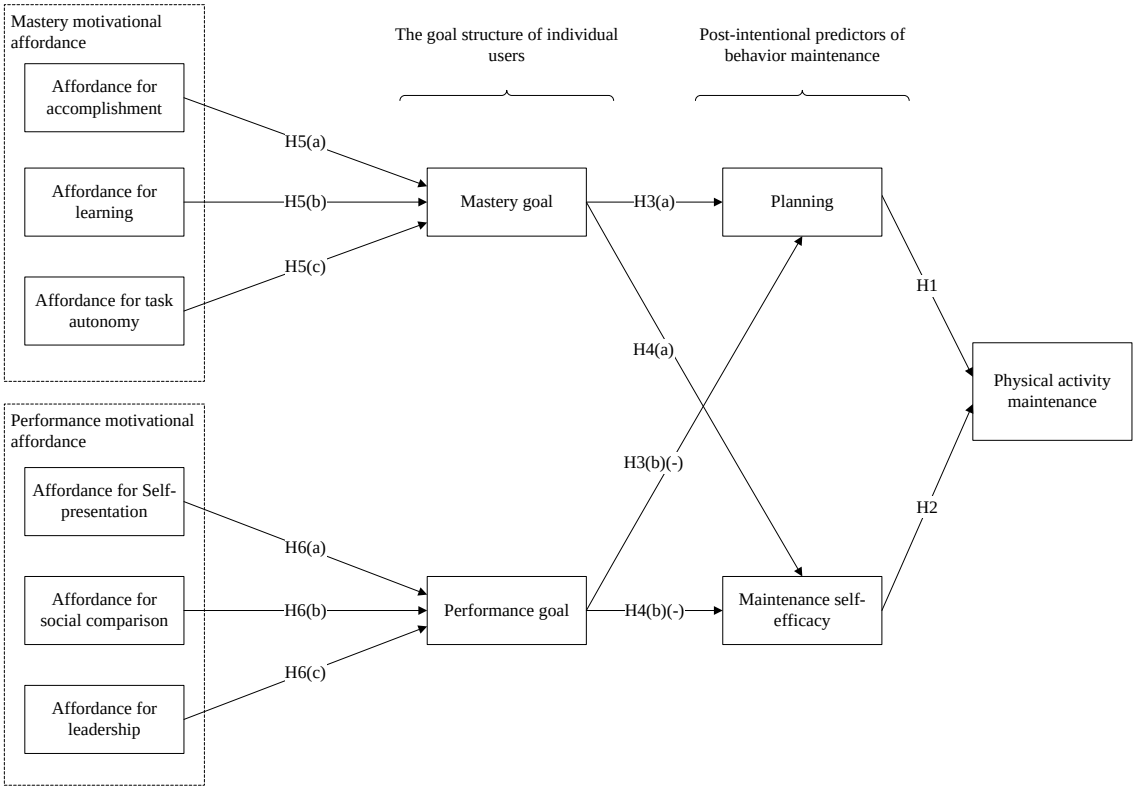

Figure 2. The research model

Bandura (1977) suggests that both mastery experience and vicarious experience could serve as information sources for individuals to form their self-efficacy perceptions. In our context, with stronger mastery goals, individuals will more likely put efforts to seek for mastery experience such as completing physical exercise tasks and mastering new exercise skills, which could increase people's self-efficacy perceptions regarding dealing with difficulties during PAM (Gist & Mitchell 1992). According to Phillips and Gully (1997), people with high mastery goal view their ability to be malleable, while people with high performance goal tend to view their ability to be fixed. Yi and Hwang (2003, p. 437) found that people with high performance goal tend to "make negative ability attributions" and underestimate their ability in performing certain tasks. Hence, we hypothesize:
H4(a): Mastery goal has a positive influence on maintenance self-efficacy.
H4(b): Performance goal has a negative influence on maintenance self-efficacy.

3.3 Motivational affordance and achievement goal structure

According to AGT, individuals' goal structures are shaped by the motivational climate of the environment (Meece et al. 2006; Papaioannou & Kouli 1999). If the environment climate emphasize

more on learning and completing tasks, higher mastery goals will be formed; whereas, if the environment climate emphasize more on competition, higher performance goals will be formed. In our context, IT designs emphasizing learning and task accomplishment will help users form mastery goals, while IT designs emphasizing competition with others will help users form performance goals. We propose:

H5(a-c): Perceived mastery motivational affordances, including perceived affordance for (a) task accomplishment, (b) learning, (c) task autonomy, are positively related with mastery goal.

H6(a-c): Perceived performance motivational affordances, including perceived affordance for (a) self-presentation, (b) social comparison, (c) leadership, are positively related with performance goal.

4. PROPOSED METHODOLOGY

4.1 Survey setup and sample selection

The research model will be tested using cross sectional survey data. An online survey will be published on Qualtrics and users of several popular QS 2.0 running platforms (e.g. Fitbit app, Nike+ running app, Runkeeper) in United State will be invited as our survey respondents. We will require each of our respondent to have either a smartphone or a wearable device to track their daily athletic information, so that the athletic data reported by our respondents will be reliable.

4.2 Variable operationalization and measures

The measurement scales are all adapted from existing literature and well contextualized into our PAM context. To be specific, measurement scales for mastery goal and performance goal are adapted from Elliot and McGregor (2001); measures for PAM are adapted from Schwarzer et al. (2008); measures of planning are adapted from Schwarzer et al. (2007) and measures for maintenance self-efficacy are adapted from Luszczynska and Schwarzer (2003) and Luszczynska and Sutton (2006). To measure six specific kinds of motivational affordances of QS 2.0 running platforms, we combine the motivational affordance scale of Jo-Peng et al. (2012) with the corresponding constructs: for instance, to measure motivational affordance for social comparison, we combine the motivational affordance scale of Jo-Peng et al. (2012) and social comparison scale of Gibbons and Buunk (1999).

5. CURRENT STAGE OF RESEARCH AND FUTURE PLANS

A pilot survey has been conducted with 50 running platform users to ensure the reliability and validity of our measurement scales. The results suggested good reliability, convergent and discriminant validity of our measures. We are now engaging in the main round data collection with a plan to collect around 600 valid responses to test our baseline research model. We have several plans for future research. First, we would like to involve avoidance achievement goals in addition to the current approach achievement goals in our research model, to fully capture users' goal structures. Second, we plan to test the possible contingent effects within our research context, for instance gender differences. Third, we plan to conduct a longitudinal study to observe the long-term effects of achievement goals on PAM.

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