

EXPLORE THE RELATIONS BETWEEN PERSONALITY AND GAMIFICATION

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EXPLORE THE RELATIONS BETWEEN PERSONALITY AND GAMIFICATION

Successful gamification motivates users to engage in systems using game-like experiences. However, a one-size-fits-all approach to gamification is often unsuccessful; prior studies suggest that personality serves as a key differentiator in the effectiveness of the approach. To advance the understanding of personality differences and their influence on users' behavior and motivation in gamification, this dissertation is comprised of three studies that: 1) explore the relationships among individuals' personality traits and preferences for different gamification features through an online survey; 2) investigate how people with different personality traits respond to the motivational affordances in a gamified application over a period of time through a diary study; and 3) reveal how individuals respond differentially to different kinds of leaderboard experiences based on their leaderboard rankings, the application domain, and the individuals' personality traits through their responses to 9 dynamic leaderboards.

The results from the first study show that extraversion and emotional stability are the two primary personality traits that differentiate users' preferences for gamification. Among the 10 types of motivational affordances, extraverts are more likely to be motivated by Points, Levels, and Leaderboards. However, the results from the second (diary) study indicate that, after the first week, extraverts' preferences for Points decreased. The motivation effects of Points and Leaderboards changed over the course of using the gamified application. The results from the third study confirm the findings from the first two studies about extraversion and revealed that ranking and domain differences

are also effective factors in users' experiences of Leaderboards in gamification. Design guidelines for gamification are presented based on the results of each of the three studies.

Based on a synthesis of the results from these three studies, this dissertation proposes a conceptual model for gamification design. The model describes not only the impact of personality traits, domain differences, and users' experience over time, but also illustrates the importance of considering individual differences, application context, and the potential significance of user persistence in gamification design.

This research contributes to the HCI and gamification communities by uncovering factors that will affect the way that people respond to gamification systems, considered holistically.

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TABLE OF CONTENTS

List of Tables	x
List of Figures	xi
Chapter 1. Introduction.....	1
Chapter 2. Literature Review on Gamification.....	4
Game	4
Gamification.....	5
Chapter 3. Literature Review on Motivational Affordances	9
Points in Game and Gamification	10
Leaderboards in Game and Gamification	11
Leaderboards in Different Domains	14
Chapter 4. Literature Review on Personality Traits.....	16
Personality Traits	16
Personality Traits in Human-Computer Interaction	17
Chapter 5. Study 1	20
Introduction	20
Methodology	21
Survey Design	24
Participant Recruitment.....	25
Results.....	26
Participant Demographics	26
Motivational Affordances	28
Discussion	35
Appealing to a Broad User Population	35
For Users with a Specific Personality Type.....	37
Looking beyond Personal Informatics and Habit-Tracking Applications	40
Limitations	42
Next Step.....	43
Conclusion of Study 1	43
Chapter 6. Study 2.....	44
Introduction	44
Background	45
Self-Determination Theory	46
Methodology	47
Participant Recruitment.....	48
Habits Tracking Application	49
Study Procedure.....	52
Diary Survey Design.....	52
Follow-up Interview.....	53
Results.....	53
Habits Tracking Performance.....	54
Motivations.....	55
Points and Leaderboards	58
Extroverts vs. Introverts.....	60
Difficulty Level of Habits Matters	63

Discussion	64
Preferences for Points and Leaderboards.....	64
Extrinsic Motivation: External Regulation	64
Intrinsic Motivation	66
Limitations	69
Next Step.....	69
Conclusion of Study 2	70
Chapter 7. Study 3.....	71
Introduction	71
Survey Design	73
Participant Recruitment.....	76
Results.....	76
Participant Demographics	76
Positions on Leaderboard.....	79
Leaderboards in Different Domains	80
Personality Type and Leaderboard Preferences	82
Discussion	86
Leaderboard Position and Domain Differences	87
Personality-targeted Leaderboards	91
Five questions that designers should consider in leaderboard design	92
Limitations	92
Conclusion of Study 3	93
Chapter 8. A Conceptual Model of Gamification Design	94
Domain Differences: Context.....	94
Personality Traits: Individual Differences	96
User Persistence: Long-term vs. Short-term	98
Motivational Affordances	99
Gamified Tasks.....	100
Chapter 9. Conclusion and Future Work.....	103
Appendices.....	105
Appendix A. Survey Questions in Study 1	105
Appendix B. Pre-test Questions in Study 2.....	112
Appendix C. Diary Survey Questions in Study 2.....	116
Appendix D. Post-study Interview Questions in Study 2	121
Appendix E. Survey Questions in Study 3.....	123
References.....	139
Curriculum Vitae	

LIST OF TABLES

Table 1: Affordance Types and Their Corresponding Motivational Source and Design Principles.....	10
Table 2: Definition of the Big Five Personality Factors.....	17
Table 3: Study 1 Participants Demographics.....	26
Table 4: Study 1 Correlation Matrix and Descriptive Statistics	27
Table 5: Study 1 Descriptive Results for 10 types of Affordances for 4 Types of Perception Measures.....	29
Table 6: Study 1 Significant Standardized Coefficients as Calculated by Multiple Regression.....	32
Table 7: Motivational Affordances Categorized by Participants' Concerns About How Each Might Be Demotivating.....	35
Table 8: Study 2 Participants Personality Score	48
Table 9: Study 2 Participants Demographics.....	49
Table 10: Study 3 Participants Demographics.....	77
Table 11: Study 3 Correlation Matrix and Descriptive Statistics	78
Table 12: Study 3 ANOVA Results	79
Table 13: Study 3 Descriptive Results	81

LIST OF FIGURES

Figure 1: Video Screenshots illustrating motivational affordance type “Challenge”	23
Figure 2: Screenshots of the online survey	25
Figure 3: The Respondents’ Experience of the Mockups Showing Leaderboards Applied to the Application from the Survey	51
Figure 4: Habits Tracking Performance	54
Figure 5: Intrinsic Motivation	56
Figure 6: External Regulation	57
Figure 7: Survey Results of Participants’ Preferences for Points and Leaderboard	60
Figure 8: The Respondents’ Experience of the Mockups Showing Leaderboards Applied to the Fitness Domain from the Survey	74
Figure 9: The Interface of the Leaderboard Mockups for Social Network and Productivity Domains in the Survey	75
Figure 10: Study 3 Summarized Results of Respondents’ Opinions on Whether They Would Like to See Their Names on Leaderboards and Whether They Have Preferences on Competing Only with Their Friends	82
Figure 11: A Conceptual Model for Gamification Design	94

Chapter 1. Introduction

Designers of information systems have increasingly used game design elements as one way to engage users and enhance user experiences (Codish and Ravid, 2014; Deterding et al. 2011; Huotari and Hamari, 2011; Zichermann and Cunningham, 2011). Gamification is broadly defined as “using game elements in non-game contexts” (Deterding et al. 2011). There are an increasing number of practitioners and researchers applying gamification in various domains such as education, e-commerce, health, social networking, fitness, workplace productivity, and intra-organizational systems (Badenes et al. 2014; Codish and Ravid, 2014; Hamari et al. 2014; Sheldon, 2011)

Gamification employs the use of interface affordances to motivate users to engage in the systems with gameful experiences (Deterding, 2011; Deterding et al. 2011). These specific affordances are often referred to as motivational affordances. The most common motivational affordances used in gamification are Points, Badges, and Leaderboards (Antin and Churchill, 2011; Codish and Ravid, 2014; Narasimhan et al. 2011). Other affordances used in academic studies and commercial applications include Levels, Challenges, Rewards, Feedback, Clear Goals, Avatar/Theme, and Progress (Werbach and Hunter, 2012; Zichermann and Cunningham, 2011)

While researchers in gamification have reported a number of positive outcomes, studies have also pointed out negative consequences, such as increased effects of competition. Some researchers have found that individuals are impacted by gamification differently, suggesting the effects of personality differences in responding to gamification (Hamari, 2013, Hamari et al. 2014). In a study that applied gamification to an educational context, Codish and Ravid (2014) found significant differences between extroverts and

introverts in how students perceived different motivational affordances in their courses; for example, extroverts reported a lack of playfulness in leaderboards.

While some users find some affordances to be motivating, others may find that they detract from the experience—possibly even leading to technology abandonment. Based on prior research, personality may serve as a key differentiator; however, little is known about how people with different personality traits relate to or prefer various specific motivational affordances. Therefore, in order to foster the design of applications that most effectively motivate and appeal to individual users, it is imperative to understand the relations between personality traits and motivational affordances in gamified applications.

Many theories of personality exist, and they each focus on different personality types. In this study, we utilized a derivative of the “Big-Five” model (extraversion, agreeableness, conscientiousness, emotional stability and imagination/openness), which has been widely accepted and adopted in the research community (McCrae and Costa, 1989).

To explore the impact of context and individual differences in people’s experience with gamification, three studies were conducted in this dissertation. Study 1 was a survey study to explore the relations between personality traits and people’s preferences for different motivational affordances in gamification. Based on the results of Study 1, Study 2 was conducted to understand how people with different personality traits responded to the motivational affordances in a real, deployed gamified application over an extended period of time. Following Study 1 and Study 2, one motivational affordance, Leaderboard, was selected for further investigation. In Study3, a survey study was conducted to understand people’s perceived differences based on their rankings on

leaderboards, application domains, and personality traits. Finally, a conceptual model of gamification design is presented and discussed with the lessons learned from the three studies in this dissertation.

Chapter 2. Literature Review on Gamification

Gamification is defined as “using game elements into non-game contexts” by Deterding et al. (2011). To clarify the concept and related terminology of gamification, I begin with understanding game, which is involved in multiple Gamification definitions and uses in complex contexts.

Game

In game studies, researchers distinguish between game and play. Salen and Zimmerman (2004) illustrated that game and play have a unique relationship: “games are a subset of play”, which means some of the play (playful) activities are games, and “play is a subset of games”, therefore, game is a system that contains three aspects: rules, play and culture (Chapter 7, P14). Avedon and Sutton-Smith (1971), two important scholars of play and game, defined game as “an exercise of voluntary control systems, in which there is a contest between powers, confined by rules in order to produce a disequibrial outcome.” In 1984 Crawford, a computer game designer, listed four primary qualities of a game: representation, interaction, conflict, and safety. He asserted that a game is a system that represents reality (representation), an interaction between the system and the user (interaction), provides conflict that prevents the user from achieving the goal (conflict), and is a less harsh way to experience reality (safety). Game was defined by Huizinga (2000) as “a non-serious but intensely engaging voluntary activity structured by rules and secretive social boundaries.” Juul (2003) proposed that games have six features, which are “rules, variables, quantifiable outcomes, value-laden outcomes, player effort, player investment; and negotiable consequences, with respect to real-life effects.” Inspired by Avedon and Sutton Smith, game designers Salen and Zimmerman (2004) defined games

as “a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome” (p. 80).

More recently, Jane McGonigal, in 2011, in her book *Reality is Broken*, described that all games share four defining traits, they are 1) a goal, which is the specific outcomes that the players want to work to achieve; 2) the rules, which place limitations on how players can achieve their goals; 3) a feedback system, which tells players how close they are to achieving the goal; and 4) voluntary participation, which requires that everyone who is playing the game knows and willingly accepts the goal, the rules, and the feedback (McGonigal, 2011).

Although these definitions were created under different contexts, some of them do share common elements, such as voluntary activities, rules, conflict, and outcomes. Seaborn and Fels (2014) summarized that “games emerge from a variety of combinations of these criteria in different proportions, and whether an experience is a game or gameful is determined by participant perceptions.”

Gamification

A number of researchers in HCI were interested in understanding the process of designing for fun, pleasure and enjoyment rather than just designing for usability (Shneiderman, 2004; Monk et al. 2002; Pagulayan et al. 2003). Back in the early 1980s, a HCI researcher created 10 heuristics of designing enjoyable interfaces from computer games (Malone 1980; Malone 1982). From several experiments, he summarized that challenge, fantasy, and curiosity as three main categories to analyze the appeal of a computer system. The full list of Malone’s heuristics is discussed in the following section. Carroll and Thomas (1988) mentioned that some game-like features, such as

metaphoric cover stories, could be a solution to address the vigilance and boredom problems for those routine tasks. Ten years later, Don Norman (1998) proposed three “axioms” as simplicity, versatility, and pleasurability for designers to follow. Laurel (1997) also pointed out that enjoyment should be applied to system design with a “causally related enjoyment” manner. For example, in Chao’s study, the task of using standard text-mode UNIX tools for processes management was replaced with a first-person shooter game, called PSDoom. This game-like interface highly enhanced user interface engagement. The author also stated, “games have amazingly complex maneuvers that skilled operators can use in addition to their simple repertoires for novices.” (Chao et al. 2001)

In addition to the term “gamification”, several interrelated concepts were studied in the area of human-computer interaction. Azadegan and Riedel (2012) called gamification “Funware”. They explained it as the use of game mechanics to engage audiences and solve problems. Blythe et al. (2004) published a book *Funology*, which introduced pleasurable designs as an emotional level of user experience, and inspiration and guidance of how to design more enjoyable products and services. Another concept, “serious games”, or so-called “applied games”, was defined as “games that are used for purposes other than mere entertainment.”

(Azadegan and Riedel, 2012) Similar to gamification, serious games have also been applied to a broad spectrum of domains from education, healthcare, corporate or business areas. Some other similar but distinct concepts, such as behavioral games, productivity games, and alternate reality games, were examined by McGonigal (2011).

However, gamification is different from game. Deterding et al. (2011) distinguished three game-related concepts: “gamefulness, gameful interaction, and gameful design.” The author explained that gamefulness is an experience and it is also the design goal of gameful design; gameful interaction refers to the tools or artifacts that afford the experience of gamefulness. In Deterding et al.’s seminal efforts, gamification was defined as “the use of game design elements in non-game contexts”.

Zichermann (2011) defined gamification as “the use of game thinking and game mechanics to engage audiences and solve problems.” From a psychological perspective, he explained how gamification works in a way of understanding human motivation by breaking it into intrinsic and extrinsic motivation. While intrinsic motivation is “an innate drive to do something”, extrinsic motivation “pushes you to do (to avoid) something because of an external reward or punishment.” Self-Determination Theory suggested that motivation is fluid from extrinsic to intrinsic, which means extrinsic motivators could be adopted as an intrinsic motivator for some people under a certain context. Although researchers commonly agree that external incentives reduce people’s sense of intrinsic motivation, Zichermann argued that these external incentives do not always damage performance. Thus, he suggested that gamified designers should use both intrinsic and extrinsic motivators together, with both non-cash and cash rewards together. The author summarized his conclusion with not only previous empirical evidence but also using motivational theory. Similar to the concept of fame and wealth, motivational theory introduces “if someone wants an extrinsic reward badly enough, it can become intrinsic and authentic”.

In the book *Gamification in Design*, Cunningham and Zichermann (2011) listed seven primary game mechanics from literature and gamified applications, which are Points, Levels, Leaderboards, Badges, Challenges/quests, Onboarding, and Engagement loops. In addition to the core game elements, the authors pointed out that Feedback importantly affects player's interactions and is intricately tied to many other mechanics, such as Progress and Points. Based on the 42 different fun interactions listed in *Game On* (Wiley) by Jon Radoff, Cunningham and Zichermann categorized 12 “things people like” from gamification and game mechanics illustrated by examples.

Combined literature, mainly from Deterding et al. (2011), Werbach and Hunter (2012), Huotari and Hamari (2012), led Seaborn and Fels (2014) to define gamification as “the intentional use of game elements for a gameful experience of non-game tasks and contexts.” The “game elements” refer to “patterns, objects, principles, models, and methods” directly inspired by games.

Chapter 3. Literature Review on Motivational Affordances

The motivation of human behavior is an important but often under-utilized theoretical perspective (Zhang, 2008). Studies on motivation have mainly examined two questions: (1) what causes behavior and (2) why the intensity of behavior varies (Reeve, 2005). These questions help us understand how motivation gives behavior direction—the purpose of behavior, for example, why people start, continue, or terminate an activity—and energy—the strength of behavior, for example, how much or how often people conduct an activity.

The term affordance is defined as the set of “actionable properties between an object and an actor” [50] (Gibson, 1977; Norman, 1999; Zhang, 2008). Combining these notions of motivation and affordance, Zhang described motivational affordances as being “the properties of an object that determines whether and how it can support one’s motivational needs” (Zhang, 2008). He also commented that applications that promote motivation would attract usage and increase the sense that people “cannot live without it” (Zhang, 2008).

By examining 24 empirical studies in literature, Hamari and colleagues categorized 10 types of motivational affordances used in gamification: Points, Leaderboards, Achievements/Badges, Levels, Story/Theme, Clear Goals, Feedback, Rewards, Progress and Challenge (Hamari et al. 2014). Among the research they reviewed, Hamari et al. (2014) found that Points, Leaderboards, and Badges were the most commonly used game-like motivational affordances. To summarize the characterizations of motivational affordances provided by Zhang (2008) and the other 24 studies selected by Hamari et al. (2014), I compiled a taxonomy of motivational

affordance types and their corresponding motivational source and design principles; this taxonomy appears in Table 1.

Table 1. Affordance Types and Their Corresponding Motivational Source and Design Principles (Hamari et al. 2014; Zhang, 2008).

Motivational Affordances	Motivational Sources	Design Principles
Points, Badges, Levels, Clear goals, Feedback, Progress, Challenge, Rewards	Cognitive: Competence and achievement	Systems provide various challenge levels or immediate performance feedback
Leaderboard	Social & Psychological: Leadership and followership	Systems facilitate one's desire to influence others, or influenced by others.
Story/Theme	Emotional: Affect and emotion; Psychological: Autonomy and the Self.	Systems induce intended emotions via interaction with the system, or promote creation and representation of self-identity.
Rewards	Extrinsic motivators	Systems provide incentives for certain actions.

Points in Game and Gamification

Compared to other gamification features, nearly all of the gamification studies used Points as a core reward element. Previous research concluded that through the use of points, people gain immediate performance feedback (Jia et al. 2016). This study also found that the accumulation of points helps users build a sense of accomplishment and provide a way of tracking progress. In an educational setting, points have also been shown to stimulate learners to take on more challenging tasks and to undertake extracurricular learning (Huang and Hew, 2015).

Although points are frequently used as a gamification feature, they are rarely used alone. In many studies and systems, points were used in conjunction with other gamified

features. For example, points are commonly combined with levels and presented using a progress bar to show how many points a person has attained and how many more points they need to acquire in order to get to the next level (Mekler et al. 2013). Points were also designed with monetary incentives to motivate users, such as the way that points are used in Mango Health, a nutritional supplement manager application. In this app, users can win gift cards for shopping at the department store Target by earning points and leveling up. Another example, the Points in Bant, a diabetes management application, can be redeemed for iTunes credit (Cafazzo et al. 2012). A more recent study, Wang and Lieberoth conducted a controlled experiment to investigate the usage of the combination of points and music in a game-based learning environment named Kahoot! Their results found that points led to positive improvements in the area of concentration, engagement, enjoyment, and motivation in a classroom; but that the combination of points and music incentives affected the classroom dynamic in a more significantly positive way (Wang and Lieberoth, 2016).

Leaderboards in Game and Gamification

Gamification has been defined in the research literature as “the use of game design elements in non-game contexts” (Deterding et al., 2011). Deterding et al. (2011) defined “game elements” to include those elements used in most games, that are readily associated with games, and that play a significant role in gameplay. From the literature on games and gamification, leaderboards were identified as one of the basic ingredients for designing a great game (Reeves and Read, 2009); by displaying ranks of comparisons of users’ performances, they were also one of the most-used game elements in gamification approaches (Hamari et al., 2014). Moreover, Reeves and Read listed leaderboards among

“ten ingredients of a great game” in the context of the Massive Multiplayer Online (MMO) games. One of the “ingredients” was “competition under rules that are explicit and enforced,” which elicits an underlying motivation. Leaderboards also brought a sense of fairness for players during the competition (Reeves and Read, 2009).

In their book *Gamification in Design*, Zichermann and Cunningham (2011) noted that “feedback” critically influences players’ motivation and potentially ties in with many other elements, such as points and leaderboards. The study implied that leaderboards could serve as a type of “feedback,” rather than an outcome of their own record (Zichermann and Cunningham, 2011). Based on the 42 different “fun” interactions listed by Radoff (2011), Zichermann and Cunningham (2011) categorized “12 things people like from gamification”. Three of these 12 were associated with leaderboards. The book also proposed three underlying reasons why people were motivated by leaderboards: leading others, getting attention, and gaining status.

Mekler et al. (2013) conducted an empirical analysis to examine whether leaderboards affect users’ behavior and intrinsic motivation. Their findings indicated that leaderboards did not affect users’ intrinsic motivation, but it was one of the effective factors in increasing short-term performance in an image annotation task.

Other research categorized leaderboards into two types: “no-disincentive” and “infinite” leaderboards (Sun et al. 2015; Zichermann and Cunningham, 2011). Leaderboards, when used on social network websites like Facebook, aim to create social incentives rather than disincentives. One way to realize these types of leaderboards are to organize the names such that the user appears in the middle, with better- and worse-performing individuals bracketing his or her position. These instantiations of

leaderboards also often show the user how close he or she is to attaining the next best score. Infinite leaderboards are designed around the premise that a user's score will be beaten by another player sooner or later. Since it would be impossible to allow every user to exist on the leaderboard forever, these kinds of leaderboards are designed to present rankings with multiple layers.

For example, participants in Sánchez-Carmona and colleagues' study reported that they preferred to use the filtered leaderboard, which presented the names of students who were enrolled in the same number of courses. These participants felt unable to access the top of the leaderboard when compared with all other students (Sánchez-Carmona et al. 2017). Another example, in Latulipe and his colleagues' study of a gamified peer-learning course setting, the leaderboard was designed to show the changes in acquired rewards (Latulipe et al. 2015). Zichermann and Cunningham (2011) concluded three underlying reasons why leaderboards motivate people: getting attention, leading others, and gaining status.

In addition to the purpose of promoting competition to gain social recognition, Leaderboards have also been seen as a useful standalone feedback mechanism to present comparison information generated by other game features (Codish and Ravid, 2014). A study from Rashid (2017) applied a leaderboard, showing students' rank, together with points acquired and badges earned, to an attendance application in a class setting for 2 months. Their results showed that the leaderboard (in conjunction with the other two gamification features) had a desirable impact on improving students' attendance. In a context of requirements determination for software development in an enterprise forum in Saudi Arabia, Alharthi and Parrish (2017) used leaderboards to show which users had

gained the most points and badges to positively influence users' participation (Alharthi and Parrish, 2017).

Leaderboards in Different Domains

Leaderboards are widely used across multiple domains, including social network websites, fitness tracking, and productivity applications. To increase users' engagement on social network websites, leaderboards are usually designed to present the rank of profile views or the number of online activities undertaken. For example, Klout, a popular social leaderboard, ranks its users according to their online social influence via Klout score (Anger and Kittl, 2011; Zichermann and Cunningham, 2011). Farzan et al. (2008) conducted a study to understand the effects that a point-based incentive system (i.e., points, "status" levels, and a leaderboard) played on a social network site and found that some users were driven by leaderboards to keep up with others—an effect that did not suffer significant decay even after the leaderboard was removed. Their findings suggest that the usage of leaderboards could play a role in transferring extrinsic incentives to intrinsic motivations—at least for some users.

Leaderboards are also popular in fitness applications (e.g., Fitbit's companion app). In Wong and Kwok's mobile health app, a leaderboard displayed all users' and groups' step records and rankings (Wong and Kwok, 2016). Anderson et al.'s (2007) study found that leaderboards introduced a sense of playfulness and indirectly induced participants to walk more.

Finally, some workplaces use gamification as a way of improving productivity within the organization, namely Enterprise Gamification (Werbach and Hunter, 2012). Costa et al. (2013) found that leaderboards were effective at improving some employees'

punctuality to regularly- scheduled work meetings. However, several studies have also shown that leaderboards could reduce work performance rather than enhance it because they make the performance public for all to see in the workplace (Werbach and Hunter, 2012). For example, Mollick and Rothbard (2014) used leaderboards to motivate employees when performing tedious and cumbersome tasks at work. Their results showed that the usage of a leaderboard turned work into a more pleasurable activity and enhanced productivity when employees had provided consent to interact with the leaderboard. However, the effects of the leaderboard were reversed in the no-consent condition (Mollick and Rothbard, 2014).

Chapter 4. Literature Review on Personality Traits

While some users find some affordances to be motivating, others may find that they detract from the experience—possibly even leading to technology abandonment. Based on the prior research, personality seems to serve as a key differentiator; however, little is known about how people with different personality traits relate to or prefer various specific motivational affordances. Therefore, in order to foster the design of applications that most effectively motivate and appeal to individual users, we need to understand the relationship between personality traits and motivational affordances in gamified applications.

Many theories of personality exist, and they each focus on different personality types. In this study, we utilized a derivative of the “Big-Five” model (extraversion, agreeableness, conscientiousness, emotional stability and imagination/openness), which has been widely accepted and adopted in the research community (McCrae and Costa, 1989).

Personality Traits

Early research by Lucas (1971) indicated that personal factors affect the adoption of information systems. He argued that it was simply because some people feel computers to be incomprehensible. However, the effect of personal factors on the success of information systems was largely ignored until the 1990s (McElroy et al., 2007). Nearly 20 years after Lucas’ work, interest towards dispositional factors, such as personality, had re-entered the picture (McElroy et al., 2007). According to Maddi (1989) personality is defined as “a stable set of characteristics and tendencies that determine peoples’ commonalities and differences in thoughts, feelings, and actions.” To understand user

personalities, I base the research design on the widely used “Big Five” personality factors (Costa and McCrae, 1992; Goldberg, 1993; McCrae and Costa, 1989).

Table 2. Definition of the Big Five Personality Factors

	Big Five factors can represent the tendency to...
Conscientiousness	...actively plan, organize and carry out tasks
Agreeableness	...help others and expect help in return
Emotional Stability	..be fearful, sad, embarrassed, distrustful, and have difficulty managing stress
Extraversion	...seek out new opportunities and excitement
Imagination/Openness	...devise novel ideas, hold unconventional values, and willingly question authority

The Big-Five factors, a descriptive model of personality, has been used extensively in previous psychology and HCI research. The Big-Five factors are Conscientiousness, Agreeableness, Neuroticism, Extraversion, and Imagination/Openness (Goldberg, 1993). The model does not narrow down the personality differences to a simple set of five traits. Instead, each Big Five factor represents a collection of personality traits. Table 2 shows the definitions of each factor from the literature.

Personality Traits in Human-Computer Interaction

In HCI, several studies have explored the relations between personality traits and persuasive strategies. A study by Kaptein and Eckles (2012) investigated how personality differences influence people’s strategies and intentions relating to online purchases. Kaptein et al. (2010) studied persuadability, a trait of individual differences, and its interaction with persuasive messages on people’s participation in a health-related activity. Halko and Kientz (2010) took these ideas and examined the relationship between people’s acceptance of different persuasive technologies and their personality using an online survey.

In addition, several researchers have argued that the needs of individuals are different and suggested that the one-size-fits-all design approach needs to change (Halko, and Kientz, 2010; Nov and Arazy, 2013).

Ferro and Greuter (2013) discussed how individual differences may affect the design of gamified applications by investigating possible relations among player types (Bartle (1996), personality traits, and game elements.

Back to Malone's experiment in 1980, he found a significant difference in what they liked about a game between boys and girls. To be more specific, his results showed that boys liked the game because they liked the "fantasy", which was designed as arrows popping balloons, but girls dislike the game also because of it. As the most important implication from this experiment, Malone pointed that "Fantasies can be very important in creating intrinsically motivating environments but that, unless the fantasies are carefully chosen to appeal to the target audience, they may actually make the environment less interesting rather than more" (Malone, p64, 1982,).

Other experimental studies have investigated the interaction between UI design features and personality traits (e.g., Goren-Bar et al., 2006; McGrenere, 2002). Arteaga et al. (2009) used the idea of personality differences to tailor the design of a mobile game used to prevent obesity trends in teenagers. In their study, they used the Big-Five factors to make suggestions on game choice and to develop the motivational phrases employed to encourage users to play.

Instead of tailoring UI design to enhance usability; other studies have focused on studying a specific personality trait and investigating its effects on people's social behaviors, online activities, and experience towards gamification. For example,

conscientiousness has played an important role in previous studies of personality and social behavior. These studies found that conscientiousness was negatively correlated to social loafing, but positively correlated to “discretionary behavior which promotes the effective functioning of the organization” (Hoon and Tan, 2008; Organ, 1988; Organ, 1994; Podsakoff et al. 2000). Extending these studies, Nov and Arazy (2013) investigated the relationship between conscientiousness and people’s participation in online communities. They found that manipulation of the community’s activity indicators (e.g., critical mass) affected the high-conscientiousness and low- conscientiousness participants in opposite directions.

Codish and Ravid (2014) examined extraversion and its effects on students’ perceived playfulness of a gamified course in an educational setting. While they found no significant differences in the overall ratings of playfulness, the individual mechanisms by which playfulness was achieved were rated significantly differently by different respondents. From their results, extroverts reported less playfulness reflected by the Leaderboard component, but perceived more enjoyable experiences than introverts’ instantiated in the Rewards, Badges, Points, and Progress facets of the system. Their study addressed the need for designing different educational solutions for extroverts and introverts and suggested further investigation of personality traits and their relationship to different experiences of motivational affordances in gamification—the task that I have undertaken with this study.

Chapter 5. Study 1

Introduction

This study aims to provide a better understanding of how different people respond to various gamification approaches, as well to gain a better understanding about how persuasive and gamified apps might be customized based on users' personality traits (Jia et al. 2016). The initial interest in exploring this question was motivated by an interest in applying gamification to applications that promote health-related habit tracking. While many applications targeted at promoting a healthy lifestyle utilize gamification, they have not yet been proven effective for long-term engagement (Karanam et al. 2014). Most of these applications use various combinations of motivational affordances and are not designed for a specific user population. In this study, the main purpose is to explore the relations between personality traits and people's perception of individual motivational affordances in a sample gamified personal informatics application. Two main research questions are:

RQ1: In what ways do users consider particular motivational affordances to be helpful or unhelpful in the context of habit tracking?

RQ2: What relations exist (if any) between users' personality traits and their preferences for different types of motivational affordances?

Methodology

A large-scale online survey was conducted with 248 participants by using demonstration videos depicting 10 different motivational affordances, hosted via Survey Monkey and Amazon Mechanical Turk (AMT).

In accordance with Hamari et al. (2014), I first examined the design solutions associated with different types of motivational affordances from the research literature and created 10 interactive prototypes to demonstrate each type of motivational affordance that might be adopted as part of a personal “Habit Tracker” application. A list of definition of the 10 motivational affordance features are presented below:

Points: User gets 100 points when he/she reports that he/she successfully finishes each of their habits.

Badges: User gets badges when he/she reports that he/she successfully finishes the requirements for each badge.

Rewards: User gets rewards for another 30-day free trial when he/she finishes the requirements for the rewards.

Levels: There are two levels of user account: tracker and super tracker. User becomes a “super tracker” when he/she reports that he/she successfully finishes the requirements for “super tracker” (e.g., completion of a fixed number of habits).

Leaderboard: A “Top Trackers” board appears in the application. The user’s rank on this board is based on his/her activities in the app.

Progress: A progress bar shows the proportion of the number of habits that the user reports he/she has finished today.

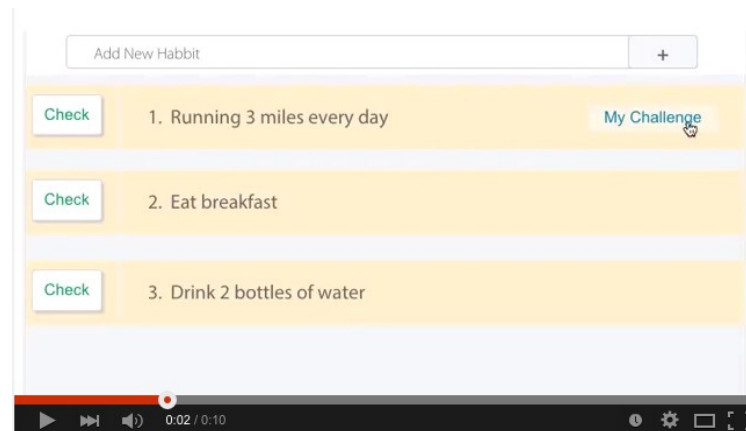
Theme (Avatar): Each user has an avatar, for example, a cartoon cat. The user’s cat turns to be happy (with a smile) when he/she reports that he/she successfully finishes his/her habits each day.

Feedback: A figure provides a summary representation of how the user performs his/her habits over time.

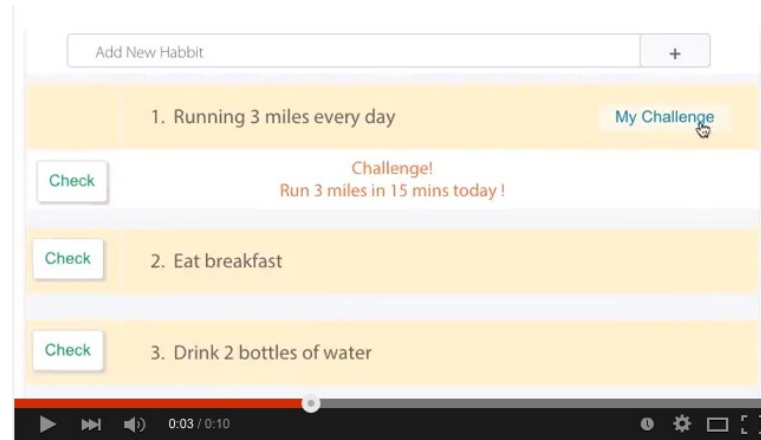
Challenges: A challenge can be set for each habit. For example, “Run 3 miles in 30 minutes” can be a challenge for the habit “Run 3 miles.”

Clear goals: A goal can be set/modified for each habit. For example, “Run 5 miles” can be the modified goal for “Run 3 miles.”

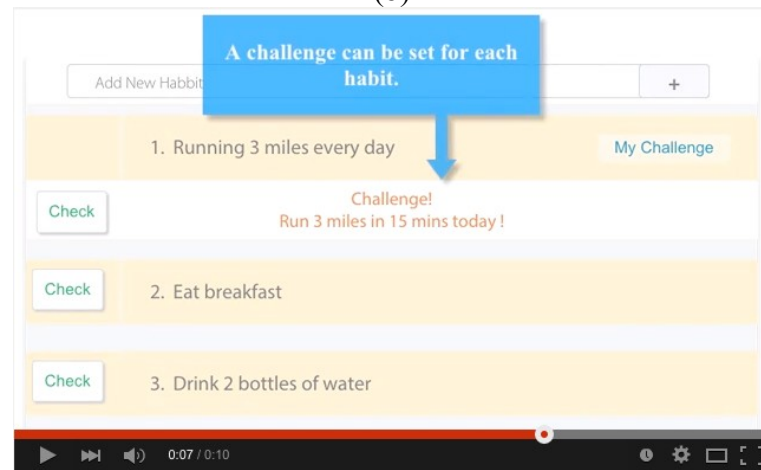
These 10 motivational affordances were presented using screen recording videos of a research using the interactive prototype. I chose to use videos because they provided a direct, visually communicated language that individuals from diverse backgrounds could understand, but did not require deployment and installation of an app on users’ personal devices. All of the videos used in this study contained illustrations of an example interaction with the application and a textual explanation of the specific affordance type at the end. Figure 1 shows the screenshots of one example, “Challenge,” as used in the study.



(a)



(b)



(c)

Figure 1. Video Screenshots illustrating motivational affordance type “Challenge”.

- (a) User clicks on “my challenge” for one of his habits; (b) A challenge with “run 3 miles in 15 minutes” shows up with a “check” button; (c) A textual explanation of this “challenge” feature is displayed.

Survey Design

The survey contained four sections. The first section featured a series of multiple-choice questions about the participant’s demographic background, such as gender, age, educational background, occupation and ethnicity. Next, I asked participants to complete an assessment of the Big-Five factors of personality (Costa and McCrae, 1992; John and Soto, 2008). I used the 50-item set of IPIP Big-Five Factor Markers, a free, research

community-developed, self-reported inventory designed to measure the five factors of personality.

The third part of the survey was designed to elicit participants' perceptions of 10 motivational affordances. Using videos showing an isolated implementation of each. Each video was followed by 5 questions: four 5-point Likert-scale questions probing the participants' opinions about each function in terms of enjoyment, the likelihood that the participant would rely on the function, helpfulness and ease of use; questions inspired by the Halko and Kientz study (2010). The fifth question is open-ended, allowing the participants to share their comments on aspects of the function that do (or do not) encourage the use of the application and reasons for which they like (or dislike) it. The screenshot of the survey is presented in Figure 2.

Finally, participants were asked to order the motivational affordances from their most favorite to least favorite. I also asked several open-ended questions about participants' overall impression of personal informatics applications. The survey took approximately 15 minutes to complete.

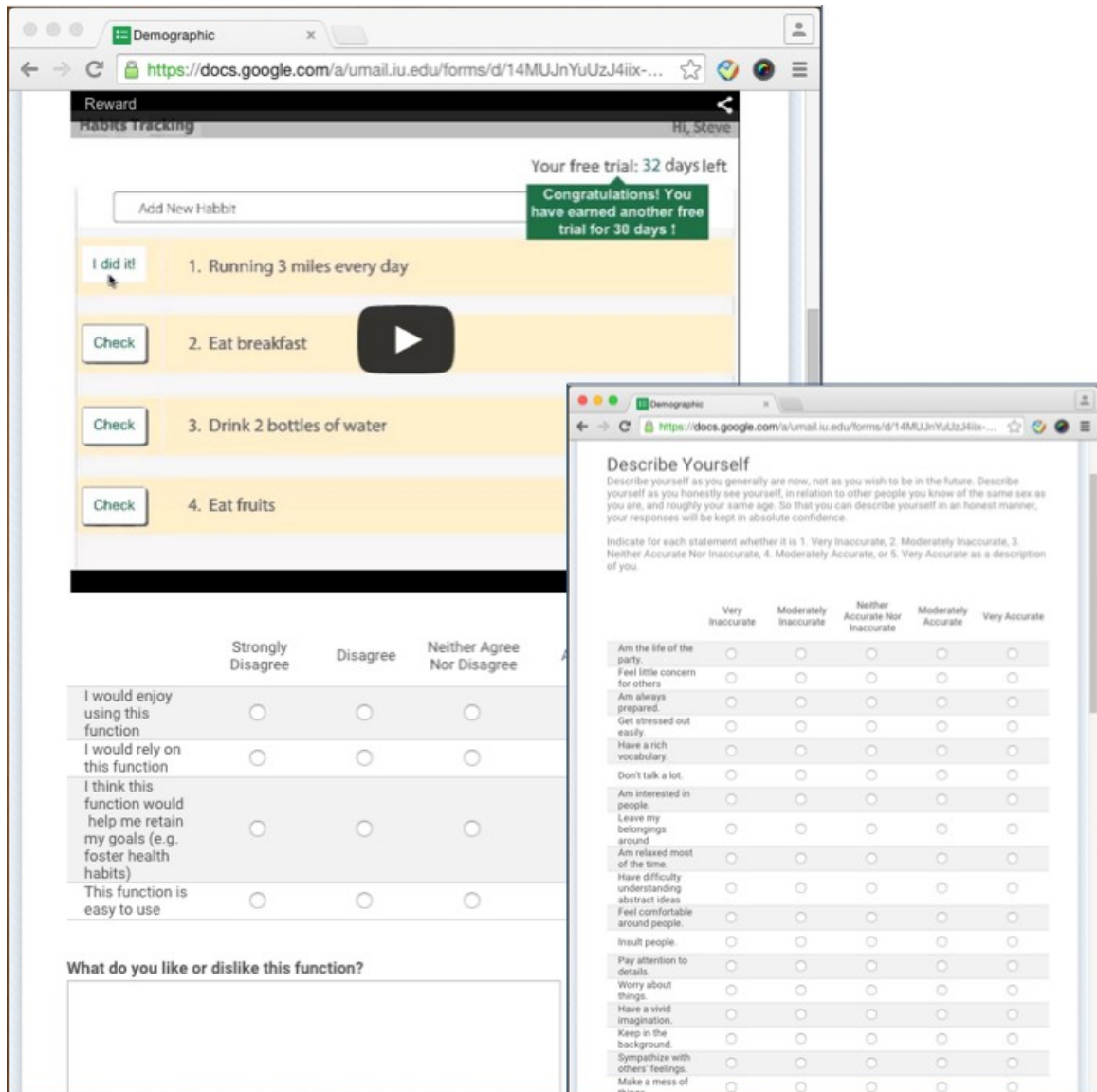


Figure 2. Screenshots of the online survey

Participant Recruitment

248 participants were recruited, out of which 40 were recruited through the research team's social networks (via snowball sampling) and 208 through AMT. The AMT was chosen to recruit due to the need for a large participant sample and AMT's efficiency of survey distribution and relatively low cost. Participants were paid USD \$1.00, the payment rate suggested by the AMT platform.

Results

Participant Demographics

To summarize demographic information of the participants, I present their responses (expressed as percentages of the overall sample population) to questions regarding their age, gender, educational level, occupation, and ethnicity (see Table 3). In general, the sample had a relatively diverse population, which I believe to be representative of the types of users who might be interested in using personal informatics applications.

Table 3. Study 1 Participants Demographics.

Total Participants (n=248)	
Age	18–24 (8.5%) 25–34 (43.6%) 35–44 (23.8%) 45–54 (12.1%) 55 and older (12.1%)
Gender	Female (52.8%) Male (47.2%)
Educational Level	Some high school (0.4%) High school graduate/GED (6.5%) Vocational/Associate degree (9.7%) Some college (17.0%) Bachelor’s degree (34.7%) Some graduate school (6.5%) Master’s degree (20.2%) Ph.D., law, or medical degree (5.2%)
Occupation	Employed for wages (63.0%) Self-employed (16.6%) Student (11.3%) Retired (5.2%) Other (4.0%)
Ethnicity	White (57.7%) Asian/Pacific Islander (28.6%) Hispanic or Latino (4.8%) Black or African American (6.5%) Native American or American Indian (2.0%) Other (0.4%)

Table 4. Study 1 Correlation Matrix and Descriptive Statistics (n=248). * Indicates cells with $p < .05$ (2-tailed), ** Indicates $p < .01$

	Mean	Std. D	1	2	3	4	5	6	7
Extraversion	29.28	9.41							
Agreeableness	39.31	6.71	.32**						
Conscientiousness	38.05	6.51	.22**	.22**					
Emotional Stability	34.79	9.00	.32**	.27**	.40*				
Imagination	38.30	6.06	.34**	.25**	.27**	.27**			
Age	2.78	1.20	-.06	.15**	.16**	.21**	.01		
Gender	0.47	0.50	.05	-.22**	.04	.18**	.05	-.13**	
Educational Level	5.05	1.60	.11	.08	.09	-.02	.09	-.11	.06

In order to support the subsequent regression analyses, respondents' demographic responses were coded into numerical variables. For age, 18–24 was coded as 1, 25–34 as 2, and so on. For gender, male was coded as 1 and female as 0; for educational level, the eight response levels were coded from 1 to 8 from lowest completed education level to the highest.

Before processing to the regression analysis, I used zero-order correlations to test for correlations among independent variables and respondents' demographic variables (see Table 4). The independent variables of interest, i.e., the five IPIP personality traits, were positively correlated to each other, which was consistent with the literature (Gosling et al. 2003). The strongest correlation was between conscientiousness with emotional stability, $r = .40$, $p < .01$, which means people with high levels of emotional stability tend to be more conscientious. In addition, people with higher extroversion level tend to be more open to new experiences ($r = .34$, $p < .01$).

In the case of age, Table 4 shows that there is a strong and positive association between respondents' age and being emotionally stable, $r = .21$, $p < .01$. In the case of

gender, Table 4 revealed a positive correlation between the coded gender variable and emotional stability ($r = .18$, $p < .01$) and a negative correlation between the coded gender variable and agreeableness ($r = -.22$, $p < .01$). This result can be interpreted for our sample ($n = 248$) that males were more emotionally stable but less agreeable than females. I found no correlation between respondents' personality characteristics and their educational levels.

Motivational Affordances

Across the 10 types of motivational affordances, the respondents responded favorably to the affordances of Clear goals, Feedback, Rewards and Progress, and had less preference for Avatars and Levels. On a scale from 1 to 5 (1 indicating strong disagreement and 5 indicating strong agreement), respondents rated the perceived ease of use and enjoyment for all types of affordances above 3.9 and 3.1, respectively, which suggests that respondents were able to understand the basic idea of each affordance in the videos and the affordances do play a role of bringing joyful experience in the presented application. However, when asked about the degree to which they felt that they would be able to “rely” on the affordances, respondents rated all of the affordances significantly lower, especially Badges, Levels, Leaderboard and Avatar. More detailed descriptive results about the ratings given to each affordance are presented in Table 5.

I also tested correlations among dependent variables in the study to find out the differences of respondents' preferences among these affordances. These results show that all 10 types of affordances are positively correlated with one another. The highest correlations were respondents' preferences for Points and Badges, $r = .763$, $p < .01$; and for Points and Levels, $r = .708$, $p < .01$. These correlations demonstrate that people who

prefer to use Points are more likely to prefer to also use Badges and Levels in gamified applications. Another relatively strong correlation was found between Challenges and Clear goals, $r = .711$, $p < .01$, which indicates that people who like customizing personal goals for their tasks also tend to set challenges for themselves. The two weakest correlations were found between Avatar and Leaderboard ($r = .494$, $p < .01$), and between Avatar and Feedback ($r = .470$, $p < .01$).

Table 5. Study 1 Descriptive Results for 10 types of Affordances for 4 types of Perception Measures. Bolded numbers emphasize responses lower than 3.0, indicating respondents' negative feedback on perceived measures.

	Enjoyable	Reliable	Helpful	Usable
Points	3.3 (1.1)	3.0 (1.2)	3.2 (1.2)	4.0 (0.9)
Badges	3.3 (1.2)	2.9 (1.2)	3.3 (1.2)	4.0 (0.9)
Levels	3.1 (1.1)	2.9 (1.2)	3.1 (1.2)	3.9 (0.9)
Progress	3.4 (1.1)	3.2 (1.2)	3.5 (1.1)	4.1 (0.8)
Leaderboard	3.2 (1.3)	2.9 (1.3)	3.2 (1.3)	4.0 (0.9)
Challenges	3.4 (1.1)	3.1 (1.2)	3.4 (1.2)	4.0 (0.9)
Avatar	3.1 (1.1)	2.6 (1.2)	2.8 (1.2)	3.9 (1.0)
Feedback	3.5 (1.1)	3.4 (1.2)	3.6 (1.1)	3.9 (1.0)
Clear goals	3.5 (1.1)	3.4 (1.2)	3.6 (1.1)	4.1 (0.8)
Rewards	3.5 (1.2)	3.3 (1.3)	3.5 (1.2)	4.1 (0.8)

To test whether there was a relationship between our participants' personality traits and their perception of motivational affordances, I employed a multiple regression analysis. All individual Beta (β) values from 40 regressions (4 perception types \times 10 affordance types) are summarized and the significant ($p < .05$) results presented in Table 6. In summary, more extroverted people tended to prefer Points, Levels, and Leaderboards; people with higher levels of agreeableness tended to like Challenges; people with higher conscientiousness preferred Levels and Progress; people with lower emotional stability scores tended to like Points, Badges, Progress, and Rewards; and those people with lower imagination/openness scores were more likely to prefer using

Avatars. In the remainder of this section, I report significant differences among perceptions (i.e., enjoyable, reliable, and helpful) for each affordance, both quantitative (from the Likert-scale ratings) and qualitative (from our open-ended survey questions, see Table 7 for a summary). Although the total number of participants in the study was 248, the number of qualitative responses reported in this section vary, because the open-ended elaboration/explanation survey prompt was optional (in the interest of balancing between expressiveness and time).

For Points, participants with higher levels of extraversion reported that this affordance is more “helpful” in supporting habit tracking ($\beta = .143, p < .05$). People with lower emotional stability scores report a stronger likelihood that Points would serve as a “reliable” tool ($\beta = -.147, p < .05$). Based on participants’ responses to the open-ended question, Points were seen as helpful in facilitating goal setting (such as aiming to earn 1000 points), and the accumulation of points helped participants feel a greater sense of accomplishment towards their goals. In addition, respondents felt that Points were “helpful” and “reliable” when used to represent progress concretely. Participants reported that monitoring Point totals made it easier to track their overall performance. On the negative side, respondents reported concerns about the “reliability” of Points because some felt that a numerical value would have little motivational impact. Some sample comments are listed below:

I would be encouraged to earn as many points as possible to enable me to feel good about my goals. (P87)

Points are fine but only when I know they relate to something or can be used for something. They need to have greater value other than just feedback. (P142)

With regards to Badges, respondents with lower emotional stability scores were more likely to identify the affordance as being “helpful” ($\beta = -.190, p < .05$) and “enjoyable”

($\beta = -.145, p < .05$). As with Points, respondents explained that Badges are most “helpful” and “enjoyable” because of the feeling of accomplishment that they provide. Some of the reasons given to justify low preference scores for Badges included “silly” and “childish.”

For Levels, people who were more extroverted were more likely to rate the affordance as being “reliable” ($\beta = .141, p < .05$), “helpful” ($\beta = .190, p < .05$), and “enjoyable” ($\beta = .148, p < .05$). Participants with higher conscientiousness scores also rated Levels as being highly “enjoyable” ($\beta = .142, p < .05$). In addition to the same positive and negative explanations reported for Points and Badges, Levels were also criticized by some participants because of the way that they felt like they were being labeled by an application employing the technique.

Table 6. Study 1 Significant Standardized Coefficients ($p < .05$) as Calculated by Multiple Regression.

Affordance Types	Perception	Extraversion	Agreeableness	Conscientiousness	Emotional Stability	Imagination
Points	Reliable	-	-	-	-.147	-
	Helpful	+.143	-	-	-	-
Levels	Helpful	+.190	-	-	-	-
	Enjoyable	+.148	-	+.142	-	-
	Reliable	+.141	-	-	-	-
Feedback	—	-	-	-	-	-
Clear Goals	—	-	-	-	-	-
Leaderboard	Enjoyable	+.160	-	-	-	-
	Reliable	+.182	-	-	-	-
	Helpful	+.163	-	-	-	-
Challenges	Enjoyable	-	+.140	-	-	-
	Helpful	-	+.142	-	-	-
Badges	Enjoyable	-	-	-	-.145	-
	Helpful	-	-	-	-.190	-
Progress	Enjoyable	-	-	-	-.172	-
	Reliable	-	-	+.147	-.147	-
	Helpful	-	-	-	-.194	-
Rewards	Enjoyable	-	-	-	-.155	-
	Helpful	-	-	-	-.186	-
Avatar	Helpful	-	-	-	-	-.162
	Reliable	-	-	-	-	-.172

Table 6 shows how people with higher levels of emotional stability rated Progress as being less “enjoyable” ($\beta = -.172$, $p < .05$), “helpful” ($\beta = -.194$, $p < .05$), and “reliable” ($\beta = -.147$, $p < .05$). However, participants with higher conscientiousness scores did tend to rate the affordance as being more “reliable” ($\beta = .147$, $p < .05$). Above and beyond the sense of accomplishment that the affordance provided, respondents reported that Progress provided motivation by calling out specific opportunities for improvement. Negative comments about Progress focused almost exclusively on the sense of pressure introduced by the affordance.

No significant relation was found between personality traits and Feedback in this study. In respondents’ comments, 67 out of 823 participants mentioned that they like

seeing the “big picture” of what they have accomplished through Feedback. The remaining 15 participants mentioned various advantages about using this information to help them plan ahead. As with Progress, Feedback also received criticism because of the sense of pressure introduced by being confronted with evidence of prior lapses in performance.

People with higher levels of agreeableness were more likely to rate Challenges as being “enjoyable” ($\beta = .140, p < .05$) and “helpful” ($\beta = .142, p < .05$). Respondents commented that there is something enjoyable about exerting control over their own pace of performance by setting sub-challenges for each task. Negative comments about the affordance dealt mainly with the pressure of failure introduced by the addition of Challenges.

No significant result was found between Clear Goals and personality traits in the data. However, in the qualitative results, 73 out of 79 participants reported that they felt empowered with “more control on their own” when using Clear Goals. Only 6 out of 79 participants mentioned concerns about the additional pressure that setting additional goals might create.

Leaderboards received lower “enjoyable” ($\beta = .160, p < .05$), “reliable” ($\beta = .182, p < .05$) and “helpful” ($\beta = .163, p < .05$) ratings from people who self-rated as being more introverted. I found three reasons for this finding from among respondents’ open-ended comments. First, some participants just did not like the sense of competition that this affordance introduced. Second, some participants do not want to share their tracking data with others, which implicitly occurs when Leaderboards are employed. Third, a few respondents believed that health-related daily activity was not an appropriate topic for

competition, for example: “I don’t want my usual routine to become some kind of competitive game” [P57].

Respondents with higher levels of imagination/openness tended to feel that Avatars were less “helpful” ($\beta = -.162, p < .05$) and “reliable” ($\beta = -.172, p < .05$). There was no significant relation found between personality traits and the “enjoyable” ratings assigned to the affordance. However, based on the respondents’ comments, 34 out of 44 respondents reported that they enjoy the feedback the avatar provided. Negative comments reported about Avatars included a lack of a personal connection with the Avatar and a sense that the Avatar was childish.

Participants with lower emotional stability scores were more likely to rate Rewards as being “enjoyable” ($\beta = -.155, p < .05$), and “helpful” ($\beta = -.186, p < .05$). No significant relation was found between personality type and assessment of the affordance’s “reliability”. From the qualitative responses, participants expressed a preference for Rewards as a motivator for two reasons: they like receiving concrete recognition for their efforts, and they appreciated the feeling of accomplishment that Rewards provide. For those participants who reported that they do not feel encouraged by Rewards, it either due to the added pressure of failure or because they felt the example Reward shown in the video would not provide adequate incentive.

Based on an analysis of respondents’ comments from our survey, I identified several reasons that the 10 types of affordances can be demotivating when used in gamification. I conducted an affinity mapping on these reasons, resulting in 4 categories of affordances, shown in Table 7.

Table 7. Motivational Affordances Categorized by Participants' Concerns About How Each Might Be Demotivating.

Motivational Affordances	Demotivating Concern
Points, Levels, Badges, Avatar, and Rewards	Lack of value
Challenges, Clear Goals	Pressure of failure
Progress, Feedback	Pressure of failure Visually confused
Leaderboard	Do not enjoy competition Don't want to share personal goals with others Health-related activity is not a competition.

Discussion

In this section, I discuss how our findings can be applied to the design of gamified self- tracking applications, both to appeal to the general users and to be employed to fit the needs of specific user groups based upon their personality types.

Appealing to a Broad User Population

Our results show that overall Levels and Avatar were the two lowest-rated motivational affordances. Additionally, the participants' preference for Points was found to be positively correlated with their preference for Levels, Badges and Rewards. From the qualitative results, participants expressed a common concern across all five of these affordances, which are a perceived "lack of value;" that is, the affordances were perceived as being disconnected from the primary purpose of the app. These results are consistent with the previous study conducted by Hamari et al. (2014), which tested the usage of badges in a trading service platform, as well as with a study that examined Points and Levels and observed that the increase of the activities diminished shortly after the launch of their platform (Farzan et al. 2008). Gartner (2012) stated that the lack of interest toward such affordances could cause gamification to fail when users' motivations are extrinsic to the system.

Therefore, I suggest that when incorporating Points, Levels, Badges, Avatars, and other Rewards mechanisms into gamified self-tracking apps, instead of simply applying a scoring system, or adding a series of titles, a few badge images, or smiling faces, designers should take steps to contextualize the instantiation these affordances—for example, to tie the representations that are used to the main purpose of the application. Doing so helps users to connect these affordances to the non-game activities that they were initially interested in, and thus the initial motivations of the application are more explicitly reinforced. For example, in the example habits tracking app, to award a user a level up from “tracker” to “super tracker” lacks real-world meaning. Instead, a way to provide a meaning by design is to let a super tracker to unlock enhanced data collection capabilities or reveal more detailed information about how daily activity relates to enhancing one’s health, in which way to assign meanings for their efforts or performance.

The results show that Clear goal was the highest-rated affordance in this study, and it was strongly and positively correlated with Challenges. The qualitative results also show that a large proportion of the respondents felt motivated by setting their own goals and challenges. These results are consistent with the prior literature (e.g., Li et al. 2012; Sweetser and Wyeth, 2005).

For example, Dong et al. (2012) reported that all participants from their study commented positively about Clear goals and Challenges. However, in this study, some respondents did express concern with these two affordances because of the pressure of avoiding failure. This concern was also reported in previous studies. Dong et al. (2012) found that engagement diminished when Goals and Challenges were too difficult.

Another study that examined Clear goals and Challenges demonstrated that setting a difficult—but attainable—goal could enhance users' performance (Jung et al. 2010).

Therefore, I suggest that when applying Clear goals and Challenges in gamified applications, the design should also provide customization and goal-setting assistance features. For example, when users are allowed to set their own sub-goals or challenges, the system should assist users by providing guidance or instruction so that users set “difficult but attainable” goals or challenges at the beginning and during the process.

For Users with a Specific Personality Type

The results show that people who are more extroverted are more likely to prefer Points, Levels, and Leaderboards. This finding indicates that more extroverted people tend to like socially competitive activities and are more likely to be motivated by “showing off” their achievements. These results are consistent with the prior work by Nov and Arazy (2013), who reported that extroverted people tend to contribute more to social participation systems when they perceived a large audience size. In an educational setting, researchers found that extroverts perceived Rewards to be most enjoyable, but also found that Leaderboards had a negative effect on the perceived playfulness by more extroverted students (Codish and Ravid, 2014), which is inconsistent with our results. An underlying psychological reason could be that these highly extravert people are more likely to enjoy being on “center stage” and keeping the spotlight on themselves in a larger crowd (Hilling, 2012) At the same time, these individuals can be very demanding and get bored quickly on repetitive tasks. In contrast, introverts are described as not preferring to draw attention from a crowd unless they are familiar with everyone in the crowd. These individuals generally enjoy solitary tasks rather than being involved in groups (Hilling,

2012), and thus in a gamification application, making their activities transparent to others might not be preferred internally by them.

Therefore, I suggest that if when designer an app that specifically appeals to users who are more extroverted, designers should consider utilizing Points, Levels, Badges, and/or Rewards. The down side to these choices is that the positive effect of their inclusion may be short-lived. To invoke more sustained engagement from extroverted users, Leaderboard may be a better choice, because it allows users to interact with a dynamic social group, which can respond to and evolve alongside an extroverted user's actions. On the other side, for users who are more introverted, Leaderboard could be a demotivating feature because of the public social impact. Therefore, I suggest that to appeal to introverted users, designers should either omit Leaderboard functionality or implement the affordance in such a way that users only compete with a close circle of well-known (and approved) friends.

People who exhibit emotional stability are defined as having “emotional maturity, self-confidence, and stability in their plans and affections” (Pavlenko et al. 2009). The survey results show that emotional stability was negatively correlated with all motivational affordances, and significantly so with Points, Badges, Progress, and Rewards. This finding indicates that people with high emotional stability are not likely to be motivated by or interested in any particular affordance in a gamified system. I also found evidences supporting this conclusion from the qualitative results, where some respondents with higher levels of emotional stability commented that our example application was “just a toy” or “silly.” Although few studies had examined the relation between emotional stability and motivational affordances in gamification, studies on

social media platforms have consistently found that emotional stability is negatively related to online social activities (Correa et al. 2010; Nov and Arazy, 2013). The survey findings suggest that, to enhance user engagement, gamification is not a one-size-fits-all solution. There is a limit to what gamification can accomplish. For those people with higher levels of emotional stability, gamification may not be an effective approach.

I also found that emotional stability is strongly and positively correlated with age and gender. This is consistent with the prior findings from the study carried out by Correa and et al. (2010). I do not have data that enable to confirm strong causal relationship between age or gender and their resistance to gamification. The survey results do suggest that there may be a relationship between age or gender and preferences on gamification via emotional stability, which is a potential future work.

For people with higher levels of imagination/openness, the survey results show that they are less likely to be motivated by Avatars in gamified self-tracking apps. Higher imagination or openness is reflected by increased novelty seeking and curiosity (Ross et al. 2009). The avatar in our study—a smiling cat picture that updated when users actively engaged with the application—was an implement from Tamagotchi, a handheld “digital pet” that was very popular during the 1990s. Results show that respondents with high levels of imagination and openness felt bored and, therefore, demotivated by the particular implementation of Avatar in our example application.

Therefore, I suggest that, to appeal to users with higher levels of imagination, designers should avoid applying Avatar in a conventional way. For example, a novel way of presenting or interacting with an avatar might result in a more successful engagement with this class of users.

A few significant results were found that indicated specific solutions (or anti-solutions) for individuals with high or low agreeableness and conscientiousness scores; thus, I think that these personality traits may not affect preference in this space strongly enough for me to make any specific design suggestions for gamification designers. As a study that examined all the Big Five personality traits, the survey findings suggest that extroversion and emotional stability are the two traits that most significantly impact the design of gamified self-tracking applications. To support personality trait-based customizations, it might be most effective to pre-screen or passively observe interactions that differentiate among these particular traits.

Looking beyond Personal Informatics and Habit-Tracking Applications

Besides the design suggestions discussed above, this work also suggests several theoretical and design implications for health applications in ubiquitous computing and, more broadly, for the human–computer interaction domain.

Personalized Interfaces

The survey results show that for motivational affordances, users with different personality traits have different perceptions of and preferences for the same affordance. Many non–healthcare- oriented systems have focused on offering personalized data. For example, recommendation systems like Netflix have been developed to offer users personalized suggestions in the entertainment domain. Facebook Newsfeed curates the contents displayed to users so that users are more likely to see information that they will perceive as being more interesting and relevant. However, these kinds of systems do not typically provide interface customizations based on users’ behaviors or preferences, let alone based upon their personality traits.

One reason that people may not have previously seen interface adaptations based on personality types is the lack of data from which users' personalities can be accurately modeled.

Even though the survey results show that users' personality traits can help to predict which and how the affordances should be implemented in a particular application, doing so still requires a priori knowledge of their personality traits. Answering a short survey may be fine for a paid Mechanical Turk worker in the context of a research study, but this would likely not be an ideal part of a setup process for users of a commercial (and paid!) application. If personality traits can be implicitly modeled—perhaps based on a user's initial actions configuring an application or working with a system for the first few days—then the resulting model might effectively serve to bootstrap this process in a way that is less costly for users. Systems like IBM's system U (Badenesh et al. 2014) have leveraged users' online social media usage patterns to infer users' emotions, values, and beliefs. Computational approaches, similar to IBM's System U, suggest how a system might automatically classify a user to determine aspects of their personality; however, additional research is necessary to evaluate the practicality and efficacy of this technique.

System as an Actor

Based on this study results, I found that for a single affordance, different users have different perceptions, which is consistent with the original definition of affordances by Gibson (1977). However, his definition of an affordance as the “the actionable properties between an object and an actor” inherently positions computing systems as objects or instruments. Based on this finding, users adapt themselves to their tools, and they choose the right tool to suit their particular situation. However, as computing

platforms continue to evolve, incorporating algorithms from artificial intelligence, new kinds of sensor technologies, and increased personalization, computing tools become much more adaptive to and conversant with the capabilities and limitations—including, for example, the personality traits—of their users. At this point, a case can be made that the computing tool ceases to be a simple tool and becomes an actor in its own right.

To explore the plausibility of designing systems that fill this kind of a co-actor role, additional research is needed to better understand the techniques for and implications of modeling users along a richer set of dimensions—including personality, which I have used as a lens in this study. Researchers will also need to understand humans' cognitive and behavioral attributes above and beyond those associated with motivation. However, I see this work as a potentially important step in acknowledging the role of human motivation as a design resource for creating adaptive tools for general users, as well as more specific user groups with particular personality characteristics.

Limitations

Habit formation is a long-term process; as a result, people may interact with motivational affordances differently over a period of time. As a result, using demo videos to communicate the instantiation of each affordance may have only elicited people's initial perceptions of these affordances and not the kind of mature thinking that would only emerge after using such an application over time.

Additionally, gamification exclusively uses extrinsic rewards, while people internalize achievements such as the ones examined in the study. However, game mechanics do not provide means to measure users' progress along the continuum where they respond to extrinsic to intrinsic rewards. Gamified affordances can only supplement

intrinsic motivation with extrinsic motivation. Hence, it does not provide a way of inculcating intrinsic motivation through other measures like creating awareness or comprehending cost-benefit analysis.

Next steps

The follow-up study took a closer look at the relationship between people's specific personality trait, extraversion, and its interaction with different motivational affordances, points and leaderboard in situ (e.g., in a real, deployed application) and over an extended period of time. This follow-up research will continue to reveal effective ways to encourage engagement in gamified applications and provide a more detailed understanding of how people's perceptions of motivational affordances evolve and mature over time.

Conclusion of Study 1

Overall, this study contributes to the understanding of how people's personality traits relate to their perceived preferences for various motivational affordances that are widely used in system gamification. The findings indicate that personality traits do play a role in people's perceived preferences on gamification, and they highlight opportunities to engage users—or, at a minimum, limit frustration and disengagement—by tailoring the design of gamified applications based on users' anticipated or measured personality traits. I discovered that the two primary personality traits that serve to differentiate habit-tracking application users are extraversion and emotional stability, and I developed a number of guidelines that system designers might consider when either targeting a broad spectrum of gamified system users or a more targeted subset, based on individuals' personality types.

Chapter 6. Study 2

Introduction

A number of studies have reported that gamification features are effective in helping to motivate users and enhance user experience. For example, among U.S. internal medicine residents, a gamified hand hygiene program reported effective enhancement of hand hygiene compliance by combining Points and a Leaderboard to engage users (Higgins and Hannan, 2013). In the education domain, Points and Leaderboards have also been found to be effective, for example, in improving students' in-class participation and out-of-class learning (Huang and Hew, 2015). However, other studies reported different results—and, sometimes, conflicting outcomes (Codish and Ravid, 2014; Jia et al. 2016). For example, in an educational setting, Hentenryck and Coffrin's study reported that 2 out of 3 students surveyed indicated that they enjoyed using the leaderboard. However, around 1 out of 3 students responded with much higher levels of ambivalence about the feature (Hentenryck and Coffrin, 2014).

These findings highlighted an important point about gamification: while some users find some gamification features to be motivating, others may find them demotivating. Previous studies pointed out that gamification is not a one-size-fits-all approach, and personality may serve a key differentiator. For example, Codish and Ravid's study found significant differences between extroverts and introverts in how students perceive different motivational affordances in their courses: extroverts reported a lack of playfulness in Leaderboards (Codish and Ravid, 2014). Jia et al. conducted a survey study and found that people who are more extroverted are more likely to prefer Points, Levels, and Leaderboards in gamified applications (Jia et al. 2016).

Although prior research has examined personality and its effects on people's preferences for gamification and "gamified" interface elements, little is known about how users' motivations change over time. In this study, we explore the relations between personality differences and users' motivation for using a gamified application over time.

Our initial interest in exploring this question was motivated by previous research findings from Study 1. In this study, I conducted an empirical study with 10 introverts and 10 extroverts for 3 weeks, to examine the personality trait extraversion and its influence on participants' preference for points and leaderboards in a gamified habit-tracking platform.

RQ1: Between extroverts and introverts, is there any difference in users' performance and motivations for completing self-directed habit-formation tasks?

RQ2: Between extroverts and introverts, is there any difference in users' preferences for points and leaderboards over time?

Background

A common criticism of using points or leaderboards as motivators is that, in some studies, these features have been found to only work very well for short-term tasks, and to undermine peoples' intrinsic motivation (Hanus and Fox, 2015). However, some other research studies disagree with these findings. For example, an empirical study by Mekler et al. (2013) showed that points and leaderboards did not harm people's intrinsic motivation in an image annotation task. To advance the understanding of the influence of gamification features on users' intrinsic and extrinsic motivations, this study uses a scale to evaluate users' motivation, based on Self-Determination Theory (SDT).

Self-Determination Theory (SDT)

In 1985, an analysis of extrinsic motivation by Ryan et al. introduced the concept of “internalization,” which refers to “taking in a behavioral regulation and the value [that] underlies it” (Ryan et al. 1985). The study explained how extrinsic behavior could become autonomous. Together with other related research, in 2000, Ryan and Deci formulated Self-Determination Theory (SDT), which is much broader in scope. Two key concepts in SDT are autonomous motivation and controlled motivation. According to Gagne and Deci (2005), autonomous motivation supports people with the experience of having a choice and a sense of volition. Controlled motivation involves the experience of being controlled with a sense of pressure to engage in an activity. One example of autonomous motivation is intrinsic motivation; in contrast, extrinsic rewards were found to induce controlled motivation (Deci, 1971). A postulate in SDT is that the main distinctions between autonomous and controlled motivation are the underlying regulatory processes.

Rather than conclude that motivation has a binary value—either internalized or not—Organismic Integration Theory (OIT), a sub-theory of SDT, presents a continuum based on the degree to which the behaviors are autonomous versus controlled (Ryan & Deci, 2000]. OIT posits a range of motivations, spanning from amotivation to intrinsic motivation. Amotivation, which involves a lack of motivation and intention, stands in contrast to autonomous and controlled motivation. Intrinsic motivation, which is driven by people’s interest and enjoyment of the task, is inherently autonomous motivation. Along the continuum between these two endpoints, four types of extrinsic motivations are presented: 1) External Regulation, “a classic type of extrinsic motivation and a

prototype of controlled motivation”, in which people act for the desired consequence; 2) Introjected Regulation, “a regulation that has been taken in by the person but has not been accepted as his or her own ,” for example, contingent self-esteem and ego involvement (deCharms, 1968; Ryan et al. 1983); 3) Identified Regulation, in which people feel relatively autonomous even if/when the activity is not intrinsically interesting, for example, when a person identifies the value of an act in satisfying his or her personal goals; and 4) Integrated Regulation, in which a person has a “full sense” that the behavior is an integrated part of his- or her-self (Gagné and Deci, 2005; Ryan and Deci, 2000).

Following SDT, researchers have developed several scales to evaluate and assess peoples’ motivation. In this study, I use the Situational Motivation Scale (SIMS), a widely used scale to assess motivations from SDT for both laboratory and field settings. SIMS includes intrinsic motivation, identified regulation, external regulation, and amotivation. Two types of regulatory processes, introjected and integrated regulation, are not included in this scale due to the consideration of the length of the questionnaire (Guay et al. 2000).

Methodology

This study investigates the interactions among and changes in participants’ task performance, motivations related to a task, and preferences for various gamified features over a period of three weeks. The participants were chosen for the study to intentionally differ in their self-identification as introverts or extroverts. I conducted a controlled study with 20 participants—10 extroverts and 10 introverts—asking these participants to use a gamified habit-tracking app developed for Android smartphones for a period of 3 weeks.

The Android app was developed with Angular JS and the database platform Firebase. Two gamification features were implemented in this app: Points and a Leaderboard.

Participant Recruitment

To recruit 20 participants that included 10 introverts and 10 extroverts, I conducted a two-phase recruitment process. In the first round, I recruited 45 participants from a university. The participants were required to be over 18 years old, to have an Android smartphone and to have experience using that phone for a minimum of 3 months. All 45 participants were asked to take a demographic survey of their gender, age, educational level, occupation, and ethnicity; and a 50-item survey for personality traits derived from the IPIP Big Five Factor Marker, a free, research-community–developed inventory. In the second round, I selected 10 introverts (with the lowest scores for extraversion) and 10 extroverts (with the highest scores for extraversion) from the larger pool of 45 participants. The demographics of all 20 participants recruited in phase 2 are listed in Table 8. From the IPIP personality scale for extraversion, each item has a scale from 1 to 5. Thus, a person can have a score as low as 10 and as high as 50. In our sample, the mean personality score for the extrovert group was significantly higher than of the introvert group ($p = .000$). The descriptive data of the two groups of participants' personality scores are listed in Table 9.

Table 8. Study 2 Participants Personality Score.

	N	Min	Max	Mean	St.D
Extroverts	10	36	50	42.4	5.70
Introverts	10	19	25	21.4	1.84

Table 9. Study 2 Participants Demographics.

	Extroverts	Introverts
Age	18-24 (2) 25-34 (7) 45-54 (1)	18-24 (2) 25-34 (7) 45-54 (1)
Gender	Female (5) Male (5)	Female (5) Male (5)
Educational Level	Bachelor Degree (7) Master Degree (3)	Bachelor Degree (6) Master Degree (3) Ph.D., Law, or Medical Degree (1)
Occupation	Employed for wages (4) Student (6)	Employed for wages (4) Student (6)
Ethnicity	White (2) Asian/Pacific Islander (7) Black or African American (1)	White (2) Asian/Pacific Islander (8)

Habits Tracking Application

Habits Tracker is a habit-tracking app (see Figure 3), designed and developed specifically for this study. It includes two main functions: Daily habits, designed to support users in tracking a series of pre-defined habits. This feature serves as a daily to-do list; when participants complete a habit, he/she can click on the “Done” button to acknowledge and record the activity. Once clicked, the button is disabled until the next day. The app’s second function, My Performance, is a Web-like page that displays points and a leaderboard, both based on the user’s performance on the habit-tracking task.

For the purpose of experimental control, I defined the rules underlying the points and leaderboard features to be the same for both experimental groups. For the points feature, each participant is awarded 0 points at the outset of the study and earns 5 points every time he/she completes a habit and clicks on the “Done” button. For the leaderboard, I defined the number of completed habit tasks to determine each position on the leaderboard. The participant’s leaderboard position goes up when he/she completes more

habit tasks, but the position does not go down if he/she stops competing tasks. For example, participants should at least complete 7 habits (out of 3 habits per day x 21 days=63 habits) to have their names appear on the board; and they could have their name displayed in the first position of the leaderboard when they complete 60 habits in total. In the beginning, the 10 names shown on the leaderboard in the app are fictional names with simulated levels of performance; participants were told that those people were other participants in this study. This leaderboard setting was intentionally designed as a control for the experiment, since the participant's relationship with the people on the leaderboard (friends vs. strangers) and their apparent position on the leaderboard (top vs. bottom) have all been proven to be confounding factors for user preference for leaderboards in gamified applications (Jia et al. 2017).

Daily Habits

Drink 5 bottle water

Done

Sleep early

Done

Run 3 miles

Done

Daily Habits

My Performance

(a)

My Performance

Points: 10

Top Habits Tracker

1	Giffin
2	Peter
3	Alisha
4	Tommy
5	Julie
6	Mike
7	Mary

Daily Habits

My Performance

(b)

Figure 3. The Respondents' Experience of the Mockups Showing Leaderboards Applied to the Application from the Survey.

Study Procedures

At the beginning of the study, each participant was asked to meet with a researcher to complete a 30-minute introduction session. During this session, they were asked to 1) install the app, 2) pre-define 3 habits that they would like to foster and track over the course of the following 21 days; 3) complete a pre-test survey about their motivations for these three habits, which was later used as a baseline of user's self-reported motivation on each habit.

During the study, participants received a reminder to log their habit tracking progress via an SMS every day. Every three days, participants were asked to complete an online diary-style survey about their motivations relative to each of their three habits and to rate their preferences for the points and leaderboard functions of the app.

At the conclusion of the 3-week deployment period, 10 participants (5 from the extrovert group and 5 from the introvert group) were interviewed with more in-depth questions about their experiences with the habit-tracking process. All participants were compensated with a \$20 Amazon.com gift card.

Study Protocol – Diary Survey Design

The diary survey consisted of two sections: 1) participants' self-reported motivation as related to each of their tracked habits. The scale was adapted from the Situational Motivational Scale (SIMS) (Ryan and Deci, 2000), which covers four OIT subscales: intrinsic motivation; identified regulation; external regulation and amotivation. There are 4 items per subscale and thus a total of 16 items. Each item represents a possible reason for completing the habit task. 2) Participants' preferences for points and leaderboards. The questions were adapted from Study 1.

Study Protocol – Follow-up Interview

As a follow-up to the diary survey, I conducted in-depth interviews with 10 participants in order to elicit their experiences of fostering habits and using the app over the three-week time frame and to contextualize their responses to the diary survey questions. At the beginning of the interview, participants' habit-tracking data from the app and responses from the diary surveys were presented to participants for self-reflection. I specifically asked about reported changes in participants' experience of habit tracking and preferences for points and leaderboards over the course of the three-week study, in order to understand how and why extroverts' and introverts' behaviors differed. I also encouraged participants to talk about their experience with points and leaderboard systems in other gamified applications (e.g., online games, fitness trackers).

Results

Three types of results were collected from the study: 1) habit tracking performance data, drawn from the log data collected by the app; 2) diary survey data that was collected at 8 points during the 21-day deployment period; and 3) qualitative results from the follow-up interview.

Habits Tracking Performance

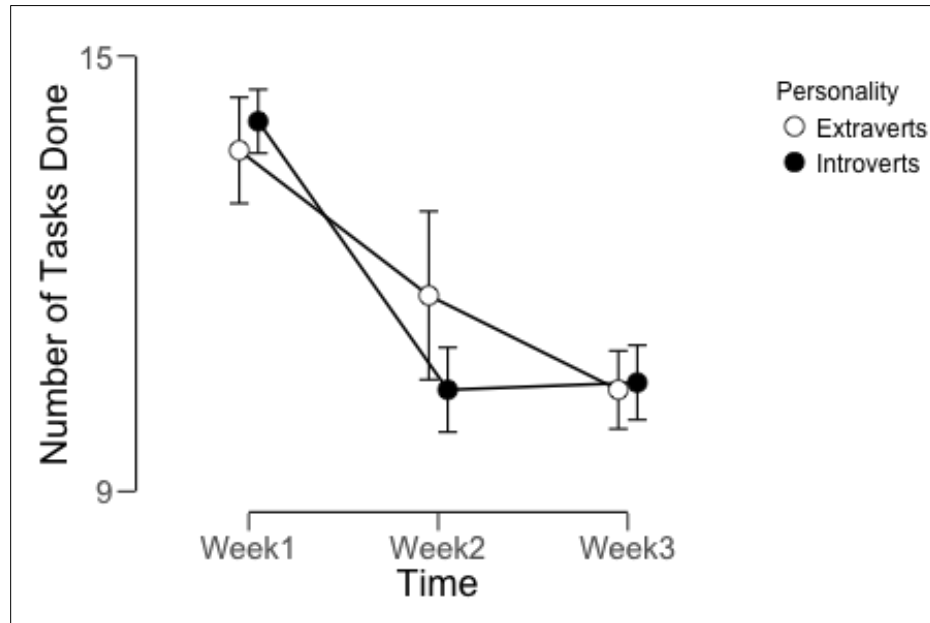


Figure 4. Habits Tracking Performance.

Overall, participants in the introvert group completed 56% of their target behaviors, and participants in the extrovert group completed 57% of their habit-tracking tasks. A repeated measure ANOVA with mixed between-within subjects was conducted. From the test of between-subject effects, the results indicated that, over the 3-week period, there was no statistically significant difference on the number of tasks done (participants' performances on habits tracking) between the extrovert group and introvert group. However, time was found as a significant main effect for participants' performances (Wilks' Lambda: $F(2,18) = 38.550$, $sig = .000$, Partial Eta Squared = .819), which suggested that there was a change on the number of tasks done across the 3-week period. In the post-hoc Pairwise Comparisons, results indicated that there was a significant change on the number of tasks done from Week 1 to Week 2, there was no significant change from Week 2 to Week3. From Figure 4, in the second week, individuals in the introverts group completed fewer habit-tracking tasks than did

individuals in the extrovert group. Although the difference was not statistically significant, the results may indicate that the gamified features, points and leaderboards, may influence extroverts for a little longer than they do for the introverts.

Motivations

From the pre-study survey, our results show that there is no difference between introverts and extroverts on any of the four types of motivations as related to the habit-tracking tasks. After the 21-day experiment, both groups' intrinsic motivation had increased. In the following sections, details about these 4 types of motivations are reported in depth.

Intrinsic Motivation

The results indicated that individuals showed a statistically significant increase in self-reported intrinsic motivation for completing their habit tasks (see Figure 5). From the results of Bayesian Repeated Measures ANOVA, during the 3-week period, there was strong evidence for an effect of time ($BF_{10} = 14.93$). From the post hoc tests, participants' intrinsic motivation significantly increased in both the first and the third week. To be specific, in the first week (on Day 3), compared to participants' initial intrinsic motivations (Day 0), the Bayes Factor was 3.338, which indicates that the hypothesis of the intrinsic motivation on Day 3 was significantly higher than Day 0 predicted the data over 3.338 times better than the null hypothesis (there was no difference in intrinsic motivation between Day 3 and Day 0). In the third week, participants' intrinsic motivations on Day 21, compared to Day 15, the Bayes Factor is 3.196, which indicates that the hypothesis of the intrinsic motivation on Day 21 was significantly higher than Day 15 predicted the data over 3.196 times better than the null

hypothesis (there was no difference on the intrinsic motivation between Day 15 and Day 21).

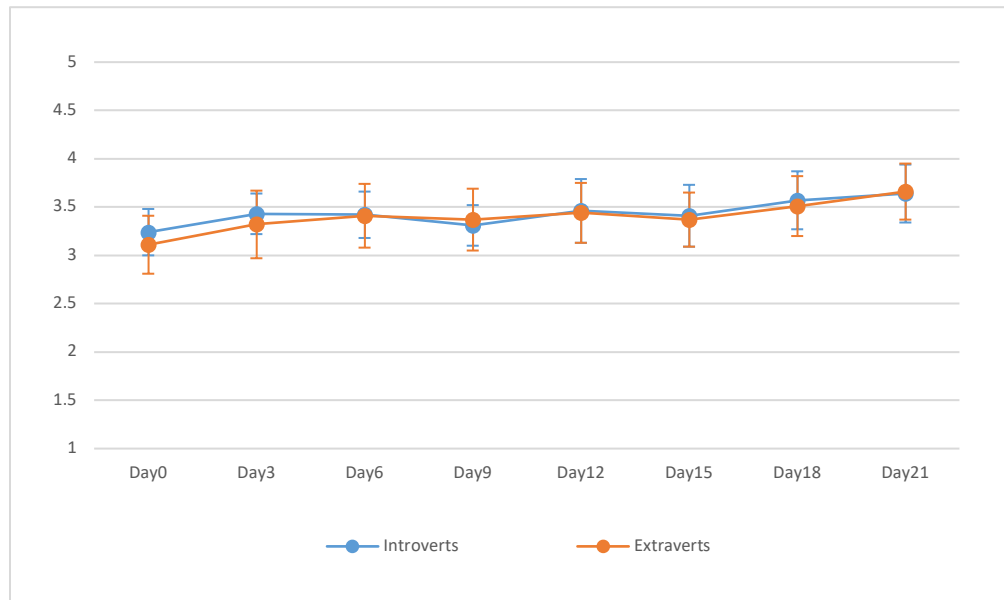


Figure 5. Intrinsic Motivation.

No evidence was found for an effect of personality (extrovert/introvert) from the Bayesian Repeated Measure ANOVA. The results indicated there is no statistically significant difference between the introvert and extrovert groups' intrinsic motivation during the three weeks of the study. In addition, both introverts and extroverts found the tasks to be more interesting and felt more enjoyment from completing the activities after performing the tasks and using the gamified application for three weeks.

External Regulation

From the results of Bayesian Repeated Measure ANOVA, during the 3-week period, there was no evidence for an effect of time or personality on participants' external regulation. The results are presented in Figure 6.

For individuals in the group of extroverts, from the results of a Bayesian Paired Sample T-test, participants' external regulation showed a significant decrease in the third

week, compared to the external regulation in the first week. To be specific, in the third week (on Day 18), compared to Day 3, the Bayes Factor is 13.891, which indicates that the hypothesis of the external regulation on Day 18 ($M=1.833$, $SD= 0.670$) was significantly lower than Day 3 ($M=2.483$, $SD= 0.794$) predicted the data over 13.891 times better than the null hypothesis (there was no difference on the external regulation between Day 18 and Day 3). These results indicate that after two weeks of using the application and performing the habit-tracking task, extroverts' intention to act had moved from obtaining the desired consequence. In other words, rewarding elements may not be as effective for extroverts over time.

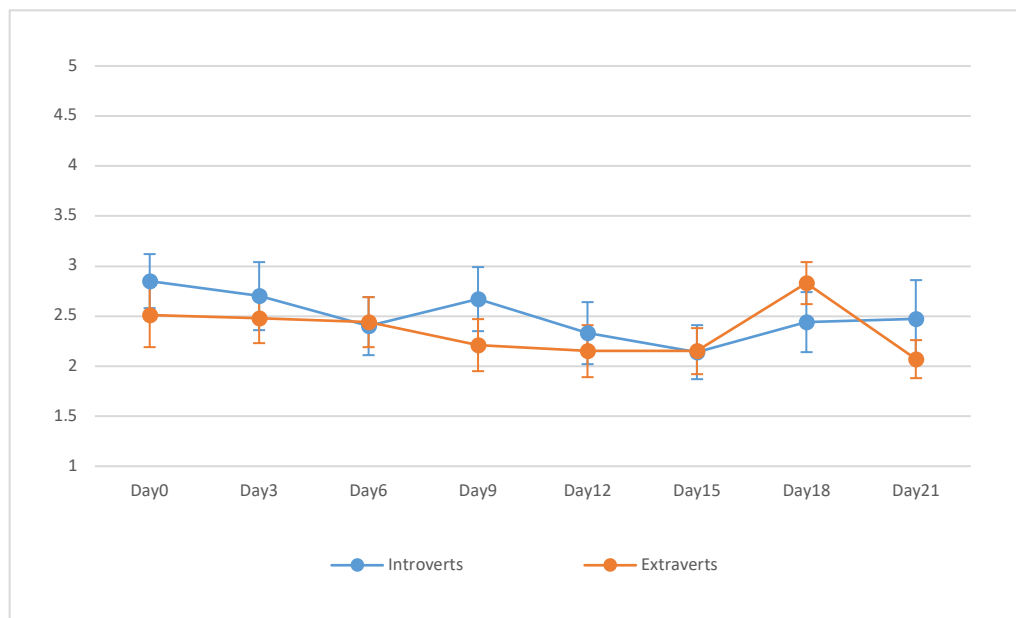


Figure 6. External Regulation

I did not observe any changes in reported external regulation from individuals in the introvert group over the 3-week period.

Identified Regulation and Amotivation

From our results, individuals in the introvert group did not report a significant change in either identified regulation or amotivation associated with the habit-tracking task during the 3-week period; neither did individuals in the extrovert group. In addition, we found no difference in either identified regulation or amotivation between the introverts and extroverts.

These results reveal that both introverts and extroverts had clearly identified the value of their self-selected habit-formation tasks prior to enrollment in the study, which is somewhat unsurprising since all habit-tracking tasks were defined by the participants, themselves.

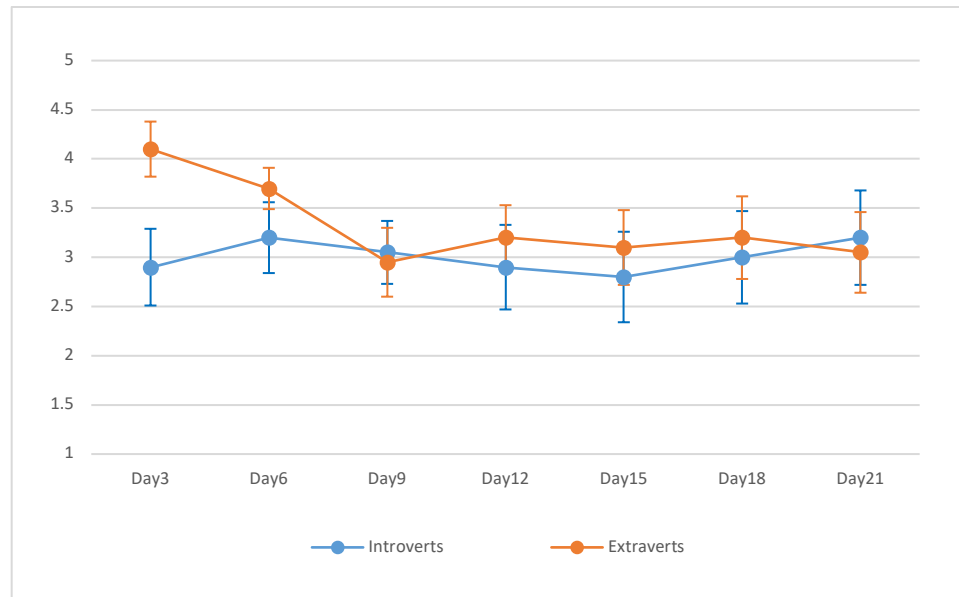
Points and Leaderboards

During the initial meeting, participants were shown the two gamification features in the app and were asked about their preferences for points and leaderboards. The results of this survey show that individuals in the extrovert group had significantly higher preferences for both points and leaderboards at the beginning of the study (see Figure 7). In addition, extroverts rated both Points and Leaderboard positively (higher than 3.0) at this phase of the study. However, participants in the introvert group rated both features negatively (lower than 3.0).

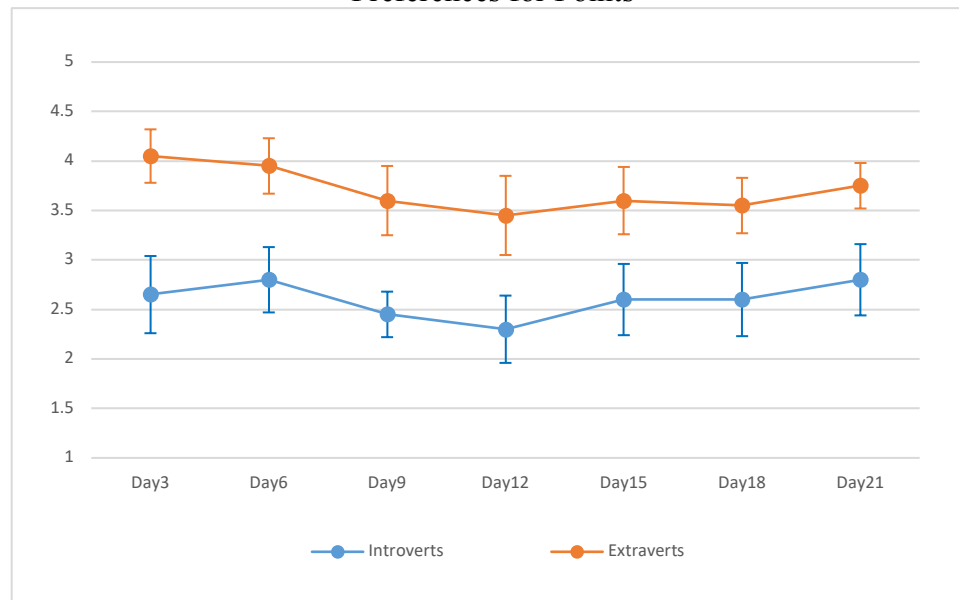
The result from Bayesian Independent Samples T-Test described that during the first 3 days, the Bayes factor is 3.049, which indicates that the hypothesis of extroverts' preferences ($M=4.10$, $SD=0.88$) for Points were significantly higher than introverts' ($M=2.90$, $SD=1.22$), predict the data over 3.049 times better than the null hypothesis (there was no difference in preferences for Points between extroverts and introverts. The

introvert group's preferences for points did not change significantly over the 21 days. However, extroverts' preference ratings for points did drop significantly after the first 3 days. From Day 6 through the end of the study, extroverts' preference ratings for points was very similar to those given by individuals in the introvert group. To be specific, within the extraverts group, from a Bayesian Paired Sample T-test, participants' preferences for Points on Day 3 ($M=4.10$, $SD=0.88$) were significantly higher than the preferences on Day 6 ($BF_{10}=2.227$, $M=3.70$, $SD=0.68$), Day 9 ($BF_{10}=10.081$, $M=2.95$, $SD=1.12$), and Day 21 ($BF_{10}=3.218$, $M=3.05$, $SD=1.30$). More detailed results will be included in the supplementary materials.

For leaderboards, the results from Bayesian Repeated Measures ANOVA showed that there was strong evidence of effects of personality (extroverts/introverts) for changes in preferences for leaderboards, $BF_{10}=4.971$. To be specific, extroverts' preference ratings were positive and significantly higher than the introverts' (negative) preference ratings for the duration of the study, especially on Day 3 ($BF_{10}=5.820$), Day 6 ($BF_{10}=3.710$), and Day 9 ($BF_{10}=4.318$). The results from Bayesian Repeated Measures ANOVA also showed that there was no evidence of effects of time for changes in preferences for leaderboards.



Preferences for Points



Preferences for Leaderboard

Figure 7. Survey Results of Participants' Preferences for Points and Leaderboard.

Extroverts vs. Introverts

In addition to the survey, the results from the interview reveal how extroverts and introverts experienced the process and the gamified application differently during the study. An important insight from the qualitative results is that although all of our

participants used the same application with the same gamified features, after using it for a while, they adjusted their approaches to seeing and using the application.

Introverts

Participants in the introvert group reported that they did not like the points or leaderboard features in applications because they don't like the feeling of being controlled. For the introverts, both points and leaderboard were instances of rules defined by others (the application) that they were expected to follow. Especially for the Leaderboard, introverts reported discomfort in having their performance compared with others'. This competitive aspect of the feature imposed an unwelcome sense of pressure:

“For leaderboard, I don't like it. Because I think the leaderboard isn't healthy, I mean, competing with others makes me unable do things with a calm heart.” (Introverts_P3)

“For these features, I think, I need more help instead of just pushing.” (Introverts_P4)

“I find that points and leaderboard gets in the way of enjoyment.” (Introverts_P9)

Points and leaderboards may serve to demotivate introverts at the beginning of the study.

However, by performing the task and using the gamified application for a period of time, introverts' motivation could slowly be increased. From the qualitative results, individuals in the introvert group reported that in order to complete their goal—to foster and monitor their own pre-defined habits—they used the points and leaderboard features in another way. Rather than seeing these features as instantiations of rewards or competition, they perceived them as record-keeping mechanisms for their own activities and a means to compare to their own previous performance, which eliminated (or at least minimized) the feeling of being controlled or compared by others:

“I use points to record my progress.” (Intro_P3)

“I just go and check the score to see how I am doing, it just makes me reflect that, Oh, today, I completed a lot.” (Intro P8)

Extroverts

Distinct from individuals in the introvert group, individuals in the extrovert group reported that they felt more motivated to compare their performance with others, especially when they saw changes in their points and leaderboard displays. They also reported that after they used the points feature for a while, they felt that the display of points was very “boring” since there were no other rewards tied to this quantification of their effort:

“I think leaderboard motivated me. I like when the leaderboard changes. I will feel more motivated if I can see changes in my rankings.” (Extroverts_P1)

“For points, I don’t know how to use the points. If the points can be used somewhere, then the points are useful to me. I still would like to know what the change in points means.” (Extroverts_P3)

In addition, extroverted participants reported that during the study process, they told their friends about this study and the application. Some of them even posted it on social media. The feedback, comments, and support they got from their friends and families—independent from any particular feature of our system—also helped them to feel motivated. However, the individuals in the introvert group did not mention this kind of emergent social support during the study; instead, they kept their participation in the research to themselves. None of them talked about the study to their friends or families much:

“I didn’t tell anyone about this app or this tracking activity.” (Intro_P3)

“I only told my boyfriend a little bit, not so much detail.” (Intro_P4)

“I told my roommates and my mom about this habit tracking app. I also posted it online and got a lot of likes.” (Extraverts_P5)

“Other people said good things about this, although some feedback was not immediate. I’m expecting compliments.” (Extraverts_P7)

Difficulty Level of Habits Matters

In the interview, participants reported that their overall experience with habit tracking in the study was affected by different difficulty levels of the target habits. To be specific, they reported that the experiences of habit cultivation and their motivation regarding the habits varied between “easy” and “difficult” habits.

Participants reported that the feeling of the difficulty level on the “easy” habits had not changed much over the 21 days. 8 out of 10 participants reported that they still completed those habits after the 21-day study.

“For the easy habit “push-ups”, before, I feel that it is not something I have to do, but after these three weeks, I feel really good, I mean, my body, after doing the “push-ups”. (Extroverts_P1)

“For the easy habit, there was not so much change during the three weeks. The only change I can feel is that my body feels good because of the exercise every day. And my body remembers, so last week, I did it more than the former two weeks, I think.” (Extroverts_P3)

“The only increased behavior that I had previous to the study is the brush the teeth (self-reported easy habit) after drinking coffee. That is the only thing that changed. After the study ended, the other two habits, like I said, I don’t actively pursue doing.” (Introverts_P9)

However, for those self-reported more difficult habits, all 10 participants reported that they felt the tasks were more difficult than they imagined before they tried. They gave up on them normally after the first week.

“After I had done it for, maybe, the first 5 days of the study, or something like that, I felt this is awful, I don’t want to do it, I actively didn’t want to do it. This difficult task that over time, I felt it was more difficult.” (Introverts_P9)

Discussion

In this section, I discuss the relationship between extraversion and its influence on people's preferences for gamification. I also delve into the link between different types of motivation and gamified features. Finally, I discuss how personality differences and motivational theory could help inform the design of gamified computing systems.

Preferences for Points and Leaderboards

The study results from the initial survey reveal that extroverts have a higher self-reported preference for points and leaderboards than introverts do. This result is consistent with previous research from Jia et al. (2016) —a survey study that indicated that people who are more extroverted are more likely to prefer Points, Levels, and Leaderboards—and Codish and Ravid (2014)—an evaluation of a gamified educational platform that found that extroverts perceived Rewards to be the most enjoyable gamification approach.

However, in this study, the results also show that extroverts' preferences for Points decreased over the course of the 3-week study. This finding has not been reported elsewhere in relation to personality type, but it is consistent with previous suggestions that the positive effects derived from the inclusion of gamified elements may be short-lived. Thus, the finding confirmed that the personality trait extraversion did play a role in influencing people's preference for leaderboards and that this result was somewhat more durable than these same users' preference for points.

Extrinsic Motivation: External Regulation

When a behavior is motivated by obtaining the desired consequence, the motivation is externally regulated, which is defined as a classic type of extrinsic

motivation and a prototype of controlled motivation. Being controlled involves the use of extrinsic rewards, external evaluation, and, often, a sense of pressure. In gamification, features like points, levels, badges, and rewards are often implemented in a way that resonates with controlled motivation because they represent extrinsic rewards and are awarded based on evaluations of a user's performance. Leaderboards can be also seen as a form of controlled motivation because of the way that they exert social pressure on users.

The study results show that there was no change over the duration of the study in extrinsic motivation with external regulation for our introverted participants. In addition, the interviews with these participants revealed that introverts re-conceptualized their interactions with points and leaderboards as self-tracking tools, minimizing the (potentially demotivating) discomfort that these components have the potential to induce when they take on evaluative and social meanings. This finding suggests that introverts may have been relying more on the reflective aspects of points and leaderboards associated with intrinsic motivation.

Extroverts' extrinsic motivation with external regulation responses significantly declined through the last week of the deployment. However, their qualitative results revealed that they felt more motivated when compared to others' performance on the leaderboard, especially when they noticed changes. In this study, because I needed to establish an experimental control and avoid introducing confounds with different leaderboard content, the leaderboard was designed to only display the participant's name alongside 9 other synthesized names. After using the app for a few days, individuals in

the extrovert group reported that they noticed that only their own name increased in rank slowly and that there was no change among the other names listed.

Extroverts also reported that they felt that our use of points was “boring” even when the points were changing, since there were no contextual or tangible rewards tied to those changes. This result confirms the findings from Study 1: 1) that a “de-motivational” concern for elements grounded in extrinsic rewards was a perceived “lack of value”; and 2) that extroverts were more likely to be motivated by the “dynamic” nature of the leaderboard.

Thus, to sustain the effectiveness of extrinsically rewarding elements for extroverts, I recommend that gamification designers maximize the dynamism and consider how the extrinsic rewards might be most effectively contextualized for the system’s users. Effective systems might award variable numbers of points for completing a task or award a special badge based on real-world events that the system might detect. For example, if a habit-formation task is completed on a day on which the user has a deadline (e.g., an all-day calendar appointment) to meet.

Intrinsic Motivation

In the literature, intrinsic motivation was defined as “people doing an activity because they find it interesting and derive spontaneous satisfaction from the activity itself” (Gaen  and Deci, 2005). Earlier studies found that intrinsic motivation could be undermined by tangible rewards, competition, evaluation or other extrinsic factors (Deci, 1971; McGraw, 1978). However, recent studies pointed out the limiting conditions of this undermining effect and failed to accept the robustness of the findings (Gaen  and Deci, 2005; Kehr, 2004). It found that “when rewards were contingent on high-quality

performance and interpersonal context was supportive rather than pressuring, tangible rewards enhanced users' intrinsic motivation". Kehr (2004) suggested that rewards may not undermine intrinsic motivation, "if they don't deactivate implicit motives related to task enjoyment."

In the gamification field, some studies also stated that extrinsic rewards and competition features, such as points and leaderboards could undermine a user's intrinsic motivation (Hanus and Fox, 2015). Previous studies also found that deadlines (Amabile et al. 1976), surveillance (Lepper and Greene, 1975) and evaluation (Smith, 1975), undermine intrinsic motivation by diminishing the user's feelings of autonomy.

In this study, the survey results show that participants' intrinsic motivation increased through the use of gamification elements including points and the leaderboard. More surprisingly, participants in the introvert group did not rate their preferences for points and leaderboards positively, but their intrinsic motivation for completing the habit-formation tasks still increased. A closer look into the qualitative results from the interview study may reveal the reason.

Gamification features can have multiple aspects, including those that can serve and those that might negatively affect a user's intrinsic motivation. Gagne and Deci (2005) suggested that intrinsic motivation is an example of autonomous motivation, and pointed out that people need to develop both competence and autonomy in order to maintain their intrinsic motivation.

In this study, the introverted participants reported that they did not like points and leaderboards because they did not like the feeling of being evaluated and compared. However, through the usage of the application over time, participants developed their

own way to use the points and leaderboard features. Introverts treated these features as a way to record their own progress rather than as rewards or as a competition. This adaptation prompted a feeling of autonomy when participants used the features in their own way. The accumulated results reflect the points total and the leaderboard rank support a self-identified sense of competence, making these users feel responsible for their own successful performance.

For extroverts, when they felt that there were not many changes on the leaderboard and there was no extra value embedded in the points that the system awarded, they created “extra rewards” for themselves by posting their progress on social media and telling their friends and family about the study in order to gain more attention and garner compliments. According to Cognitive Evaluation Theory, social-contextual factors could also prompt feelings of autonomy and competence. In addition, extroverts gain relatedness, another basic psychological need, which is also crucial for internalization (Baumeister and Leary, 1995). Relatedness endorses people’s needs to be connected to their social world. An underlying psychological reason for extraverts (but not introverts) to seek relatedness in this study could be that these highly extraverted people are more likely to enjoy being on “center stage” and keeping the spotlight on themselves in the social world (Hilling, 2012).

One insight I could gain from these findings is that rewarding features can be designed not only to reward users and that competitive features can be designed not only to foster competition. To enhance users’ intrinsic motivation, the design of gamified features should be grounded in facilitating the user’s underlying psychological needs. Therefore, I suggest that to appeal to both introverts and extroverts, points and

leaderboards should support customization. For example, a user could design his/her own leaderboard. For extroverts, they could: 1) define their comparison task; 2) define who they are going to be compared and presented against on the leaderboard, including strangers, the user's friends, or members of their family. For introverts, they could define the leaderboard: 1) to only compare with close friends or 2) to only present his own historical scores, for fostering self-reflection. This fully customizable approach provides users the feeling of competence and relatedness without undermining autonomy and thus, help to enhance users' intrinsic motivation.

Limitations

Different from a commercial app, Habit Tracker is a gamified application that was deployed for experimental study purpose. The app interface was designed in a simple and plain way to avoid possible confounding factors. It may reduce users' feeling of "fun" compared to other gamified apps. In addition, users' preferences for points and leaderboards may also be affected by the design of the features. The leaderboard used in this study did not capture the wide range of possible leaderboard types, leaderboard application domains, and positions on the leaderboard. Finally, there are about 50 items on the diary survey; participants put more effort into completing the survey questions than the habits tracking tasks.

Next steps

The study took a closer look at the relationship between people's specific personality trait, extraversion, and its interaction with different motivational affordances, points, and a leaderboard in a deployed application over time. Next, the motivation affordances of the Leaderboards were further investigated to understand users'

experience with a gamified application in different domains and leaderboards with different positions.

Conclusion of Study 2

Overall, this study contributed to the understanding of how people with different personalities interact with gamification over a period of time. The findings indicated that the personality trait, extraversion, does play a role in people's perceived preferences for the Leaderboard. I also discovered that people adjusted their way of being motivated by gamified features through the process of the study. Both introverts and extroverts' intrinsic motivation increased over the course of the study. I suggested a number of guidelines that system designers might consider when factoring in personality during gamification of applications.

Chapter 7. Study 3

Introduction

By displaying ranks of comparisons of users' performances, leaderboards are one of the most widely used game elements in gamification (Hamari et al. 2014). Previous research has shown that leaderboards are an effective way to motivate users through competition (Codish and Ravid, 2014; Hamari et al., 2014; Hamari, 2013). Additionally, leaderboards have been identified as one of the ten key "ingredients" in game design (Reeves and Read, 2009), one of the "seven primary game mechanics" and one of the "twelve things people like" from gamification (Zichermann and Cunningham, 2011). However, studies have revealed that leaderboards were only effective in motivating some users; for some other users, they could become a demotivating factor (Codish and Ravid, 2014; Hamari et al., 2014; Hamari, 2013). For example, Codish and Ravid found that extraverted people perceived leaderboards as being less playful than people who were more introverted, based on their experiences in the education domain (Codish and Ravid, 2014). In contrast, results from Study 1 found that more extroverted people reported higher preferences for leaderboards in personal informatics systems. Together, the results of these studies suggest that personality influences people's perceived preference for leaderboards and also implied that people are motivated differently by leaderboards when applied in different domains.

Zichermann and Cunningham (2011) summarized multiple ways of presenting leaderboards in gamified applications, such as displaying the user in the middle of what they term a "no-disincentive" leaderboard, in or using a multilayered leaderboard when the space of leaderboard participants is infinite. In game design, a study of leaderboards

in the Olympic Games showed that bronze medalists reported higher levels of happiness with their performance than did silver medalists (Medvec et al. 1995). In studies on digital games, researchers also tested how players were motivated differently by appearing at different leaderboard positions. For example, Butler's study showed that players were more likely to re-play a game when they attained positions at the top or bottom of leaderboards (Butler, 2013). Another study from Sun and colleagues identified an association between leaderboard positions and players' satisfaction ratings of a digital game. Players in this study reported higher levels of satisfaction when they appeared in the second, fourth or seventh position (Sun et al. 2015). These studies demonstrated that people's perceived preference for leaderboards was also influenced by how their performance was reflected by their positions on the leaderboards in digital games. However, there have been no studies on the topic of leaderboard positions in gamification.

This study aims to explore how people perceive leaderboards differently when they are ranked at different positions and when this technique is applied in different domains (Jia et al. 2017). The study selected three positions on the leaderboard to study—top, middle and bottom—and three domains in which leaderboards have been widely applied but studied little——social networking, fitness, and productivity. The study also examined the relations between personality traits and people's preferences for leaderboards. The three main research questions for this study are:

RQ1: Are users' subjective perceptions of leaderboards in gamified systems different when they are ranked at different positions on the leaderboard?

RQ2: Do these perceptions differ when gamification has been applied to different domains?

RQ3: What are the relations (if any) between users' personality traits and their perceived preferences for leaderboards, and are these relations affected by position or application domain? Methodology

A large-scale online survey with 286 participants by using dynamic leaderboard mockups, created with respondents' self-reported names and 10 of their friends' names. The survey was hosted via SurveyMonkey and Amazon Mechanical Turk (MTurk).


Survey Design

The survey contained four sections. The first section featured a series of multiple-choice questions about the participant's demographic background, such as gender, age, educational, background, occupation, and ethnicity. Next, we asked participants to complete an assessment of the Big-Five factors of personality (Costa et al. 1992; John et al. 2008). I used the 50-item set of IPIP Big-Five Factor Markers, which is a free and research community-developed inventory.

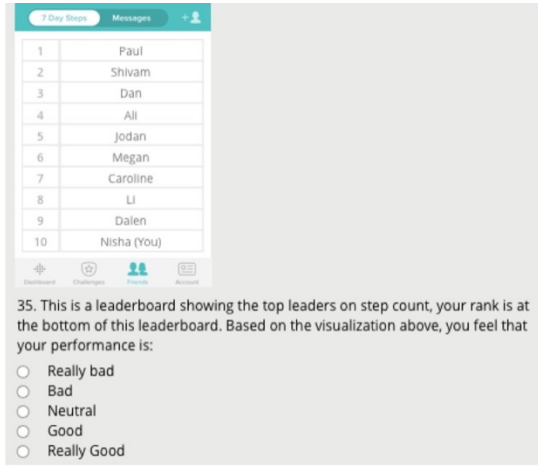
The third part of the survey was designed to elicit feedback regarding different leaderboards with the participant's name appearing at three different positions on leaderboards situated within three domains. At the beginning, each respondent was asked to enter his/her name and the names of ten of his/her close friends (Figure 8a). To help respondents understand the purpose of collecting names and how these names were going to be used (and protected), the following message was shown to all respondents:

“In the following, you will be asked to give feedback on 9 different leaderboards. To generate leaderboards with names that you are familiar with, you will be asked to

enter your name and any 10 of your friends' names in the next page. These names will not be saved or shared with researchers, and they are only used to generate the interface mockups for the rest of this survey.”



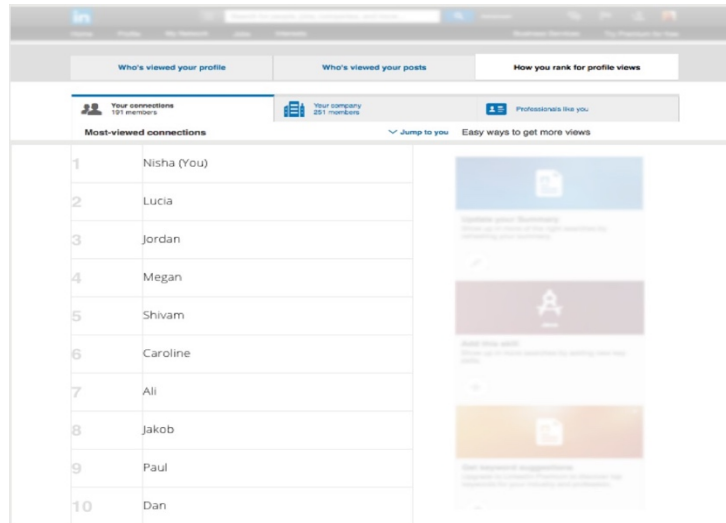
(a)



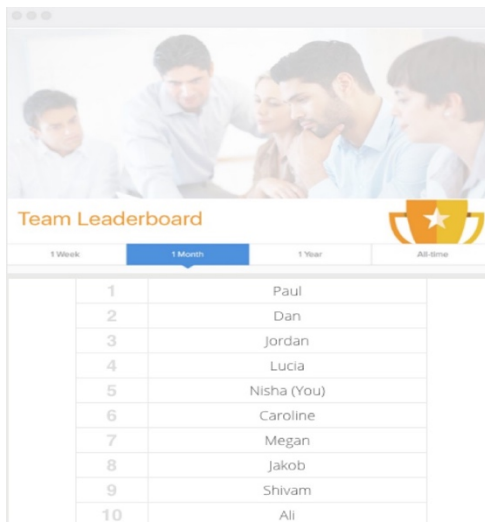
(b)

Figure 8. The Respondents' Experience of the Mockups Showing Leaderboards Applied to the Fitness Domain from the Survey. (a) Each respondent was asked to enter his/her name and 10 names of his/her friends. (b) A screenshot of the survey illustrating the display configuration of the mock-up for the situation of bottom position in the Fitness domain and our survey questions.

Based on these names, the survey automatically generated 9 interface mockups of various leaderboards for the subsequent survey questions (Figure 8b and Figure 9). Specifically, each respondent's name was displayed in 3 positions on each leaderboard (top, middle, bottom), with leaderboards applied to one of three domains (social networking, fitness, and productivity). These dynamic leaderboard interfaces were generated by a Survey Monkey feature called "Piping". I used the Latin Square method to counterbalance and avoid any potential ordering effects in the study.



(a)



(b)

Figure 9. The Interface of the Leaderboard Mockups for Social Network and Productivity Domains in the Survey.

After viewing each leaderboard, each respondent was asked to respond to questions that were designed to collect information regarding the respondents' opinions on (1) self-assessed performance (based solely on the leaderboard display), (2) the perceived enjoyment that the leaderboard might impart, (3) the perceived feeling of motivation provided by the leaderboard, (4) the participants' willingness to use an

application like the ones illustrated by the mockups, and 5) the participant's perceived willingness for recommending this application to their friends. Among these 5 questions, question 2 and 3 were designed to elicit feedback about the leaderboard, and questions 4 and 5 were designed to elicit feedback about the corresponding application domains. These questions were adapted from survey questions in Study 1 and Sun et al. (2015).

At the end of each domain section (each containing 3 leaderboards), I asked 4 questions to elicit respondents' opinions on: (1) for what reasons (if any) that the leaderboards in that particular domain appeal to them, (2) for what reasons (if any) that their positions on the leaderboard appeal to them, (3) whether the inclusion of their friends' names on the leaderboard matters, and (4) whether the inclusion of their own names are on the leaderboard matters. The fourth part of the survey consisted of only one open-ended question: it was designed to gather respondents' opinions on: 1) whether they felt that leaderboards appealed to them differently in different domain, and, if so, why. The survey took approximately 12 minutes to complete.

Participant Recruitment

286 participants were recruited through AMT. The AMT was chosen to recruit due to the need for a large participant sample and AMT's efficiency of survey distribution and relatively low cost. Participants were paid USD \$1.00, the payment rate suggested by the AMT platform for survey studies of this duration.

Results

Participant Demographics

To summarize the demographic information of the respondents, I present their responses (expressed as percentages of the overall sample population) to questions

regarding their age, gender, educational level, occupation, and ethnicity (see Table 10).

To support the subsequent correlation analyses, respondents' demographic responses were coded into numerical variables. For age, 18–24 was coded as 1, 25–34 as 2, and so on. For gender, male was coded as 1 and female as 2; for educational level, the eight response levels were coded from 1 to 8 from lowest completed education level to the highest.

Table 10. Study 3 Participants Demographics.

Total Participants (n=286)	
Age	18–24 (17.8%) 25–34 (50.3%) 35–44 (21.7%) 45–54 (8.0%) 55 and older (2.1%)
Gender	Female (47.2%) Male (52.8%)
Educational Level	Some high school (0.3%) High school graduate/GED (10.1%) Vocational/Associate degree (6.3%) Some college (24.8%) Bachelor's degree (40.6%) Some graduate school (2.8%) Master's degree (13.6%) Ph.D., law, or medical degree (1.4%)
Occupation	Employed for wages (60.5%) Self-employed (22.8%) Student (7.3%) Retired (0.7%) Other (9.8%)
Ethnicity	White (65.4%) Asian/Pacific Islander (19.2%) Hispanic or Latino (5.6%) Black or African American (7.3%) Native American or American Indian (0.3%) Other (2.1%)

Before processing to the regression analysis, I used zero-order correlations to test for correlations among independent variables and respondents' demographic variables

(Table 11). The independent variables of interest, i.e., the five IPIP personality traits, were positively correlated with one another. This result was consistent with prior literature (Gosling et al. 2003).

The strongest correlation that I saw was between conscientiousness and emotional stability ($r = .481$, $p < .01$). This means that the participants who reported high levels of emotional stability also tended to be more conscientious. Participants with higher agreeableness levels also tended to be more open to new experiences ($r = .384$, $p < .01$).

Table 11. Study 3 Correlation Matrix and Descriptive Statistics (n=286). * Indicates cells with $p < .05$ (2-tailed), ** Indicates $p < .01$.

	Mean	Std. D	1	2	3	4	5	6
1. Extraversion	29.30	9.16						
2. Agreeableness	38.19	7.05	.293**					
3. Conscientiousness	36.26	6.85	.167**	.285**				
4. Emotional Stability	32.86	8.62	.315**	.229**	.481*			
5. Imagination	38.40	5.86	.287**	.384**	.299**	.198**		
6. Age	2.26	0.91	.033	.114	.080	.070	.012	
7. Gender	1.47	0.50	-.036	.271**	.044	-.212**	.120*	-.034

For gender, there was a positive correlation between the coded gender variable and agreeableness ($r = .271$, $p < .01$) and a negative correlation between the coded gender variable and emotional stability ($r = -.212$, $p < .01$). This result shows that for this sample ($n = 286$), males were more emotionally stable but less agreeable than females. I found no correlation between respondents' personality characteristics and their age, educational levels or ethnicity.

Positions on Leaderboard

A two-way ANOVA (repeated measure) with sphericity corrections for each perception (enjoyment, motivation, desire to use, and recommend to friends) was conducted. The results show that position and domain, as two factors, did play a role, individually, to affect people's perceived perceptions significantly for leaderboard and the corresponding application (Table 12). The results also show that the interaction between the two factors is significant for each perception. Thus, to further determine the difference between people's perception at each level of each factor, I conducted several t-tests.

Table 12. Study 3 ANOVA Results. Significant Codes (with Greenhouse-Geisser Correction): $p < .05^*$.

Perception	Factor	F Value	p value
Enjoyment	Domain	0.97	3.29e-19*
	Position	0.68	6.18e-42 *
	Domain : Position	0.88	2.39e-11 *
Motivation	Domain	0.94	1.33e-21 *
	Position	0.71	3.23e-26*
	Domain : Position	0.92	8.93e-03*
Desire to Use the App	Domain	0.96	1.26e-19*
	Position	0.72	2.54e-36*
	Domain : Position	0.89	7.22e-07*
Recommend to a Friend	Domain	0.95	6.03e-20*
	Position	0.67	4.15e-29*
	Domain : Position	0.92	6.76e-08*

Across 9 types of leaderboards, 3 positions by 3 domains, respondents consistently reported significantly higher preference for the leaderboards when their names appeared in the “top” positions than when they appeared in the “middle” positions, which were also consistently and significantly higher than when they appeared in the “bottom” positions, regardless of the application domain. This suggests that respondents were able to understand each mockup presented in the survey.

Leaderboards in Different Domains

I found some interesting results when comparing the differences in reported preference based on position results across domains. To be more specific, respondents rated leaderboards highest in fitness apps and lowest in the social networking context. From Table 13, on a scale from 1 to 5 (1 indicating strong disagreement and 5 indicating strong agreement), I can see that when respondents' names were shown on the top or in the middle of the leaderboards, participants provided significantly higher ratings for their perceptions of Enjoyment, Motivation, Desire to Use the application, and would Recommend to friends in the Fitness and Productivity domains than they did for leaderboards in the Social network domain. In addition, the only negative perceptions (i.e., given a score below 3.0) that the respondents reported when appearing in the middle position were in the Social Network domain. This suggests that for social network websites, people were only positively affected by leaderboards when can readily interpret their rank relative to other users.

People's perceptions became much more negative when they saw their names at the bottom of the leaderboards. However, respondents still rated perceived Enjoyment, Motivation, Desire to Use, and Recommend to friends positively for leaderboards in the Fitness domain even when their perceived performance was low. These results indicate that people have positive experiences of leaderboards in the fitness domain, regardless of their ranking.

Table 13. Study 3 Descriptive Results. Reported as mean (SD)—for respondents' perceptions for leaderboards based on their name appearing at three positions (top, middle, and bottom) within three domains (social, fitness, and productivity).

	Top Soc	Top Fit	Top Prod	Top Avg
Performance	4.3 (0.9)	4.5 (0.9)	4.6 (0.7)	4.5 (0.9)
Enjoyment	3.3 (1.4)	3.9 (1.2)	3.8 (1.3)	3.7 (1.3)
Motivation	3.3 (1.4)	4.0 (1.2)	3.9 (1.2)	3.7 (1.3)
Desire to Use	3.3 (1.4)	3.9 (1.2)	3.7 (1.3)	3.6 (1.3)
Recommend	3.2 (1.4)	3.8 (1.2)	3.6 (1.4)	3.5 (1.3)
	Mid Soc	Mid Fit	Mid Prod	Mid Avg
Performance	3.2 (0.6)	3.3 (0.7)	3.2 (0.7)	3.2 (0.7)
Enjoyment	2.9 (1.2)	3.6 (1.1)	3.2 (1.2)	3.2 (1.2)
Motivation	3.0 (1.3)	3.6 (1.2)	3.5 (1.2)	3.4 (1.3)
Desire to Use	2.9 (1.3)	3.6 (1.2)	3.2 (1.2)	3.2 (1.3)
Recommend	2.8 (1.3)	3.5 (1.2)	3.1 (1.3)	3.1 (1.3)
	Bot Soc	Bot Fit	Bot Prod	Bot Avg
Performance	2.1 (1.2)	2.0 (1.2)	1.7 (1.1)	1.9 (1.2)
Enjoyment	2.5 (1.4)	3.1 (1.4)	2.5 (1.4)	2.7 (1.4)
Motivation	2.6 (1.4)	3.4 (1.4)	3.0 (1.5)	3.0 (1.4)
Desire to Use	2.5 (1.4)	3.2 (1.4)	2.6 (1.4)	2.8 (1.4)
Recommend	2.5 (1.4)	3.2 (1.4)	2.6 (1.4)	2.8 (1.4)

Respondents were also asked about their opinions about whether they would like to see their name on leaderboards and whether they prefer competing only with their friends. Figure 10 summarizes the results from these questions. This figure illustrates that 1) showing users' name on the leaderboard was very important in both the fitness and productivity domains; 2) people had even higher preferences for seeing their names among the top three entries for leaderboards in productivity domain; 3) respondents generally rated leaderboards highly when competing among their friends; and 4) compared to the other two domains, respondents thought that the leaderboard feature in social networking websites was least appealing, regardless of whether their name or their friends' names appeared in the list.

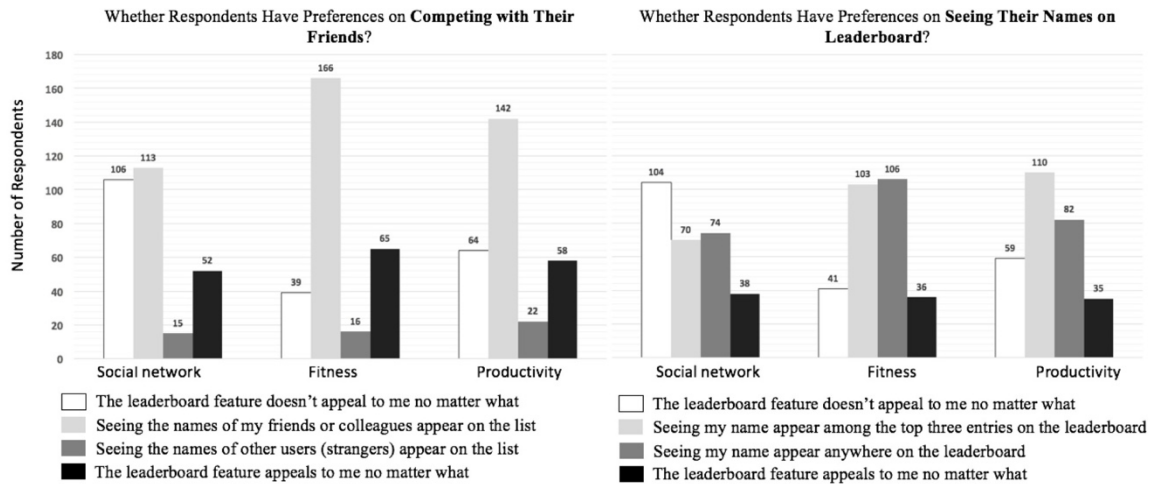


Figure 10. Study 3 Summarized Results of Respondents' Opinions on Whether They Would Like to See Their Names on Leaderboards and Whether They Have Preferences on Competing Only with Their Friends.

Personality Type and Leaderboard Preferences

To explore the relationship between personality and users' perception, I used structural equation modeling (SEM), a mediational analysis, to test the proposed models. I developed two measurement models showing the relationship between exogenous variables and endogenous variables as well as a structural model showing the relationship between the latent personality traits and latent users' perception. For the measurement model of personality, I used the test scores of the 50 questions from the Big-Five personality inventory as the exogenous variables.

I assumed five latent variables (extraversion, agreeableness, conscientiousness, emotional stability, and imagination) for them. As to users' perception, I assumed a latent variable (perception) for the 4 measurements (enjoyment, motivation, desire to use app, and recommend to friend) that I used in this survey.

For all the paths in the model, I estimated the path parameters based on maximum likelihood, and the process converged normally after 72 iterations. The overall badness-

of-fit of our model is significant ($\text{Chi-square} < 0.001$). Based on examination of the path parameters, while the two measurement models showed strong factor loadings, the path parameters of the paths from the Big-Five personality traits to users' perception are fairly small, which suggests a weak impact of personality on users' perception of leaderboards. Thus, from the SEM analysis, I find no statistically significant casual relationships between personality traits and perception on leaderboard.

I also conducted a multiple regression analysis. All individual Beta (β) values from 36 regressions (4 perception types by 3 positions by 3 domains) are summarized, and the significant ($p < .05/36 = .001$) results presented in the Appendices. Overall, more extroverted people tended to have more positive perceptions of leaderboards in the domains of social networking and productivity; people with higher levels of agreeableness tended to express greater enjoyment of leaderboards in the fitness domain. I found no significant results for the personality traits of conscientiousness, emotional stability, or imagination.

In the remainder of this section, I report significant differences among perceptions (i.e., enjoyment, motivation, desire to use the application, and would recommend to friends) for each type of leaderboard. In addition, I also report the qualitative results from our open-ended survey questions.

For leaderboards in the social networking domain, when respondents' names were shown in the middle position, the more extroverted people expressed more desire to use the social networking websites ($\beta = .216, p = .001$) and were more likely to recommend the websites to their friends ($\beta = .218, p = .001$). When respondents' names were at the bottom of the leaderboard on social networking websites, the more extroverted people

reported stronger likelihood of being motivated by the leaderboard ($\beta = .218$, $p = .001$); in addition, for more extroverted people, they expressed more desired to use the websites ($\beta = .219$, $p = .001$) and were more likely to recommend it to their friends ($\beta = .232$, $p = .001$).

The qualitative results from the open-ended questions show that leaderboards on social websites provide another mode of connection, help monitor social influence status, and increase communication among friends:

“Leaderboards on social networks help me assess the reputation of people I may not know all that well.” (P146)

“I like the leaderboard just for the purpose of being able to identify who I am staying in contact with, and who wants to stay in contact with me.” (P224)

However, respondents reported that they use social media to communicate with others rather than for competition, and the social influence showed from the leaderboard does not reflect reality since their social connections are not derived solely from social websites:

“It doesn’t appeal to me because I don’t see the point in such a ranking, specially between friends. Feels like added competition where there shouldn’t be any.” (P25)

“If I’m being honest, I don’t think I care for the ranking system when it comes to a social network site. It doesn’t seem like it belongs on a social site.” (P105)

“The leaderboard feature in social networking websites doesn’t appeal to me because it doesn’t reflect my real connections that I have people rather than on some networking websites.” (P172)

With regards to leaderboards in fitness domain, when respondents’ names were shown at the bottom of the leaderboards in fitness apps, the more agreeable respondents rated Enjoyment of the leaderboard more highly ($\beta = .227$, $p = .001$). From the qualitative results, respondents reported that fitness itself can be competitive in nature. They also

reported feeling a sense of motivation from leaderboards in this domain because leaderboards turn fitness activities into a more fun competition. The leaderboard can also be seen as a type of progress tracking mechanism, which is a good match to this domain.

Some sample comments from the open-ended survey questions included:

“I always wanted to use a fitness app like this. It’s addicting to keep watching your rank go up as you work towards your fitness goals. It’s like when you work for hours leveling on a video game only with real life results.” (P118)

Consistent with the quantitative results, one reason that respondents reported enjoying the leaderboards was that people enjoy engaging in competition with their friends or families on fitness activities:

“I like the competitive nature of it, plus, having friends and family on the leaderboard is an extra incentive to do well.” (P207)

“I have a Fitbit on my hand right now and I look at the leaderboard from time to time to make sure my steps don’t get too low. It really does motivate me because I know my mom will get worried if she sees my numbers go too low.” (P 32)

“It’s just interesting to know how well my performance is compared to my friends. It makes doing activities more exciting and motivating, to me. It motivates me to compete.” (P256)

The results of leaderboards in the productivity domain reveal that when respondents’ names were at the top of the leaderboard, people who are more extroverted were more likely to have positive perceptions of the leaderboards ($\beta = .222$, $p = .001$) and the surrounding system ($\beta = .233$, $p = .000$); for the personality traits of agreeableness, emotional stability and imagination, people rated leaderboards in this domain negatively, but this was not a statistically significant difference. When respondents’ names were shown in the middle of the leaderboard in productivity applications, the more extroverted people still provided positive ratings of the leaderboard and the application. From the qualitative results, respondents reported that they liked the idea of incorporating

leaderboards into teamwork because it offers an incentive for doing a good job, it provides a visual representation of work performance, and it might be especially valuable when a deadline is approaching:

“This leaderboard lets me know how well I am doing within my team and if I need to improve my performance.” (P10)

“Gives real, easily quantifiable feedback on my performance.” (P175)

“It is fun to see how well you are doing and makes work feel a little more like a game which makes it a little easier to enjoy what you are doing and feel motivated.” (P148)

“I really do like to know how my output and quality of work (of any kind) measures up to my peers. It’s good to know whether I need to work harder or if I can relax a bit and maintain.” (P192)

On the other hand, many negative comments from respondents mentioned that the competition derived from a leaderboard in a working environment reads more like a “name-and-shame” feature instead of a “game-like” feature since employees don’t have other options. They also felt that employees should cooperate to reach a common goal instead of competing with one another, that leaderboards might foster animosity at work, and that some work cannot be judged in a fair and objective manner upon which a leaderboard visualization could be built:

“when I am down at the list I will have a motive to work better, it’s a job, it’s not optional...” (P12)

“This leaderboard does not appeal to me as I do not feel my work can be judged adequately through it.” (P74)

“It does not appeal to me because I feel that productivity in the workplace should be a matter between each employee and their employer and not a public matter between employees.” (P47)

Discussion

In this section, I discuss the link between differences in a person’s position on a leaderboard and their preferences for leaderboards. I also delve into the relations between their rank or position and their preferences for leaderboards across different domains.

Finally, I discuss how personality differences could help to inform the design of leaderboards in gamified applications.

Leaderboard Position and Domain Differences

In the gaming literature, leaderboard position was found to be a factor that affects players' game experiences. In the example of leaderboards in Olympic games, researchers explained the finding that bronze medalists reported higher levels of happiness than silver medalists because of the notion of "what could have been," which implies that silver medalists framed their thinking about the fact that they could have won a gold medal, while and bronze medalists understood their ranking as being better than not having received any medal at all (Medvec et al. 1995). For leaderboards in digital games, in the example of Gold Mine, Sun and colleagues found that players reported higher satisfaction when they appeared in positions 2, 4, and 7 (Sun et al. 2015). The results from this study showed that respondents rated leaderboards differently when they are ranked differently in different domains. It indicates that unlike event-based competitions like the Olympics or short-time-repetitive competitions in digital games, leaderboards in gamified applications typically present long-term competitions of various types of domain-related activities. Thus, to design leaderboards in gamified contexts, in addition to leaderboard position, designers should also consider the impact of domain differences.

For rankings on leaderboards, the survey results show that respondents reported positive perceptions of leaderboards only when they appeared in the top positions of the leaderboard in the social-networking domain. However, the results from fitness and productivity domains revealed that people liked leaderboards in fitness applications no

matter what their rank; and people had only negative perceptions of leaderboards when ranked in the bottom of leaderboards in productivity domain. From the qualitative results, one of the key differences among these domains is the perceived fairness of the leaderboard in the social and productivity domains.

Unlike steps count, the metric typically used to determine ranking on fitness-oriented leaderboards, respondents reported that their social influence cannot be quantifiably reflected by the leaderboard on social websites since not all of their contacts occurred in a single social network application; and for productivity domain, respondents reported that significant facets of their work are simply not rank-able. In the research literature, a design guide for leaderboards in game design mentioned about that competition under rules should be fair and explicit (Reeves and Read, 2009). Thus, I suggest that the competitive activity used to seed the leaderboard should be designed to bring a sense of fairness for users.

In the results from this study, respondents provided the lowest ratings for leaderboards in the social networking domain. From the qualitative results, respondents expressed a common concern that they use social network sites primarily for communication instead of a site for competition with others. This finding is consistent with the findings from previous studies of people's experiences with social network games. Wohn et al. (2011) mentioned that competition in social games indirectly facilitate social interaction: people passively obtained information about others' performance from leaderboards and treated this interaction as a "friendly competition".

Leaderboards introduce the concept of competition to gamified systems, but social network domains tend to emphasize an ultimate goal of facilitating interaction

among friends. It appears that among members of a close social circle, it is not easy to encourage serious competition; rather, competition manifests as friendly banter or a lighthearted game. Thus, I suggest that leaderboards in social networking contexts should be intentionally designed to serve the purpose of facilitating communication rather than just showing results of a metricized competition. For example, leaderboards could be designed to be less competition-oriented and instead focus on expanding one's social circle; showing long-time, no-contact friends or shared-interest strangers on the board might be a more effective use of these features than when they simply display the performance of a close, stable group of friends.

I also found that respondents rated leaderboards positively in the fitness domain regardless of their position on those leaderboards. Additionally, respondents reported significantly higher preference for seeing their friends or colleagues on these leaderboards and the lowest preference for seeing strangers on them. The qualitative results reinforce these quantitative findings: people expressed more enjoyment and motivation when competing against people with whom they were familiar, such as family, friends, or close colleagues. One reason is that the activity people are competing with in this domain is usually reflective of their personal, daily routines. This may be why people are more comfortable competing with their closer friends and family members in this context. Competing with close acquaintances leverages people's universal desire to interact with and be involved in the lives of their friends and family members; additionally, it provides motivation for improving one's fitness levels because making unhealthy decisions can in some ways be perceived as "letting down" those close friends and family members. This duality is unique in the fitness domain because fitness

activities are both deeply personal and influenced by the behavior of others. The finding is consistent with the previous study from Hamari and Koivisto (2015), which found that users felt more attached to gamified applications when they have more friends participating in the gamified system. The findings from this study also supports Wong and Kwok's hypothesis that people's fitness- or exercise-related motivation could be positively satisfied through human-relatedness needs, such as social recognition and affiliation (Wong and Kwok, 2016). People care more about who the individuals are on these leaderboards than his/her own ranking. Thus, I suggest that when designing a leaderboard for a fitness app, designers should first understand who should appear on the leaderboard rather than where to position the user, focusing on supporting constructive competitions among a small circle of close friends.

The results from the findings about productivity-oriented leaderboards reveal that it is very important for respondents to see their name on the leaderboard in this domain. In addition, people have even higher preferences for seeing their names among the top three entries of these leaderboards. From the qualitative results, respondents expressed the most negative perceptions of these leaderboards when their names appeared towards the bottom of the ranked list. Instead of introducing a sense of "fun," respondents thought that the competitive tasks used to seed the rankings on productivity-oriented leaderboards spur serious competition. They also expressed concern that appearing at a low rank might have negative consequences for how they were perceived among their colleagues, or even to strain their relationship with their employer. The finding is consistent with the study by Mollick and Rothbard (2014), which found that employees experienced less positive affect from leaderboards at work in the "no-consent" condition. Werbach and Hunter

(2012) also noted the negative effects of leaderboards in working environments, pointing out that leaderboards can play a role in “reducing the richness of a game to a zero-sum struggle for supremacy [and] therefore inherently turns off some people and makes them behave in less desirable ways” (Werbach and Hunter, 2012, p76). This might be due to the sensitivity associated with introducing (additional) competitiveness into workplaces. On the other hand, in those successful documented examples of using leaderboards in the productivity domain, the competitive tasks around which rankings were based were usually repetitive and boring. For example, to reduce the death rate from hospital-acquired infections, leaderboards have been successfully applied in hospitals to motivate staff to compete with one another in washing their hands often and well, which turns hand washing into a competitive game. Thus, I suggest that when designing leaderboards for the productivity domain, the competitive tasks should be selected from the set of simple and repetitive tasks associated with the job.

Additionally, designers might strive to avoid showing the lowest-ranking employees on workplace leaderboards. It is desirable that at workplaces the design of the leaderboard should consider the dynamics among co-workers and the impact that their introduction might have on the overall office culture.

Personality-targeted Leaderboards

The results from this study show that more extroverted people tended to have more positive perceptions of leaderboards. This finding is consistent with results from Study 1 and Nov and Arazy (2013). Werbach and Hunter (2012) also mentioned that leaderboards have the capability of showing progress that other motivational affordances like points and levels cannot. One reason for extroverted people to prefer leaderboards is

because of their dynamic nature—they reflect the ever-changing social landscape constituted by the gamified system’s participants. Thus, I suggest, to appeal to more extroverted users, designers should not only design leaderboards as a way of showing rankings, but also emphasizing changes.

Five questions that designers should consider in leaderboard design

Based on the findings from this study, I provide several concrete suggestions for the design of leaderboards in gamified applications. For these interfaces, I propose that there are five questions that designers should consider:

1. In what domain is the leaderboard going to be applied?
2. Does the competitive task on the leaderboard feature rules that are fair and equally applicable to all participants?
3. What are the relationships among the participant-competitors?
4. Where should the active user be displayed on the leaderboard — at the top, middle, or bottom of the list, or does it not matter? In other words, how should the user’s performance be communicated relative to the other users of the system?
5. Will the task or activity that will be measured to seed the leaderboard provide a dynamic enough competitive landscape?

Limitations

This study used regression results from an online survey. The mockup leaderboards did not capture the wide range of possible leaderboards application domains. Leaderboards could be used in multiple domains and the social dynamics between leaderboard players could vary among these domains. Additionally, the results were gathered from a one-time survey and thus the findings might not reflect actual

“after-use” user experiences. To constrain the number of questions in the survey, I manipulated the user’s ranking on the generated leaderboards to be at the top, in the middle, and at the bottom, which does not reflect a person’s real relationship to the domain or the task, given that he/she did not put real effort into improving his/her ranking. Finally, this study uses personality traits as indicator of preference on leaderboard designs. Other factors might play a larger role in determining perceptions of gamification designs.

Conclusion of Study 3

Overall, this study contributes to the understanding of how leaderboard positions affect people’s experiences of leaderboards across different domains. I discovered that for leaderboards in gamified applications, competition is a media rather than purpose. I found that one primary personality trait affects participant’s perceived preferences on leaderboards by a small amount—and did so in different ways: extraversion. I developed several design guidelines for leaderboards in specific domains and for specific personality types.

Chapter 8. A Conceptual Model of Gamification Design

In this chapter, I present a conceptual model of/for gamification design (see Figure 11). It provides a high-level discussion of the lessons learned from the three studies and explains how these outcomes can inform the application of gamification in the design of future systems. In brief, the model describes the main phases in gamification design: the selection of motivational affordances and the design of gamified tasks. There are three aspects that need to be considered in the process of selecting motivational affordances and designing gamified tasks: domain differences, personality traits, and user persistence.

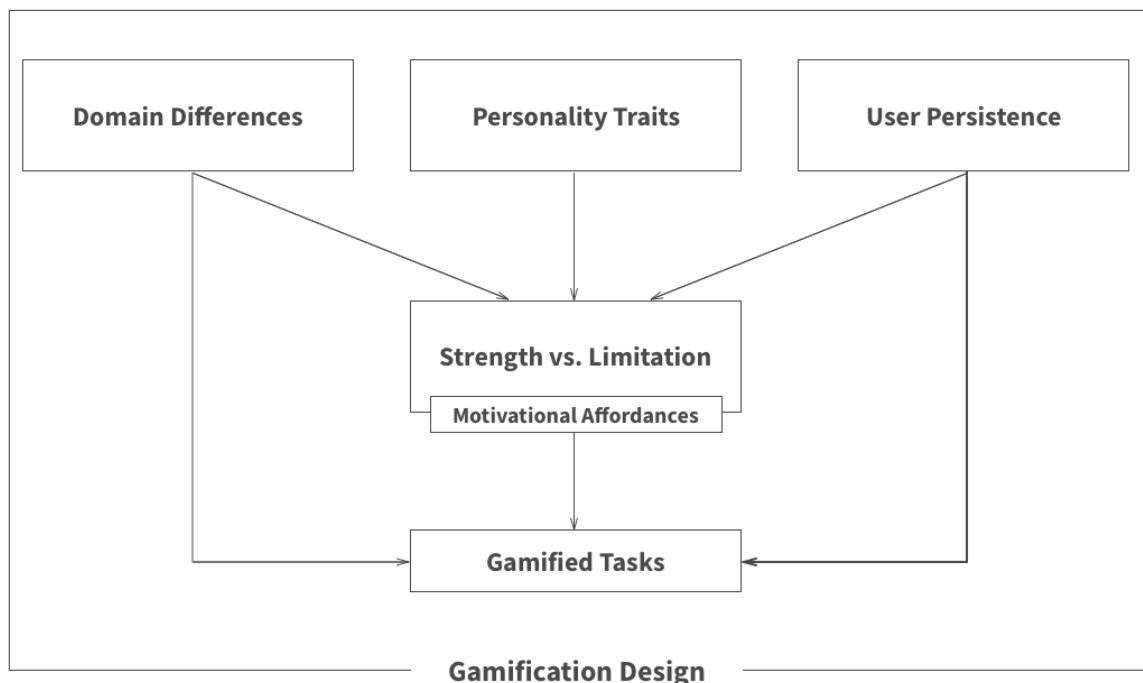


Figure 11. A Conceptual Model for Gamification Design.

Domain Differences: Context

With the growth of gamification used in various domains, it has become increasingly important to involve the consideration of domain differences in the gamification design process. In other words, the design of the gamified tasks and the

selection of the game mechanics (motivational affordances) should be applied to the messages from the specific domain. For example, respondents in Study 3 provided negative ratings for gamification in the social networking domain but rated it positively in the fitness domain.

In the literature, researchers reported that individuals perceived motivational affordances differently when they were applied in different domains. For example, among U.S. hospitals, studies reported that users' preferences and overall awareness of hand hygiene were effectively enhanced through gamified applications built around the affordances of points and leaderboard. Similar positive effects were also found on the affordances of points and leaderboard in fitness domain (Wong and Kwok, 2016). In the social media domain, researchers mentioned that users passively obtained information about others' performance from leaderboards and treated this interaction as a "friendly competition" (Wohn et al. 2011). However, in the educational domain, some students reported with a high level of ambivalence about the leaderboard due to the pressure from the competition (Hentenryck and Coffrin, 2014). Werbach and Hunter also noted the negative effects of leaderboards in working environments, pointing out that leaderboards can play a role in "reducing the richness of a game to a zero-sum struggle for supremacy and therefore inherently turns off some people and makes them behave in less desirable ways" (Werbach and Hunter, 2012, p76). Even though the implementation of this motivational affordance, leaderboards, was similar across the domains, the responses to the gamification element varied significantly.

In this dissertation, one motivational affordance, Leaderboards, was tested across four domains: a healthy habit-tracking application in the lifestyle and health domain, step

count in the fitness domain, profile views in the social medial domain, and team performances in the productivity domain. My findings confirm that, individuals' responses to Leaderboards differently from gamified applications in different domains.

Although Leaderboards within four domains were explored in this dissertation, the impact of domain differences on people's preferences on motivational affordances in gamification is still understudied. For example, gamification is commonly applied in educational settings. Yet, a comparison of students' feedback on motivational affordances between an educational setting and other domains have not been conducted before. The findings from these comparison studies among domains may uncover additional guidance for gamification design and research in specific domains. In addition to domain differences, other aspects of context could also be valuable to investigate, such as culture. It would be interesting to see the effect of cultural differences on people's perceived perceptions on gamification.

Personality Traits: Individual Differences

Another aspect of the model in gamification design is Individual Differences, which is often overlooked by researchers or designers. In this dissertation, one type of individual differences, personality traits, was investigated. Personality differences have previously been found to be a factor influencing individuals' responses to different kinds of interface designs spanning many application areas in HCI. Nov and Arazy investigated the relationship between the Big-Five construct of conscientiousness and people's participation in online communities. They found that manipulation of the community's activity indicators (e.g., critical mass) affected the high-conscientiousness and low-conscientiousness participants in opposite directions (Nov and Arazy, 2013). Codish and

Ravid (2014) examined extraversion and its effects on students' perceived playfulness of a gamified course in an educational setting. While there were no significant differences found in the overall ratings of playfulness, the mechanisms through which playfulness was achieved were rated significantly differently by different respondents (Codish and Ravid, 2014). Extraverts reported negative effects on the sense of playfulness as reflected by the Leaderboards component but perceived more enjoyable experiences than introverts when instantiated through Rewards, Badges, Points, and Progress. Their study addressed the need for designing different educational solutions for extraverts and introverts and also suggested further investigation on personality traits and their relationship to different experiences of motivational affordances in gamification—the task that is undertaken with the three studies in this dissertation.

The findings from this dissertation indicate that personality traits do play a role in people's perceived preferences on gamification, and they highlight opportunities to engage users by tailoring the design of gamified applications based on users' anticipated or measured personality traits. Study 1 examined all Big Five personality traits; the findings suggest that extraversion and emotional stability are the two traits that most significantly impact the design of gamified self-tracking applications.

When designing gamified tasks, the correlation among people's preferences for different motivational affordances and personality difference should also be taken into consideration. People who are more extraverted are more likely to prefer Points, Levels, and Leaderboards. People with high emotional stability are not likely to be motivated by or interested in any particular affordance in a gamified system. Study 2 shows that extroverts' preference ratings for points did change significantly over time. Study 3

suggests that, together with domain differences, people with different personality traits experienced gamification differently. In order to support personality trait-based customizations, it might be most effective to pre-screen or passively observe interactions that differentiate among these particular traits.

The findings from these three studies did not only confirm the impact of personality traits on user experience in gamification, but also highlighted opportunities for exploring the influences of other facets of individual differences. For example, a recently published paper in CHI 2018 reused the survey design in Study 1 and investigated the relations between 6 user types from the Hexad model and peoples' preferences of motivational affordances in gamification (Orji et al. 2018). Other than user types, gamer types could also be investigated in the future.

User Persistence: Long-term vs. Short-term

A common criticism of using gamification to enhance user engagement is that, in some studies, these gamification features have been found to only work very well for short-term tasks (Hanus and Fox, 2015). Thus, in gamification design, especially in the process of the selection of motivational affordances and designing gamified tasks, time effects of short-term vs. long-term could be an important factor that needs to be considered. Leaderboards allow users to interact with a dynamic social group, which can respond to and evolve alongside users' actions. For those affordances with repetitive feedback, some users' preferences changed over time. For example, findings from this dissertation (Study 2) confirmed that extraverted people's preferences for Points decreased after one week of usage. To get strong evidence to understand how people's

preferences on gamification change over time, future longitudinal studies on more types of motivational affordances are needed.

An interesting finding from Study 2 reported that Introverts were found to use Leaderboards as a mechanism for monitoring progress and tracking feedback, instead of supporting social competition over the 3-week period. This may be a direction about the user persistence on the gamified applications that worth to be explored further: Do people with different personality types develop approaches to adapt to gamified features differently over time to fulfill their psychological needs?

Motivational Affordances

Domain, personality differences, and user persistence are vital aspects that affect the gamification design process. To deeply understand the strengths and limitations of each motivational affordance, the variety and specificity of each affordance are also need to be investigated. For example, there are several types of leaderboards: no-disincentive or infinite leaderboards; leaderboards showing the relative performance of strangers or the users' close friends; leaderboards showing the user's rank at different positions, etc.

In the literature of event games or video games, studies reported interesting results on the differences among leaderboard positions. A study of leaderboards in the Olympic Games showed that bronze medalists reported higher levels of happiness with their performance than did silver medalists (Medvec et al. 1995). In digital games, Butler et al. showed that players were more likely to replay a game when they attained positions at the top or bottom of leaderboards (Butler, 2013). Sun and colleagues identified players' higher levels of satisfaction when they appeared in the second, fourth or seventh position (Sun et al. 2015). These studies demonstrated that people's preference for

leaderboards was influenced by their positions on the leaderboards. No prior studies had been done on the topic of leaderboard positions in gamification; thus, in this dissertation, leaderboards with different users' rank positions in gamified applications were investigated.

The findings from Study 3 indicated that Leaderboards ranking did play a role in affecting people's perceptions of the leaderboards significantly—and their perceptions of the corresponding gamified application. Respondents generally rated leaderboards highly when competing with their friends. Significant interaction results were also found between the ranking of leaderboards and the application domain. People had high preferences for seeing their names among the top three entries for leaderboards in the productivity domain. Showing users' name on the leaderboard was very important for obtaining high preference ratings in both the gamified fitness and productivity domains.

To design a gamified application with multiple motivational affordances, many other gamified features remain to be investigated. For example, Avatars can be designed as a pre-defined set of different visual representations (e.g., a flower, a car, an image of a sunset over a beach); or a customized character representing the user, him/herself. It would be helpful for researchers and designers to understand how these different types of avatars could affect people's experiences of gamification, especially the potential interactions among these representations, users' personality traits, and the application domain.

Gamified Tasks

In addition to understanding the strengths and limitations of each motivational affordance, researchers should also consider how to define the “non-game activity”

augmented by the gamification design. To select a non-game activity to gamify, first, one needs to consider the domain (context) of the application. Two questions that the designers or researchers could consider are: 1) What are the possible user activities in this application domain? 2) What is the main purpose for users in adopting this application? The non-game activity should be connected to the application purpose. Doing so helps users to connect the gamified task to that they were initially interested in, and thus the initial motivations of the application are more explicitly reinforced. For example, in the habit-tracking app in Study 1, the user could be awarded a “level up” to unlock enhanced data collection capabilities or reveal more detailed information about how daily activity relates to enhancing one’s health.

Second, the gamified non-game activity also needs to be selected considering the impact of user persistence. For example, the difficulty levels of the gamified task design may affect users’ performance in the application. Therefore, this design choice may affect users’ engagement with the application over time. In Study 2, participants reported that the feeling of the difficulty level of the “easy” habits did not change much over the three weeks, but participants reported that they often gave up on the “difficult” habits sometime in the first week. To solve this user persistence issue in gamification design, besides the approach of using dynamic motivational affordances (e.g. leaderboard), the non-game activity may also be able to designed in a dynamic way—for example, a collaborative activity that involves other users or tasks that are generated based on user’s performance. Further studies are needed to explore more potential approaches in this area.

This conceptual model shows a roadmap that illustrated how each of these inputs can (and does) have an effect on how the selected motivational affordance(s) and gamified tasks are perceived by the app's users. This is a significant contribution because it illustrates not only the impact of personality traits on gamification, but suggests the importance of taking individual differences, taken broadly, into consideration in gamification design; it reflects not only the importance of domain differences in the design of gamification, but the significance of understanding context before even starting the process of gamification design; it emphasizes not only how people experience gamification differently over time, but points out the potential significance of user persistence that all designers and researchers may face when creating these systems.

Overall, the model helps to illustrate all of the different factors that come into play, uncovering some of the nuance and dynamism that's fundamentally missing in most of the rest of the gamification literature. The model is making the case that: (a) all of these input factors are important; (b) they influence the way that people will respond to both the individual motivational affordance(s) and the task(s); and (c) the way that both of these things play out combine to affect the way that people respond to the overall system. The model is a very evocative way to help researchers/practitioners to understand the importance of looking back at all the input factors before jumping in to make decisions. But the generalizability is largely suggested as facets of future work that will help to cement other inputs or input types into this network.

Chapter 9. Conclusion and Future Work

This dissertation investigated the relations among people's self-reported experiences of different motivational affordances in gamification and their personality traits, in a context of a personal informatics application that promotes healthy habits. It contributes to the HCI community, and in particular to designers of persuasive and gamified apps, by providing design suggestions for targeting specific audiences based on personality.

The findings from the first two studies indicate that personality traits do play a role in people's perceived preferences for gamification, and they highlight opportunities to engage users by tailoring the design of gamified applications based on users' anticipated or measured personality traits. Two primary personality traits were discovered that serve to differentiate habit-tracking application users: extraversion and emotional stability. In addition, extroverts' perceptions for motivational affordances changed over time.

A number of guidelines were developed for system designers to consider when either targeting a broad spectrum of gamified system users or a more targeted subset, based on individuals' personality traits.

The third study contributes to the understanding of how leaderboard positions affect people's experiences of leaderboards across different domains. I discovered that for leaderboards in gamified applications, competition is a media rather than purpose. I developed several design guidelines for leaderboards in specific domains and for specific personality traits. In addition, for designing leaderboards in gamification, I also propose that designers should consider: the applied domains; the fairness of the competitive task;

the relations among the participant-competitors, the user's position on the leaderboard; and the dynamic nature of the competitive task.

In future work, four directions could be explored based on findings from this dissertation. First, other personality traits or other domains could be further investigated. For example, the personality trait of emotional stability and the domain of education. Second, in addition to personality traits, other facets of individual differences, such as user types, individual's motivational types, and gamer types could also be investigated in the future. Third, for motivational affordances, many other gamified features remain to be investigated, for example, Themes/Stories and Avatars. It would be helpful for researchers and designers to understand how different types of a specific motivational affordance could affect people's experience in gamification, especially for their interactions with personality traits and domain differences. In the end, an interesting point for the researcher to explore is about the effects of different motivational affordances on user persistence in gamification.

Appendices

Appendix A. Survey Questions in Study 1

Please fill in the forms as it applies to you

Q 1 - 6 Demographics (Multiple choice)

1. My age:

☐ 18-24

☐ 25-34

☐ 35-44

☐ 45-54

☐ 55-64

☐ 65 and older

2. My gender:

☐ Female

☐ Male

☐ Other

☐ Prefer not to disclose

3. Highest level of education completed

☐ Some high school

☐ High school graduate/ GED

☐ Some college

☐ Vocational/Associate degree

☐ Bachelor degree

☐ Some graduate school

☐ Master degree

☐ Ph.D., law and medical degree

4. My occupation

☐ Employed for wages

☐ Self-employed

☐ Homemaker

☐ Student

☐ Military

☐ Retired

☐ Other (please specify) _____

5. Ethnicity

☐ White

☐ Hispanic or Latino

☐ Black or African American

☐ Native American or American Indian

☐ Asian / Pacific Islander

☐ Other (please specify)

6. My English fluency

☐ Minimal

☐ Fair

☐ Moderate

☐ Good

☐ Excellent

Q 7 - 11 Describe yourself (Matrix/Rating Scale)

7. Describe Yourself (Part 1)

Describe yourself as you generally are now, not as you wish to be in the future.

Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence.

Indicate for each statement:

I am the life of the party. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I feel little concern for others. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am always prepared. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I get stressed out easily. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have a rich vocabulary. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I don't talk a lot. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am interested in people. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I leave my belongings around. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am relaxed most of the time. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have difficulty understanding abstract ideas. __1(Disagree) __2 __3 (Neutral) __4
__5 (Agree)

8. Describe Yourself (Part 2)

Indicate for each statement:

I feel comfortable around people. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I insult people. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I pay attention to details. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I worry about things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have a vivid imagination. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I keep in the background. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I sympathize with others' feelings. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I make a mess of things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I seldom feel blue. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am not interested in abstract ideas. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

9. Describe Yourself (Part 3)

Indicate for each statement:

I start conversations. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am not interested in other people's problems. __1(Disagree) __2 __3 (Neutral) __4
__5 (Agree)

I get chores done right away. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am easily disturbed. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have excellent ideas. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have little to say. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have a soft heart. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I often forget to put things back in their proper place. __1(Disagree) __2 __3 (Neutral)
__4 __5 (Agree)

I get upset easily. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I do not have a good imagination. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

10. Describe Yourself (Part 4)

Indicate for each statement:

I talk to a lot of different people at parties. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am not really interested in others. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I like order. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I change my mood a lot. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am quick to understand things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I don't like to draw attention to myself. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I take time out for others. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I shirk my duties. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have frequent mood swings. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I use difficult words. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

11. Describe Yourself (Part 5)

Indicate for each statement:

I don't mind being the center of attention. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I feel others' emotions. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I follow a schedule. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I get irritated easily. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I spend time reflecting on things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am quiet around strangers. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I make people feel at ease. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am exacting in my work. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I often feel blue. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am full of ideas. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

Q12 - 21 Rate different functions for an application (Matrix/Rating Scale)

"Habits Tracker" is an application to help people self-track healthy habits. And here are 10 functions we would like to consider as we develop this application. Each function will be presented in a video. Please answer the five questions follow each video.

I would enjoy using this function __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I would rely on this function __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I think this function would help me meet my goals __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

This function is easy to use __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

What about this function does/does not encourage your use of this application?

Q22 - 25 Open questions

22. In this application, please select 3 functions you would find most motivating:

Most Motivating

No.1 _____

No.2 _____

No.3 _____

Least Motivating

No.1 _____

No.2 _____

No.3 _____

23. Have you ever used a similar self-tracking app?

If yes, are you still using it?

If you are not using it anymore, why not?

24. Imagine that an app like this were available online included the set of functions that you mentioned as being important, would you like it? Why or why not?

25. What specific goals or habits would you be most interested in using an app like this to track/monitor?

Thank you for participating in our survey!

Appendix B. Pre-test Questions in Study 2

You are invited to take part in a research study about Personality and Preference for habits self-tracking interfaces. Your participation will require approximately 5 minutes per day and is completed online on your computer. There are no known risks or discomforts associated with this survey. Taking part in this study is completely voluntary. You can withdraw at any time. Your responses will be kept strictly confidential, and the digital data collected by the researchers will be stored in secure computer files. Any report of this research that is made available to the public will not include your name or any other individual information by which you could be individually identified. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, researcher Yuan Jia by email to jiayuan@umail.iu.edu, or the Institutional Review Board by email to kmumaw@iu.edu. Please feel free to print a copy of this consent page to keep for your records.

Clicking the “Next” button below indicates that you are 18 years of age or older and indicates your consent to participate in this survey.

NEXT>

Please enter 3 daily habits you are willing to form in the following 21 days. Please rate the difficulty level for each of them. (please try to select three habits that with different levels of difficulty, an easy one, a moderate one, and a difficult one)

Habit 1. _____ __1 (very easy to form) __2 __3 __4 __5 (very difficult to form)

Habit 2. _____ __1 (very easy to form) __2 __3 __4 __5 (very difficult to form)

Habit 3. _____ __1 (very easy to form) __2 __3 __4 __5 (very difficult to form)

For these three habits, please answer the following questions: (1= does not correspond at all, 4= Corresponds moderately, 7= Corresponds exactly)

8. For your first planned-to-tracked habit, what is reason for you to do it?
- 1) Because I think that this activity is interesting
 - 2) Because I think that this activity is pleasant
 - 3) Because this activity is fun
 - 4) Because I feel good when doing this activity
 - 5) Because I am doing it for my own good
 - 6) Because I think that this activity is good for me
 - 7) By personal decision
 - 8) Because I believe that this activity is important for me
 - 9) Because I am supposed to do it
 - 10) Because it is something that I have to do
 - 11) Because I don't have any choice
 - 12) Because I feel that I have to do it
 - 13) There may be good reasons to do this activity, but personally I don't see any
 - 14) I do this activity but I am not sure if it is worth it
 - 15) I don't know

16) I don't see what this activity brings me I do this activity, but I am not sure it is a good thing

9. For your third planned-to-tracked habit, what is reason for you to do it?

- 1) Because I think that this activity is interesting
- 2) Because I think that this activity is pleasant
- 3) Because this activity is fun
- 4) Because I feel good when doing this activity
- 5) Because I am doing it for my own good
- 6) Because I think that this activity is good for me
- 7) By personal decision
- 8) Because I believe that this activity is important for me
- 9) Because I am supposed to do it
- 10) Because it is something that I have to do
- 11) Because I don't have any choice
- 12) Because I feel that I have to do it
- 13) There may be good reasons to do this activity, but personally I don't see any
- 14) I do this activity but I am not sure if it is worth it
- 15) I don't know
- 16) I don't see what this activity brings me I do this activity, but I am not sure it is a good thing

10. For a leaderboard feature in this app from the video demo, how likely are you to... (1=very unlikely; 5=very likely)

- 1) Feel this leaderboard feature is helpful

- 2) Enjoy this leaderboard feature
 - 3) I feel that I rely on this leaderboard feature
 - 4) Feel motivated by this leaderboard feature
11. For a Points feature in this app from the video demo, how likely are you to...
- (1=very unlikely; 5=very likely)
- 1) Feel this Points feature is helpful
 - 2) Enjoy this Points feature
 - 3) I feel that I rely on this Points feature
 - 4) Feel motivated by this Points feature
12. For an application in this app from the video demo, how likely are you to...
- (1=very unlikely; 5=very likely)
- 1) Desire to use this application
 - 2) Recommend this application to my friends

We will send you a survey link every 3 days in the following 21 days from tomorrow, and a \$15 Amazon Gift Card at the end of this study for your participation.

Appendix C. Diary Survey Questions in Study 2

Base on your experience on habits tracking these three days, please answer the following questions:

1. What reminded you to log your actions or behaviors?

☐ Reminder from this questionnaire

☐ Wanting to log my own behaviors

☐ Other

2. I feel that my performance on completing my goals these three days was

☐ Really bad

☐ Bad

☐ Neutral

☐ Good

☐ Really good

Base on your experience from the last 3 days, please rate your motivation on your habits:

(1= does not correspond at all, 4= Corresponds moderately, 7= Corresponds exactly)

3. For your first planned-to-tracked habit _____, what is the reason for you to do it?

1) Because I think that this activity is interesting

2) Because I think that this activity is pleasant

3) Because this activity is fun

4) Because I feel good when doing this activity

5) Because I am doing it for my own good

6) Because I think that this activity is good for me

- 7) By personal decision
- 8) Because I believe that this activity is important for me
- 9) Because I am supposed to do it
- 10) Because it is something that I have to do
- 11) Because I don't have any choice
- 12) Because I feel that I have to do it
- 13) There may be good reasons to do this activity, but personally I don't see any
- 14) I do this activity but I am not sure if it is worth it
- 15) I don't know
- 16) I don't see what this activity brings me I do this activity, but I am not sure it is a good thing

4. For your second planned-to-tracked habit _____, what is the reason for you to do it?

- 1) Because I think that this activity is interesting
- 2) Because I think that this activity is pleasant
- 3) Because this activity is fun
- 4) Because I feel good when doing this activity
- 5) Because I am doing it for my own good
- 6) Because I think that this activity is good for me
- 7) By personal decision
- 8) Because I believe that this activity is important for me
- 9) Because I am supposed to do it

- 10) Because it is something that I have to do
- 11) Because I don't have any choice
- 12) Because I feel that I have to do it
- 13) There may be good reasons to do this activity, but personally I don't see any
- 14) I do this activity but I am not sure if it is worth it
- 15) I don't know
- 16) I don't see what this activity brings me I do this activity, but I am not sure it is a good thing

5. For your third planned-to-tracked habit _____, what is the reason for you to do it?

- 1) Because I think that this activity is interesting
- 2) Because I think that this activity is pleasant
- 3) Because this activity is fun
- 4) Because I feel good when doing this activity
- 5) Because I am doing it for my own good
- 6) Because I think that this activity is good for me
- 7) By personal decision
- 8) Because I believe that this activity is important for me
- 9) Because I am supposed to do it
- 10) Because it is something that I have to do
- 11) Because I don't have any choice
- 12) Because I feel that I have to do it
- 13) There may be good reasons to do this activity, but personally I don't see any

- 14) I do this activity but I am not sure if it is worth it
- 15) I don't know
- 16) I don't see what this activity brings me I do this activity, but I am not sure it is a good thing

6. What is your rank on the leaderboard today?

No. ____

7. The leaderboard shows the top leader on habits tracking tasks. Based on this visualization, I feel that my performance so far was:

___Really bad

___Bad

___Neutral

___Good

___Really good

8. For the Leaderboards feature in this app, how likely are you to... (1=very unlikely; 5=very likely)

___Feel this Leaderboards feature is helpful

___Enjoy this Leaderboards feature

___I feel that I rely on this Leaderboards feature

___Feel motivated by this Leaderboards feature

9. For the points feature in this app, how likely are you to... (1=very unlikely; 5=very likely)

___Feel this points feature is helpful

___Enjoy this Points feature

__ I feel that I rely on this Points feature

__ Feel motivated by this Points feature

10. For an application like this, how likely are you to... (1=very unlikely; 5=very likely)

__ Desire to use this application

__ Recommend this application to my friends

11. Could you please share some thoughts or comments about the application or your progress?

Appendix D. Post-study Interview Questions in Study 2

1. Can you tell me about your experiences using the habit tracking application?
2. Let's look at how you used the app for the last week of the study. Can you show me what habits you decided to track?
 - 1) How did it go?
 - 2) What parts of the system did you use?
 - 3) Let's look at the data that we logged about your meeting your habits and/or using the application -- can you tell me what was happening here?
3. For [the easy habit], could you describe your experience in accomplishing it of fostering it during your first week? And how did it change compare to the second and third week?
4. For [the moderate habit], could you describe your experience of fostering it during your first week? and how did it change compare to the second and third week?
5. For [the difficult habit], could you describe your experience of fostering it during your first week? and how did it change compare to the second and third week?
6. For each habit, especially the difficult one, which aspect of the habit stopped you from having it before? (negative motivation). And for those negative motivation, how did it change over time, the first, second and third week?
7. Thinking back to the first week of tracking your habits, how did you feel about your easy, moderate and difficult tasks? Was there a difference, for you?
 - 1) Did your feelings about these different difficulty levels of tasks change during the second week of tracking your habits? If so, how?

- 2) Did your feelings about these different levels of tasks change during the last week of tracking your habits? If so, how?
8. Please describe your experiences in using the leaderboard feature in the study. How did your experience change (if any) for the first, second and last week?
1. How did you feel when (if) your position changed on the leaderboard? Did you change your behavior based on what the leaderboard was showing you?
9. Please describe your experience of the points in the study. How did your experience change (if any) for the first, second and last week?
10. Did this experiment foster conversations with other people about your habit tracking or habit formation?
11. Anything else that you'd like to tell us about your experiences in the study, but that we have forgotten to ask?

Appendix E. Survey Questions in Study 3

Please fill in the forms as it applies to you

Part 1: Demographics (Multiple choice)

1. My age:

☐ 18-24

☐ 25-34

☐ 35-44

☐ 45-54

☐ 55-64

☐ 65 and older

2. My gender:

☐ Female

☐ Male

☐ Other

☐ Prefer not to disclose

3. Highest level of education completed

☐ Some high school

☐ High school graduate/ GED

☐ Some college

☐ Vocational/Associate degree

☐ Bachelor degree

☐ Some graduate school

☐ Master degree

☐ Ph.D., law and medical degree

4. My occupation

☐ Employed for wages

☐ Self-employed

☐ Homemaker

☐ Student

☐ Military

☐ Retired

☐ Other (please specify) _____

5. Ethnicity

☐ White

☐ Hispanic or Latino

☐ Black or African American

☐ Native American or American Indian

☐ Asian / Pacific Islander

☐ Other (please specify)

Part 2: Describe yourself (Matrix/Rating Scale)

6. Describe Yourself (Part 1)

Describe yourself as you generally are now, not as you wish to be in the future.

Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence.

Indicate for each statement:

I am the life of the party. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I feel little concern for others. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am always prepared. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I get stressed out easily. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have a rich vocabulary. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I don't talk a lot. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am interested in people. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I leave my belongings around. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am relaxed most of the time. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have difficulty understanding abstract ideas. __1(Disagree) __2 __3 (Neutral) __4
__5 (Agree)

7. Describe Yourself (Part 2)

Indicate for each statement:

I feel comfortable around people. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I insult people. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I pay attention to details. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I worry about things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have a vivid imagination. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I keep in the background. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I sympathize with others' feelings. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I make a mess of things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I seldom feel blue. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am not interested in abstract ideas. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

8. Describe Yourself (Part 3)

Indicate for each statement:

I start conversations. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am not interested in other people's problems. __1(Disagree) __2 __3 (Neutral) __4
__5 (Agree)

I get chores done right away. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am easily disturbed. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have excellent ideas. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have little to say. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have a soft heart. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I often forget to put things back in their proper place. __1(Disagree) __2 __3 (Neutral)
__4 __5 (Agree)

I get upset easily. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I do not have a good imagination. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

9. Describe Yourself (Part 4)

Indicate for each statement:

I talk to a lot of different people at parties. __1(Disagree) __2 __3 (Neutral) __4 __5
(Agree)

I am not really interested in others. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I like order. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I change my mood a lot. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am quick to understand things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I don't like to draw attention to myself. __1(Disagree) __2 __3 (Neutral) __4 __5
(Agree)

I take time out for others. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I shirk my duties. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I have frequent mood swings. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I use difficult words. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

10. Describe Yourself (Part 5)

Indicate for each statement:

I don't mind being the center of attention. __1(Disagree) __2 __3 (Neutral) __4 __5
(Agree)

I feel others' emotions. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I follow a schedule. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I get irritated easily. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I spend time reflecting on things. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am quiet around strangers. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I make people feel at ease. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am exacting in my work. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I often feel blue. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

I am full of ideas. __1(Disagree) __2 __3 (Neutral) __4 __5 (Agree)

Part 3: Enter Names

Thank you for completing the “Demographics” and “Describe yourself” parts of this survey. In the following, you will be asked to give feedback on 9 different leaderboards.

To generate leaderboards with names that you are familiar with, you will be asked to enter your name and 10 of your friends' names in the next page. These names won't be saved or shared with researchers, and they are only used to generate the interface mockups for the rest of this survey.

Please enter names of you and your friends

11. Please enter your name: _____
12. Your friend's name 1: _____
13. Your friend's name 2: _____
14. Your friend's name 3: _____
15. Your friend's name 4: _____
16. Your friend's name 5: _____
17. Your friend's name 6: _____
18. Your friend's name 7: _____
19. Your friend's name 8: _____
20. Your friend's name 9: _____
21. Your friend's name 10: _____

Part 4: Leaderboard in Social Network Domain

Leaderboards are widely used in social network websites, such as LinkedIn and Facebook. In the following, there will be three leaderboards from a social network website showing that your rank (at the top, in the middle, or at the bottom) for profile views. Please answer the questions after viewing each leaderboard.

22. This is a leaderboard showing the top leaders on profile views, your rank is in the middle of this leaderboard. Based on the visualization above, you feel that your performance is:

☐ Really bad

☐ Bad

☐ Neutral

☐ Good

☐ Really Good

23. For a social network website with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

Feel motivated by this leaderboard: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

24. For a social network website with a leaderboard feature like this, how likely are you to:

Desire to use this application: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

Recommend it to my friends: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

25. This is a leaderboard showing the top leaders on profile views, your rank is at the top of this leaderboard. Based on the visualization above, you feel that your performance is:

☐ Really bad

☐ Bad

☐ Neutral

☐ Good

☐ Really Good

26. For a social network website with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

Feel motivated by this leaderboard: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

27. For a social network website with a leaderboard feature like this, how likely are you to:

Desire to use this application: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

Recommend it to my friends: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

28. This is a leaderboard showing the top leaders on profile views, your rank is at the bottom of this leaderboard. Based on the visualization above, you feel that your performance is:

☐ Really bad

☐ Bad

☐ Neutral

☐ Good

☐ Really Good

29. For a social network website with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

Feel motivated by this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

30. For a social network website with a leaderboard feature like this, how likely are you to:

Desire to use this application: __1=Very unlikely __2 __3 __4 __5=Very likely

Recommend it to my friends: __1=Very unlikely __2 __3 __4 __5=Very likely

In the previous pages, three leaderboards with your name on different positions were shown to get your feedback.

To reflect your answers in the previous questions, please share your thoughts with us and answer the next two questions

31. For what reasons (if any), does the leaderboard feature in social network website appeal to you?

32. For what reasons (if any), does your rank on the leaderboard affect how this leaderboard of this social network website appeal to you?

33. What aspects of the Social Network leaderboards appeal to you?

__ Seeing the names of my friends or colleagues appear on this list

__ Seeing the names of other users (strangers) appear on the list

__ I like the leaderboards no matter it shows names of my friends or strangers

__ The leaderboard feature doesn't appeal to me no matter what

34. What aspects of the Social Network leaderboards appeal to you?

__ The leaderboard feature appeals to me even it doesn't show my name

__ Seeing my name appear anywhere on the leaderboard

__ Seeing my name appear among the top three entries on the leaderboard

__The leaderboard feature doesn't appeal to me no matter what

Part 5: Leaderboard in Fitness Domain

Leaderboards are also widely used in fitness apps, such as Fitbit. In the following, there will be three leaderboards from a fitness app showing that your rank (at the top, in the middle, or at the bottom) for step count. Please answer the questions after viewing each leaderboard.

35. This is a leaderboard showing the top leaders on step count, your rank is at the bottom of this leaderboard. Based on the visualization above, you feel that your performance is:

__Really bad

__Bad

__Neutral

__Good

__Really Good

36. For a fitness app with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

Feel motivated by this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

37. For a fitness app with a leaderboard feature like this, how likely are you to:

Desire to use this application: __1=Very unlikely __2 __3 __4 __5=Very likely

Recommend it to my friends: __1=Very unlikely __2 __3 __4 __5=Very likely

38. This is a leaderboard showing the top leaders on step count, your rank is at the top of this leaderboard. Based on the visualization above, you feel that your performance is:

☐ Really bad

☐ Bad

☐ Neutral

☐ Good

☐ Really Good

39. For a fitness app with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

Feel motivated by this leaderboard: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

40. For a fitness app with a leaderboard feature like this, how likely are you to:

Desire to use this application: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

Recommend it to my friends: ☐1=Very unlikely ☐2 ☐3 ☐4 ☐5=Very likely

41. This is a leaderboard showing the top leaders on step count, your rank is in the middle of this leaderboard. Based on the visualization above, you feel that your performance is:

☐ Really bad

☐ Bad

☐ Neutral

☐ Good

☐ Really Good

42. For a fitness app with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

Feel motivated by this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

43. For a fitness app with a leaderboard feature like this, how likely are you to:

Desire to use this application: __1=Very unlikely __2 __3 __4 __5=Very likely

Recommend it to my friends: __1=Very unlikely __2 __3 __4 __5=Very likely

In the previous pages, three leaderboards with your name on different positions were shown to get your feedback.

To reflect your answers in the previous questions, please share your thoughts with us and answer the next two questions

44. For what reasons (if any), does the leaderboard feature in fitness apps appeal to you?

45. For what reasons (if any), does your rank on the leaderboard affect how this leaderboard of this social network website appeal to you?

46. What aspects of the Fitness leaderboards appeal to you?

__ Seeing the names of my friends or colleagues appear on this list

__ Seeing the names of other users (strangers) appear on the list

__ I like the leaderboards no matter it shows names of my friends or strangers

__ The leaderboard feature doesn't appeal to me no matter what

47. What aspects of the Fitness leaderboards appeal to you?

__ The leaderboard feature appeals to me even it doesn't show my name

__ Seeing my name appear anywhere on the leaderboard

__ Seeing my name appear among the top three entries on the leaderboard

__The leaderboard feature doesn't appeal to me no matter what

Part 6: Leaderboard in Productivity Domain

Recently, companies, such as Microsoft, use leaderboards to improve productivity within the organization in order to foster innovation or derive positive business results.

Imagine that the company or organization you are working with has also applied a leaderboard feature in its internal productivity management system.

In the following, there will be three leaderboards from this productivity management system showing that your rank (at the top, in the middle, or at the bottom) for working performance in the organization. Please answer the questions after viewing each leaderboard.

48. This is a leaderboard showing the top leaders on working performance in your team, your rank is at the top of this leaderboard. Based on the visualization above, you feel that your performance is:

__Really bad

__Bad

__Neutral

__Good

__Really Good

49. For a productivity management application with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

Feel motivated by this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

50. For productivity management application with a leaderboard feature like this, how likely are you to:

Desire to use this application: __1=Very unlikely __2 __3 __4 __5=Very likely

Recommend it to my friends: __1=Very unlikely __2 __3 __4 __5=Very likely

51. This is a leaderboard showing the top leaders on working performance in your team, your rank is in the middle of this leaderboard. Based on the visualization above, you feel that your performance is:

__Really bad

__Bad

__Neutral

__Good

__Really Good

52. For a productivity management application with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

Feel motivated by this leaderboard: __1=Very unlikely __2 __3 __4 __5=Very likely

53. For productivity management application with a leaderboard feature like this, how likely are you to:

Desire to use this application: __1=Very unlikely __2 __3 __4 __5=Very likely

Recommend it to my friends: __1=Very unlikely __2 __3 __4 __5=Very likely

54. This is a leaderboard showing the top leaders on working performance in your team, your rank is at the bottom of this leaderboard. Based on the visualization above, you feel that your performance is:

☐ Really bad

☐ Bad

☐ Neutral

☐ Good

☐ Really Good

55. For a productivity management application with a leaderboard feature like this, how likely are you to:

Enjoy this leaderboard: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

Feel motivated by this leaderboard: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

56. For productivity management application with a leaderboard feature like this, how likely are you to:

Desire to use this application: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

Recommend it to my friends: ☐ 1=Very unlikely ☐ 2 ☐ 3 ☐ 4 ☐ 5=Very likely

In the previous pages, three leaderboards with your name on different positions were shown to get your feedback.

To reflect your answers in the previous questions, please share your thoughts with us and answer the next two questions

57. For what reasons (if any), does the leaderboard feature in productivity management application appeal to you?

58. For what reasons (if any), does your rank on the leaderboard affect how this leaderboard of this productivity management application appeal to you?

59. What aspects of the working performance leaderboards appeal to you?

___ Seeing the names of my friends or colleagues appear on this list

___ Seeing the names of other users (strangers) appear on the list

___ I like the leaderboards no matter it shows names of my friends or strangers

___ The leaderboard feature doesn't appeal to me no matter what

60. What aspects of the working performance leaderboards appeal to you?

___ The leaderboard feature appeals to me even it doesn't show my name

___ Seeing my name appear anywhere on the leaderboard

___ Seeing my name appear among the top three entries on the leaderboard

___ The leaderboard feature doesn't appeal to me no matter what

Thank you for participating in our survey!

References

Saleh Alharthi and James Parrish. 2017. The Role of Gamification in Motivating User Participation in Requirements Determinations.

Teresa M. Amabile, Phyllis Goldfarb, and Shereen C. Brackfield. 1990. Social influences on creativity: evaluation, coaction, and surveillance. *Creativity Research Journal*, 3, 6–21.

Teresa M. Amabile, William DeJong, and Mark R. Lepper (1976). Effects of externally imposed deadlines on subsequent intrinsic motivation. *Journal of Personality and Social Psychology*, 34, 92–98.

Ian Anderson, Julie Maitland, Scott Sherwood, Louise Barkhuus, Matthew Chalmers, Malcolm Hall, Barry Brown, and Henk Muller. 2007. Shakra: Tracking and sharing daily activity levels with unaugmented mobile phones. *Mobile Networks and Applications* 12, 2–3: 185–199.

Isabel Anger and Christian Kittl. 2011. Measuring influence on Twitter. In *Proceedings of the 11th International Conference on Knowledge Management and Knowledge Technologies*, 31.

Judd Antin and Elizabeth F. Churchill. 2011. Badges in social media: A social psychological perspective. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Workshop on Gamification*.

Sonia M. Arteaga, Mo Kudeki, and Adrienne Woodworth. 2009. Combating obesity trends in teenagers through persuasive mobile technology. SIGACCESS Accessibility and Computing 94: 17–25. <http://doi.acm.org/10.1145/1595061.1595064>

Yigal Attali and Meirav Arieli-Attali. "Gamification in assessment: Do points affect test performance." *Computers & Education* 83 (2015): 57-63.

Hernan Badenes, Mateo N. Bengualid, Jilin Chen, Liang Gou, Eben Haber, Jalal Mahmud, Jeffrey W. Nichols, Aditya Pal, Jerald Schoudt, Barton A. Smith, Ying Xuan, Huahai Yang, and Michelle X. Zhou. 2014. System U: automatically deriving personality traits from social media for people recommendation. In *Proceedings of the 8th ACM Conference on Recommender Systems (RecSys '14)*, 373–374.

Roy F. Baumeister and Mark R. Leary. 1995. The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117, 497–529.

Richard Bartle. 1996. Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD research* 1, 1: 19.

Gabriel Barata, Sandra Gama, Joaquim Jorge, and Daniel Gonçalves. 2013. Engaging engineering students with gamification. In *Proceedings of the 5th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES '13)*, 1–8.

Charles Butler. 2013. The effect of leaderboard ranking on players' perception of gaming fun. In *International Conference on Online Communities and Social Computing*, 129–136.

Joseph A. Cafazzo, Mark Casselman, Nathaniel Hamming, Debra K. Katzman, and Mark R. Palmert. (2012) Design of an mHealth app for the self-management of adolescent type 1 diabetes: a pilot study. *J Med Internet Res* 14(3). DOI: 10.2196/jmir.2058.

David Codish and Gilad Ravid. 2014. Personality based gamification-educational gamification for extroverts and introverts. In *Proceedings of the 9th CHAIS Conference for the Study of Innovation and Learning Technologies: Learning in the Technological Era*, 36–44.

Teresa Correa, Amber Willard Hinsley, and Homero Gil De Zuniga. 2010. Who interacts on the Web: The intersection of users' personality and social media use. *Computers in Human Behavior* 26, 2: 247–253.

Paul T. Costa, Jr. and Robert R. McCrae. 1992. *NEO Personality Inventory–Revised (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) Professional Manual*. Psychological Assessment Resources, Odessa, FL.

João P. Costa, Rina R. Wehbe, James Robb, and Lennart E. Nacke. 2013. Time's up: Studying leaderboards for engaging punctual behaviour. In Proceedings of the First International Conference on Gameful Design, Research, and Applications, 26–33.

Edward L. Deci. 1971. Effects of externally mediated rewards on intrinsic motivation. *Journal of Personality and Social Psychology*, 18, 105–115.

Richard deCharms. 1968. *Personal causation: The internal affective determinants of behavior*. New York: Academic Press.

Sebastian Deterding, 2011. Situated motivational affordances of game elements: A conceptual model. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Workshop on Gamification.

Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. From game design elements to gamefulness: defining “gamification”. In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, 9–15. <http://doi.acm.org/10.1145/2181037.2181040>

Sebastian Deterding, Miguel Sicart, Lennart Nacke, Kenton O'Hara, and Dan Dixon. 2011. Gamification. using game-design elements in non-gaming contexts. In Extended Abstracts of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11), 2425–2428. <http://doi.acm.org/10.1145/1979742.1979575>

Tao Dong, Mira Dontcheva, Diana Joseph, Karrie Karahalios, Mark Newman, and Mark Ackerman. 2012. Discovery-based games for learning software. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12), 2083–2086. <http://doi.acm.org/10.1145/2207676.2208358>

Rosta Farzan, Joan M. DiMicco, David R. Millen, Casey Dugan, Werner Geyer, and Elizabeth A. Brownholtz. 2008. Results from deploying a participation incentive mechanism within the enterprise. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08), 563–572. <http://doi.acm.org/10.1145/1357054.1357145>

Panagiotis Fotaris, Theodoros Mastoras, Richard Leinfellner, and Yasmine Rosunally (2016). Climbing up the Leaderboard: An Empirical Study of Applying Gamification Techniques to a Computer Programming Class. *Electronic Journal of e-Learning*, 14(2), 94-110.

Marylène Gagné and Edward L. Deci. 2005. Self - determination theory and work motivation." *Journal of Organizational behavior* 26, (4): 331-362.

Gartner. 2012. Gartner says by 2014, 80 percent of current gamified applications will fail to meet business objectives primarily due to poor design. Retrieved November 27, 2012 from <http://www.gartner.com/it/page.jsp?id=2251015>

Samuel D. Gosling, Peter J. Rentfrow, and William B. Swann. 2003. A very brief measure of the Big-Five personality domains. *Journal of Research in personality* 37, 6: 504–528.

James J. Gibson, 1977. The theory of affordances. In *Perceiving, Acting, and Knowing: Toward an Ecological Psychology*, Robert Shaw and John Bransford (eds.). Lawrence Erlbaum Associates, Hillsdale, NJ, 67–82.

Lewis R. Goldberg. 1993. The structure of phenotypic personality traits. *American Psychologist* 48, 1: 26–34.

Dina Goren-Bar, Ilenia Graziola, Fabio Pianesi, and Massimo Zancanaro. 2006. The influence of personality factors on visitor attitudes towards adaptivity dimensions for mobile museum guides. *User Modeling and User-Adapted Interaction* 16, 1: 31–62.

Frédéric Guay, Robert J. Vallerand, and Céline Blanchard. 2000. On the assessment of situational intrinsic and extrinsic motivation: The Situational Motivation Scale (SIMS). *Motivation and emotion* 24, no. 3, 175-213.

Sajanee Halko, and Julie A. Kientz. 2010. Personality and persuasive technology: an exploratory study on health-promoting mobile applications. In *Persuasive Technology*, 6137: 150– 161.

Juho Hamari. (2013). Transforming homo economicus into homo ludens: A field experiment on gamification in a utilitarian peer-to-peer trading service. *Electronic Commerce Research and Applications* 12, 4: 236–245.

Juho Hamari and Jonna Koivisto. 2015 “Working out for likes”: An empirical study on social influence in exercise gamification. *Computers in Human Behavior* 50: 333–347.

Juho Hamari, Jonna Koivisto, and Harri Sarsa. 2014. Does gamification work?: A literature review of empirical studies on gamification. In *Proceedings of the 47th Hawaii International Conference on System Sciences (HICSS '14)*, 3025–3034.

Michael D. Hanus and Jesse Fox. 2015. Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education* 80, 152-161.

Pascal Van Hentenryck and Carleton Coffrin, C. 2014. Teaching Creative Problem Solving in a MOOC. In J. Dougherty, & K. Nagel (Ed.), *SIGCSE'14*, 677–682

Anthony Higgins and M. M. Hannan (2013). Improved hand hygiene technique and compliance in healthcare workers using gaming technology. *Journal of Hospital Infection*, 84(1), 32-37.

Anthony Hilling. 2012. Extrovert and Introvert – What is the difference? Retrieved November 5, 2012 from: <http://www.hillinghypnotherapy.co.uk/personality-test-online/personality-testing-explained/extrovert-and-introvert-what-is-the-difference/>

Hwee Hoon and Tan Min Li Tan. 2008. Organizational citizenship behavior and social loafing: The role of personality, motives, and contextual factors. *The Journal of Psychology* 142, 1: 89–108.

Biyun Huang, Khe Foon Hew. 2015. Do points, badges and leaderboard increase learning and activity: A quasi-experiment on the effects of gamification. In *Proceedings of the 23rd International Conference on Computers in Education*, 275-280.

Kai Huotari, and Juho Hamari. 2012. Defining gamification: A service marketing perspective. In *Proceedings of the 16th International Academic MindTrek Conference*, 17–22.

Kai Huotari and Juho Hamari. 2011. “Gamification” from the perspective of service marketing. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Workshop on Gamification*. <http://doi.acm.org/10.1145/2393132.2393137>

Yuan Jia, Bin Xu, Yamini Karanam, and Stephen Voida. 2016. Personality-targeted gamification: A survey study on personality traits and motivational affordances. In

Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems.
2001–2013.

Yuan Jia, Yikun Liu, Xing Yu, and Stephen Voids. 2017. Designing Leaderboards for Gamification: Perceived Differences Based on User Ranking, Application Domain, and Personality Traits. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17). 1949-1960.

Oliver P. John, Laura P. Naumann, and Christopher J. Soto. 2008. Paradigm shift to the integrative Big Five trait taxonomy: History, measurement, and conceptual issues. In Handbook of Personality: Theory and Research (3rd ed.), Oliver P. John, Richard W. Robbins, and Lawrence A. Pervin (eds.). Guilford Press, New York , NY, 114–158.

J.H. Jung, Christoph Schneider, and Joseph Valacich. 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: 724–742.

Maurits Kaptein and Dean Eckles. 2012. Heterogeneity in the effects of online persuasion. *Journal of Interactive Marketing* 26, 3: 176–188.

Maurits Kaptein, Joyca Lacroix, and Privender Saini. 2010. Individual differences in persuadability in the health promotion domain. In Proceedings of the 5th International

Conference on Persuasive Technology (PERSUASIVE '10), 94–105.

http://dx.doi.org/10.1007/978-3-642-13226-1_11

Yamini Karanam, Hanan Alotaibi, Leslie Filko, Elham Makhsoom, Lindsay Kaser, and Stephen Voida. 2014. Motivational affordances and personality types in personal informatics. In Adjunct Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp '14), 79–82.

<http://doi.acm.org/10.1145/2638728.2638800>

Hugo M. Kehr. 2004. Integrating implicit motives, explicit motives, and perceived abilities: the compensatory model of work motivation and volition. *Academy of Management Review*, 29, 479–499.

Wei Li, Tovi Grossman, and George Fitzmaurice. 2012. GamiCAD: a gamified tutorial system for first time autocad users. In Proceedings of the 25th Annual ACM Symposium on User Interface Software and Technology (UIST '12), 103–112.

<http://doi.acm.org/10.1145/2380116.2380131>

Henry C. Lucas. 1971. Computer-based information systems in organizations. Science Research Associates, Chicago, IL.

Celine Latulipe, N. Bruce Long, and Carlos E. Seminario. 2015. Structuring flipped classes with lightweight teams and gamification In Proceedings of the 46th ACM Technical Symposium on Computer Science Education, 392-397.

MR Lepper and D Greene. 1975. Turning play into work: effects of adult surveillance and extrinsic rewards on children's intrinsic motivation. *Journal of Personality and Social Psychology*, 31, 479–486.

Salatore R. Maddi. 1989. *Personality theories: A comparative analysis* (5th ed.). Dorsey Press, Chicago, IL.

Robert R. McCrae, and Paul T. Costa. 1989. Reinterpreting the Myers-Briggs type indicator from the perspective of the Five Factor model of personality. *Journal of Personality* 57, 1: 17– 40.

Rudy McDaniel, Robb Lindgren, and Jon Friskics. 2012. Using badges for shaping interactions in online learning environments. In *Proceeding of IEEE International Professional Communication Conference*, 1–4.

James C. McElroy, Anthony R. Hendrickson, Anthony M. Townsend, and Samuel M. DeMarie. 2007. Dispositional factors in Internet use: Personality versus cognitive style. *MIS Quarterly* 31, 809–820.

KO McGraw. 1978. The detrimental effects of reward on performance: a literature review and a prediction model. In M. R. Lepper, & D. Greene (Eds.), *The hidden costs of reward* (pp. 33–60). Hillsdale, NJ: Erlbaum.

Joanna McGrenere, Ronald M. Baecker, and Kellogg S. Booth. 2002. An evaluation of a multiple interface design solution for bloated software. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '02)*, 164–170.
<http://doi.acm.org/10.1145/503376.503406>

Victoria Husted Medvec, Scott F. Madey and Thomas Gilovich. 1995. When less is more: Counterfactual thinking and satisfaction among Olympic medalists. *Journal of Personality and Social Psychology* 69, 4, 603.

Elisa D. Mekler, Florian Brühlmann, Klaus Opwis, and Alexandre N. Tuch. 2013. Do points, levels and leaderboards harm intrinsic motivation? An empirical analysis of common gamification elements. In *Proceedings of the First International Conference on Gameful Design, Research, and Applications*, 66–73.

Aaron S. Miller, Joseph A. Cafazzo, Emily Seto. 2016. A game plan: Gamification design principles in mHealth applications for chronic disease management. *Health informatics journal*, 22(2), 184-193.

Ethan R. Mollick and Nancy Rothbard. 2014. Mandatory fun: Consent, gamification and the impact of games at work. *The Wharton School research paper series*.

Andrew Monk, Marc Hassenzahl, Mark Blythe, and Darren Reed. 2002. Funology: designing enjoyment. In CHI '02 Extended Abstracts on Human Factors in Computing Systems, 924-925.

Nitya Narasimhan, Silviu Chiricescu, and Venu Vasudevan. 2011. The gamification of television: Is there life beyond badges? In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Workshop on Gamification.

Mark J. Nelson. 2012. Soviet and American precursors to the gamification of work. In Proceedings of the 16th International Academic MindTrek Conference, 23–26.

Donald A. Norman, 1999. Affordance, conventions, and design. *Interactions* 6, 3: 38–43.

Oded Nov and Ofer Arazy. 2013. Personality-targeted design: Theory, experimental procedure, and preliminary results. In Proceedings of the 2013 ACM Conference on Computer Supported Cooperative Work (CSCW '13), 977–984.

<http://doi.acm.org/10.1145/2441776.2441887>

Dennis W. Organ. 1988. Organizational citizenship behavior: The good soldier syndrome. Lexington Books, Lexington, MA.

Dennis W. Organ. 1994. Personality and organizational citizenship behavior. *Journal of Management* 20, 2: 465–478.

Rita Orji, Gustavo F. Tondello, and Lennart E. Nacke. 2018. Personalizing Persuasive Strategies in Gameful Systems to Gamification User Types. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 62.

Randy J. Pagulayan, Keith R. Steury, Bill Fulton, and Ramon L. Romero. 2003.

Designing for fun: User-testing case studies. In *Funology*, 137-150.

Vladimir Pavlenko and S.V. Chernyi and D.G. Goubkina. 2009. EEG correlates of anxiety and emotional stability in adult healthy subjects. *Neurophysiology* 41, 5: 337–345.

Mads Kock Pedersen, Nanna Ravn Rasmussen, Jacob F. Sherson, and Rajiv Vaid Basaiawmoit. 2017. Leaderboard Effects on Player Performance in a Citizen Science Game.

Philip M. Podsakoff, Scott B. MacKenzie, Julie Beth Paine, and Daniel G. Bachrach. 2000. Organizational citizenship behaviors: A critical review of the theoretical and empirical literature and suggestions for future research. *Journal of Management* 26, 3: 513–563.

Jon Radoff. 2011. *Game on: Energize your business with social media games*. John Wiley & Sons.

Mustaque B. Rashid. 2017. Gamification: An Initiative to Increase Engagement and Performance in Education.

Byron Reeves and J. Leighton Read. 2009. Total engagement: Using games and virtual worlds to change the way people work and businesses compete. Harvard Business School Press, Boston, MA.

Johnmarshall Reeve. 2005. Understanding Motivation and Emotion. John Wiley & Sons, New York, NY.

Craig Ross, Emily S. Orr, Mia Sisic, Jaime M. Arseneault, Mary G. Simmering, and R. Robert Orr. 2009. Personality and motivations associated with Facebook use. *Computers in Human Behavior* 25, 2: 578–586.

Richard M. Ryan and Edward L. Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68–78.

Richard M. Ryan, James P. Connell, and Edward L. Deci. 1985. A motivational analysis of self-determination and self-regulation in education. In C. Ames, & R. E. Ames (Eds.), *Research on motivation in education: The classroom milieu*. New York: Academic Press, 13–51.

Richard M. Ryan, Valerie Mims, and Richard Koestner (1983). Relation of reward contingency and interpersonal context to intrinsic motivation: a review and test using cognitive evaluation theory. *Journal of Personality and Social Psychology*, 45, 736–750.

Adrián Sánchez-Carmona, Sergi Robles, and Jordi Pons. 2017. A gamification experience to improve engineering students' performance through motivation." *Journal of Technology and Science Education* 7, (2) 150-161.

Katie Seaborn and Deborah I. Fels. 2015. Gamification in theory and action: A survey. *International Journal of Human-Computer Studies* 74, 14–31.

Lee Sheldon. 2011. *The multiplayer classroom: Designing coursework as a game*. Cengage Learning, Boston, MA.

Ben Shneiderman. 2004. Designing for fun: how can we design user interfaces to be more fun. *interactions* 11, 5, 48-50.

Wilson Emerson Smith. 1975. The effect of anticipated vs. unanticipated social reward on subsequent intrinsic motivation. Dissertation, Cornell University

Emily Sun, Brooke Jones, Stefano Traca, and Maarten W. Bos. 2015. Leaderboard position psychology: counterfactual thinking. In *Extended Abstracts of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 1217–1222.

Penelope Sweetser and Peta Wyeth. 2005, July. GameFlow: A model for evaluating player enjoyment in games. *ACM Computers in Entertainment (CIE)* 3, 3: Article 3A.

Alf Inge Wang and Andreas Lieberoth. (2016, October). The effect of points and audio on concentration, engagement, enjoyment, learning, motivation, and classroom dynamics using Kahoot!. In *European Conference on Games Based Learning*, 738.

Kevin Werbach and Dan Hunter. 2012. *For the win: How game thinking can revolutionize your business*. Wharton Digital Press, Philadelphia, PA.

Donghee Yvette Wohn, Cliff Lampe, Rick Wash, Nicole Ellison, and Jessica Vitak. 2011. The “s” in social network games: Initiating, maintaining, and enhancing relationships. In *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS 2011)*, 1–10.

Clara Choi-Ki Wong and Ron Chi-Wai Kwok. 2016. The effect of gamified mHealth app on exercise motivation and physical activity. In *Proceedings of Pacific Asia Conference on Information Systems (PACIS)*, 389.

Ping Zhang. 2008. Technical opinion: Motivational affordances: Reasons for ICT design and use. *Communications of the ACM* 51, 11: 145–147.

<http://doi.acm.org/10.1145/1400214.1400244>

Gabe Zichermann and Christopher Cunningham. 2011. Gamification by design:
Implementing game mechanics in web and mobile apps. O'Reilly Media, Sebastopol,
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Curriculum Vitae

Yuan Jia

Education

Ph.D., Human Computer Interaction

- Indiana University, Indianapolis, IN, U.S.A. 2011.08-2018.08

Master of Science, Human Computer Interaction

- Uppsala University, Uppsala, Sweden, 2009.08-2012.07

Bachelor of Engineering, Software Engineering

- Nankai University, Tianjin, China, 2005.08-2009.07

Professional Experience

User Experience Researcher, Oct 2016 – Present

- Work on a web data platform and a CRM mobile application for TOTVS | Labs
- Conduct user research: contextual inquiry, interview, and usability testing in the process of the development.
- Create flow models to define the road map and prioritized tasks for the design and development group with project manager.

Research Assistant at IUPUI, July 2015 – Feb 2016

- Conduct mixed-methods user research for Drug-Drug Interaction Alerts in EMR (Electronic Medical Record) system

User Experience Intern, May 2014 – April 2015

- User Experience research and design at Walmart Labs
- Conducted formal usability testing on savingscatcher.walmart.com, both web and mobile

- Information architecture, wire-framing, and rapid prototyping for Savings Catcher

Teach Assistant for Usability Testing at IUPUI, Sep 2013 – May 2014

- Mentored a class of Master students to conduct heuristic evaluations and usability testing

Research Assistant Institute for American Thought, Sep 2012 – Oct 2013

- Conduct user research and conducted contextual Inquiries and usability testing, in person and remote
- Created affinity diagrams, work models, wire-framings, and interactive prototypes

Research Intern at SAAB Aerosystems, Sep 2010 – Dec 2010

- Conducted research on dashboard in aircraft
- Enhance situation awareness and aid decision making

Research Intern at Aftonbladet.se, Oct 2009 – Jan 2010

- Conducted laboratory-based usability testing with customers of aftonbladet.se

Conferences Attended

- The ACM CHI Conference on Human Factors in Computing Systems is the premier international conference of Human-Computer Interaction, 2017, Denver, U.S.
- The ACM CHI Conference on Human Factors in Computing Systems is the premier international conference of Human-Computer Interaction, 2016, San Jose, U.S.A.
- The 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp) 2015, Osaka, Japan

- The ACM CHI Conference on Human Factors in Computing Systems is the premier international conference of Human-Computer Interaction, 2014, Toronto, Canada
- The 17th ACM Conference on Computer Supported Cooperative Work and Social Computing, CSCW 2014, Vancouver, BC, Canada
- The 4th International Conference of Human-Centered Software Engineering 2012, Toulouse, France

Publications

- Jia, Y., Liu, Y., Yu, X., Volda, S. (2017) Designing Leaderboards for Gamification: Perceived Differences Based on User Ranking, Application Domain, and Personality Traits. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2017). Full Paper Accepted.
- Jia, Y., Xu, B., Karanam, Y., Volda, S. (2016) Personality-targeted Gamification: A Survey Study on Personality Traits and Motivational Affordances. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI).
- Volda, S., Jia, Y., Karanam, Y., Chambers, A. (2015) Challenges, Feedback & Notifications: Empirical Explorations to Inform the Design of Interfaces to Motivate and Encourage Long-Term Personal Informatics Use. In Proceedings of Ubicomp 2015.
- Jia, Y., Niu, X. (2014). Should I Stay or Should I Go: Two Features to Help People Stop an Exploratory Search Wisely. In Proceedings of the 32th ACM Conference on Human Factors in Computing Systems (CHI 2014), 1357-1362.

- Jia, Y., Niu, X., Bharali, R., Bolchini, D., De Tienne, A. (2014) CORPUS: Next-Generation Online Platform for Research Collaborations in Humanities. Human-Computer Interaction International (HCII). Springer International Publishing. 3-12.
- Jia, Y., Niu, X., Bharali, R. Bolchini, D., Tienne, A.D. (2014) Collaborative Online Research Platform for Scholars in Humanities. In Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW 2014), 181-184.
- Liu, Y., Jia, Y., Pan, W., & Pfaff, M. S. (2014). Supporting task resumption using visual feedback. In Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW 2014), 767-777.
- Jia, Y., Larusdottir, M. K., Cajander, A. (2012). The usage of usability techniques in scrum software projects. In Proceedings of Human-Centered Software Engineering 2012, 331-341.
- Jia, Y. (2012). Examining usability activities in scrum projects – a survey study. Master Thesis in Uppsala University.

Honors

- Top Honors in Human Factors and Ergonomics Society (HFES) 2016 Mobile Health Application for Consumer Design Competition: