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# Personalityzation: UI Personalization, Theoretical Grounding in HCI and Design Research

## *ABSTRACT*

*Personalization is an effective means for accommodating differences between individuals. Therefore, the personalization of a system's user interface (UI) features can enhance usability. To date, UI personalization approaches have been largely divorced from psychological theories of personality, and the user profiles constructed by extant personalization techniques do not map directly onto the fundamental personality traits examined in the psychology literature. In line with recent calls to ground the design of information systems in behavioral theory, we maintain that personalization that is informed by psychology literature is advantageous. More specifically, we advocate an approach termed "personalityzation", where UI features are adapted to an explicit model of a user's personality. We demonstrate the proposed personalityzation approach through a proof-of-concept in the context of social recommender systems. Our discussion identifies two key contributions to information systems research. First, extending prior works on adaptive interfaces, we introduce a UI personalization framework that is grounded in psychology theory of personality. Second, we reflect on how our proposed personalityzation framework could inform the discourse in design research regarding the theoretical grounding of system's design.*

Keywords: personalityzation, human-computer interaction (HCI), user interface (UI); adaptive interfaces; personality; personalization, design research.

## 1. Introduction

As the amount information captured about users has exploded over the last decade, interest in personalized user interfaces has surged in the HCI community (Grudin 2009; Jameson 2009). The fundamental idea behind this trend rests on the notion that if the system can gather useful information about the user, generate a relevant user model and apply it appropriately, it would be possible to adapt the behavior of a system and its interface to the user at the individual level (Findlater and Gajos 2009; Jameson 2008).

The primary objective of this paper is to make a contribution to HCI research by introducing a novel personality-based approach to the design of personalized user interfaces (UI), which we term 'personalityzation' (personality-zation). Despite the long tradition in HCI research of grounding design in theoretical frameworks from the field of psychology, extant research on personalization has been largely disconnected from psychological research on personality. Existing approaches to personalization often construct a user profile that is suited for a particular task such that the profile is based on a user's consumption history or topics of interest relevant for the particular task at hand. As a consequence, profiles are restricted to a particular online application. Moreover, these profiles are quite malleable and are updated frequently, such that personalized UI may also need to adapt repeatedly, resulting in unpredictability (Jameson 2008). Users of such systems struggle to continually adapt their mental maps and learn to navigate the ever-changing interfaces. Taking these potential shortfalls of personalized UIs in mind, we propose to construct the user model around personality traits, which are more fundamental and relatively stable attributes of the user (for example, extroversion or conscientiousness). We argue that such personality-based personalization (or personalityzation) would ameliorate some of the challenges facing research on personalized UI, namely by offering a personalization approach that is more durable and applicable across a wider range of tasks and contexts.

With recent technological advances, personalityzation is now achievable. While users could be asked to explicitly describe their personality (using psychometric survey instruments), it is now increasingly possible to automatically and unobtrusively construct a model of users' personality due to technological advances. Recent years have seen an explosion of information available about individuals in a variety of contexts. This data is being collected by a multitude of companies in the information aggregation industry and is also being bought and sold in market-like commodity exchanges (Angwin 2010). This preponderance of personal data online in conjunction with advances in data mining technologies has opened up new opportunities for personalization. In particular, it is now possible to automatically construct a profile of users' key personality traits based on their online behavior (Chittaranjan et al. 2012; Golbeck et al. 2011; Park et al. 2014).

In order to provide a proof-of-concept for our proposed personalityzation framework, we describe empirical studies that tested how the interaction between users' personality and UI design features affects participation in social recommender systems. Our focus here is on the application of the personality profiles in the context of personalized UI. The first study reported in this research explores the personality trait of emotional stability and its interaction with a UI feature of social anchoring; the second study investigates how people with varying conscientiousness levels respond differently to UI cues regarding the number of active participants. The contribution of our work to HCI research is in proposing a novel framework for personalized UI - personalityzation - where interface features are adapted to users' personality profile.

A secondary objective of this paper is to contribute to the ongoing discourse in the Design Research (DR) field regarding the role of theory in grounding system's design (Arazy et al. 2010; Gregor and Jones 2007; Kuechler and Vaishnavi 2012). 'Personalityzation' calls for grounding UI adaptation practices in the theory of personality; similarly, theory could play a role in guiding the design of other system components. Design Research seeks to develop prescriptive design knowledge (often

referred to as 'design principles') through building and evaluating innovative IT artifacts (Hevner et al. 2004). There is a stream within DR that emphasizes the role of explanatory and predictive theories from the natural and behavioral sciences (i.e. 'kernel theories') in directing design (Walls et al. 1992). However, there are several key challenges in bridging kernel theories and design principles, and the DR literature provides little guidance on how to address these challenges (Arazy et al. 2010). In recent years, there have been preliminary attempts to guide the process of theory-directed design by prescribing the use of an intermediate model between kernel theories and design (Arazy et al. 2010; Kuechler and Vaishnavi 2012). Nonetheless, in developing our personalityzation framework, we found that we are able to ground UI design in the theory of personality without requiring such an intermediate model. Reflecting on the lessons learned from our research, we seek to contribute to the ongoing conversation within DR regarding ways for addressing the challenges associated with theory-directed design.

The paper proceeds as follows: Section 2 reviews relevant works on personalization in HCI; in Section 3 we present our proposed theory-driven personality-targeted UI approach, and illustrate it through two studies; Section 4 discusses the contribution of our work to HCI research; in Section 5 we discuss the implications of our work on personalityzation to the discourse on theoretical grounding in design research; Section 6 concludes with a discussion of the promise of our approach and offers pointers to possible future research directions.

## 2. Personalized User Interfaces

In the past, personalization research in HCI has been studied under various labels such as Adaptive UI, User Modeling (UM), and Intelligent User Interfaces (IUIs). Maybury and Wahlster (1998) define these adaptive UIs as "human-machine interfaces that aim to improve the efficiency, effectiveness and naturalness of human-machine interaction by representing, reasoning and acting on models of the user, domain, task, discourse and media (e.g. graphics, natural language, gesture)" (p. 3).

A well designed personalized interface can help improve the effectiveness of the user by taking over parts of routine tasks (as in Gmail's feature that automatically sorts emails into broad categories such as promotions and social updates), changing the appearance of the interface so that it fits better with users' way of working with the system (e.g. Smart Menus on Microsoft software products), offering advice on the task at hand (e.g. Microsoft Intelligent Help feature) and even mediating the interaction of the user with the real world based on the emotional and cognitive state of the user (Begole et al. 2004; Findlater and Gajos 2009; Jameson 2008). It can also help the user manage information overload by filtering relevant information and customize information presentation appropriately (Jameson 2008; Maes 1994). Recent research in online shopping shows that personality based personalization can be effective in helping consumers understand product information better as well as lead to increased purchase intentions (Bosnjak et al. 2007; Hirsh et al. 2012; Woo and Shirmohammadi 2008).

However, users do not always respond positively to UI personalization. For example, Mitchell and Shneiderman (1989) adapted the UI (namely, menu design) based on users' frequency of usage, and found that the adaptive interfaces fared poorly when compared to standard non-personalized UI. Several problems and unintended side effects have been noted in the design and use of adaptive interfaces (Höök 2000; Jameson 2009; Mitchell and Shneiderman 1989; Shneiderman and Maes 1997). In his survey of the field, Jameson (2008) identified five major usability challenges for adaptive interfaces: diminished predictability and comprehensibility, diminished controllability, obtrusiveness, infringement of privacy and diminished breadth of experience. Research on adaptive UI has been trying to address these usability issues, proposing a diverse range of strategies (Cockburn et al. 2007; Findlater and Gajos 2009; Gajos et al. 2006; Mitchell and Shneiderman 1989). One approach proposed to hand users' some control over the adaptation procedure (Bunt et al. 2010). Another approach argued for minimizing adaptation only to situations where the personalized approach is expected to be most effective by automatically

analyzing factors such as users' prior familiarity with interfaces, length of usage, and complexity of tasks (Cockburn et al. 2007; Findlater and Gajos 2009; Gajos et al. 2006; Tsandilas and Schraefel 2005).

In this paper we propose a different approach for addressing the usability issues associated with personalized UI, namely in basing the adaptation on factors that change less frequently. Personality traits are more durable aspects of individuals' background (Costa and McCrae 1996) and hence can serve as a useful foil for the more transient contextual data collected about these individuals. Thus, personality-based adaptation – or personalityzation - has the potential to alleviate the concerns for diminished predictability, comprehensibility and controllability. For example, prior studies have demonstrated that personality-based design can mitigate usability concerns and reduce users' cognitive load (Goren-Bar et al. 2006; Jahng et al. 2002; McGrenere et al. 2002). It should be noted that our proposed approach for personalization does not seek to replace existing strategies for adapting the UI; in fact, our approach could *complement* existing adaptive UI strategies (e.g. taking into consideration a user's prior behavior with the UI). We believe that personality traits - when paired with contextual data - can not only help better anticipate how individuals might react to variations introduced by adaptive interfaces (one of the critical factors that affected performance), but also provide useful signposts for incorporating appropriate design elements into the interface, thus boosting performance and satisfaction with the interfaces.

## 3. Personalityzation: Grounding UI Personalization in the Psychology of Personality

Our personalityzation approach to HCI design is informed by psychology research. A fundamental factor that distinguishes individuals from one another is personality - the dispositions and interpersonal strategies that explain people's behavior, and the unique and relatively stable patterns of behaviors exhibited by individuals (Zweig and Webster 2004). In line with the interactionist approach in

psychology (Endler and Parker 1992; Swann and Seyle 2005) and its application in the field of informatics (Oreg and Nov 2008), we propose that HCI design be adapted to users' personality, such that specific UI features are presented to users with a particular personality profile (and not to others). Given that personality traits are relatively stable, personalityzation could alleviate the concerns for diminished predictability, comprehensibility and controllability that are associated with personalized UI design (Jameson 2008), potentially yielding higher levels of flow, performance, user satisfaction and engagement. As a practical matter, surveying new users about their personality traits as a part of their enrollment process could provide a minimally intrusive way to learn about users' personal attributes. As an alternative, personality attributes could be automatically extracted by analyzing users' online behavior (Chittaranjan et al. 2012).

In the sections that follow, we offer a proof-of-concept for our personalityzation approach through two studies. Building on our argument that personality-based user models are more stable and thus are less likely to suffer from usability issues, our objective in this paper is to demonstrate that the proposed personalityzation framework is effective. Namely, we aim to show that there are noticeable differences between users of dissimilar personalities in terms of their response to UI design manipulations. Given that prior studies have showed the feasibility of automatically constructing users' personality profiles based on their online behavior (Chittaranjan et al. 2012; Golbeck et al. 2011), our proof-of-concept employs a simple survey-based method for measuring users' personality.

In the two studies reported below, we investigated whether differences in users' enduring personal attributes could explain the effects of design interventions on users' online behavior. Building on prior studies which have used social movie recommender system as a live laboratory setting for investigating the effects of design on user behavior (Fugelstad et al. 2012; Ling et al. 2005), our studies were performed in the context of social recommender systems (although, in principle, our proposed approach is applicable in a variety of online settings). Recommender systems are a class of social participation

systems (Kraut et al. 2010), and thus our outcome variable is online participation (i.e. providing a recommendation online). We investigate UI design manipulations that enact social influence processes and are expected to affect online participation. In our studies, personality traits moderate the relationships between the effect of UI manipulations (i.e. independent variables) and online participation (dependent variable).

The following section elucidates two studies we conducted to examine the interaction between personality traits and UI design interventions. The studies reported below provide two independent examples of personalityzation. Each explores one distinct UI feature and its interaction with particular personality attribute. It should be stressed that we chose simple examples to demonstrate the principle. For example, one of the UI design manipulations we investigate is social anchoring, which in the context of social recommender system entails presenting to the user the community's rating of the item under consideration. An example of a personality trait we investigate is emotional stability. Different design features may call for personalityzation around a different trait. The most relevant personality trait for a particular problem could be selected based on both theoretical considerations and empirical explorations. We note that there are various ways in which personality traits and design interventions could be categorized and operationalized (e.g. as nominal or ordinal categories). For simplicity, here we assume ordinality along a single personality trait and design intervention. Table 1 below illustrates the 2x2 experimental design for our personalityzation framework.

| Table 1: Experimental design: traits X interventions | | |
|---|---|---|
| | **Experimental UI Design Interventions** | |
| **Individual Trait** | *Design intervention: low level* | *Design intervention: high level* |
| *Low level of individual trait* | Outcome for:<br>low trait X<br>low intervention | Outcome for:<br>low trait X<br>high intervention |
| *High level of individual trait* | Outcome for:<br>high trait X<br>low intervention | Outcome for:<br>high trait X<br>high intervention |
| | **Experimental Outcomes** | |

For both studies, we drew on the Big Five Model of personality (Goldberg 1981). This model of personality traits consists of five high-level factors, which represent personality at the broadest level of abstraction. Each bipolar factor (e.g., Extraversion vs. Introversion) summarizes several more specific facets, which, in turn, subsume a large number of even more specific traits (Gosling et al. 2003). The Big-Five framework has been widely used and extensively researched in a variety of research domains (John and Srivastava 1999). In particular, the "Big Five" personality factors were found to be useful predictors of internet use (McElroy et al. 2007), online shopping (Bosnjak et al. 2007; Hirsh et al. 2012; Jahng et al. 2002), perceived and actual usage of technology (Barnett et al. 2014) and participation in social media sites (Buffardi and Campbell 2008; Chen and Caropreso 2004; Correa et al. 2010). For our personalityzation project, we focused on three of the five personality traits that we believed to be most relevant for the context of UI design: *emotional stability, conscientiousness*, and *extraversion*. In the first study reported here, we focused on the personality trait of *emotional stability*, while in the second study we investigated the role of *conscientiousness* (more on the rationale for the choice of these traits below). The operationalization of these personality traits was based on the Ten Item Personality Instrument (Gosling et al. 2003), which includes two items per each of the five personality constructs

(this scale has been validated and tested numerous times in prior studies (Ehrhart et al. 2009)). In both studies we surveyed participants for *emotional stability, conscientiousness*, and *extraversion*; the results of a confirmatory factor analyses (CFA, using Varimax rotation with Kaiser Normalization) showed that item loadings on relevant constructs were in the 0.73-0.90 range, while cross loadings were below 0.30. Please see results of CFA in Tables 2a and 2b below (loadings under 0.3 suppressed).

**Table 2a: Results of CFA, Study 1**

| | Component | | |
|---|---|---|---|
| Scale Item | 1 | 2 | 3 |
| Emotional_Stability1 | 0.871 | | |
| Emotional_Stability2 | 0.846 | | |
| Extraversion1 | | 0.869 | |
| Extraversion2 | | 0.896 | |
| Conscientiousness1 | | | 0.729 |
| Conscientiousness2 | | | 0.873 |

**Table 2b: Results of CFA, Study 2**

| | Component | | |
|---|---|---|---|
| Scale Item | 1 | 2 | 3 |
| Emotional_Stability1 | 0.874 | | |
| Emotional_Stability2 | 0.862 | | |
| Extraversion1 | | 0.878 | |
| Extraversion2 | | 0.902 | |
| Conscientiousness1 | | | 0.848 |
| Conscientiousness2 | | | 0.862 |

The setting for both these studies was a simulated online recommender system called PetLink, which was developed as an experimental platform. PetLink is presented as a research project involving the development of a technique to match users' personality traits with pets that are most suitable for them. PetLink's landing page invites participants to answer a very short personality questionnaire. Given this setting, users had an incentive to answer the questionnaire items candidly. After answering the personality questions, respondents were presented with their purported "best match": an image of an animal based on the responses to the survey questions, such that each combination of responses was associated with a specific pet image. Unbeknown to the respondents, the system arbitrarily paired images with personality profiles, with no attempt to match images to personalities. At this stage, respondents were presented with additional, experimentally manipulated, UI cues about prior participation by other users, and were requested to rate the quality of the match on a five-star scale. Social recommender systems rely on users to provide their assessment of items (e.g., ratings), and thus the UI design experimental manipulations we explored were intended to induce users to contribute by

providing their ratings. These two studies demonstrate the effectiveness of a personality-based UI adaptation, or personalityzation. Details for both studies are provided in the sections that follow.

### 4.1 Study #1: Emotional Stability, Social Anchoring, and Online Participation

In this study, we investigated how user participation is affected by the interaction between the personality trait of emotional stability and a design intervention of social anchoring (Nov et al. 2013a). Following, we briefly review the theoretical grounding guiding the design (in terms of the choices regarding the relevant personal attributes and the appropriate UI design interventions), describe the research methodology, present the study's findings, and discuss their implications for HCI research.

**Related Studies.** Human judgment tends to be influenced by anchoring: when asked to make a quantitative judgment, people are often influenced by externally presented information when such information is available to them (McElroy and Dowd 2007). Anchoring is seen as one of three basic heuristics in intuitive judgment (Kahneman et al. 1982). Extant psychology research demonstrates that in asking people to make a judgment, the experimental manipulation of initial values, or anchors, leads to estimates that are biased toward that anchor (Englich et al. 2006; Galinsky and Mussweiler 2001). As a result, studies of the effects of anchoring on human behavior were carried out in a variety of disciplines, including finance (Johnson et al. 2009), law (Guthrie et al. 2007) and marketing (Adaval and Wyer Jr 2011). Some of the psychological mechanisms underlying anchoring are confirmatory hypothesis testing, numeric or magnitude priming, and insufficient adjustment. Recent studies took a broader view of anchoring and adopted an attitudes and persuasion perspective, focusing on the social context in which anchors arise (Wegener et al. 2010). We use the term *social anchoring* to refer to an anchoring effect where the social context, and in particular the anchor's source, elicit processes of persuasion and social influence and affect judgment (Epley and Gilovich 2010).

In the context of UI design, anchors could be used as design features, prompting users to make a particular action. Generally speaking, HCI research on the effects of anchoring has been relatively scarce, with the notable exception of Cosley et al. (2003), who found that when users of a movie recommender system were asked to re-rate movies while (experimentally manipulated) being presented with "predicted" ratings, they tended to change their rating toward the "prediction" anchor. More recently, Adomavicius et al. (2011) showed that users' ratings can be influenced by a recommender system's (experimentally manipulated) anchors, and that the effects of anchoring can be separated from the effects of the system's perceived reliability. Our example study builds on this prior work and extends it to explore whether some people are more sensitive to anchoring than others.

**Theoretical Context.** The interaction between personality traits and anchoring has been the subject of recent research in psychology. For example, McElroy and Dowd (2007) showed that individuals who are high in the openness-to-experience personality trait were significantly more influenced by anchoring cues relative to participants low in this trait; and Eroglu and Croxton (2010) found that those high on agreeableness and conscientiousness but low on extroversion were more susceptible to anchoring. In contrast, Furnham et al. (2012) found no significant interaction between anchoring cues and the personality traits of openness-to-experience. Our focus in this study is on the personality trait of emotional stability, sometimes known as the opposite of neuroticism (Mobbs et al. 2005; Vittersų 2001). Emotional stability is highly relevant for the anchoring context, because it affects people's likelihood of being influenced by others.

**Hypothesis Development.** The main hypothesis of this study was that emotional stability has the potential to explain user behavior in the presence of anchoring. Since individuals who are high on emotional stability tend to be more secure and self-assured (Costa and McCrae 1992), it was expected that they will be less susceptible to the influence of social anchoring cues. Individuals who are low on emotional stability, on the other hand, tend to be insecure and self-doubting (Diefendorff and Richard

2003) and they often exhibit an external control of reinforcement (Judge et al. 2002; Judge 2009) (i.e. they believe events in their life are outside of their control (Rotter 1975; Rotter 1990)). Hence, because those high in neuroticism tend to be externally focused, it was anticipated that they will be more susceptible to the influence of others, and in particular to be more influenced by anchors representing the opinions of others. In sum, this study hypothesized that the effect of social anchoring cues on users' rating will be weaker among high-emotional stability participants compared to low-emotional stability participants. Formally stated:

> *Hypothesis #1: We expect that a participant's emotional stability will moderate the effect of social anchoring cues on the participant's rating score, such that people low on the emotional stability scale would react more strongly (when compared to those with high emotional stability) as a response to the cue, increasing their rating score.*

Figure 1 below illustrates this study's hypothesis.

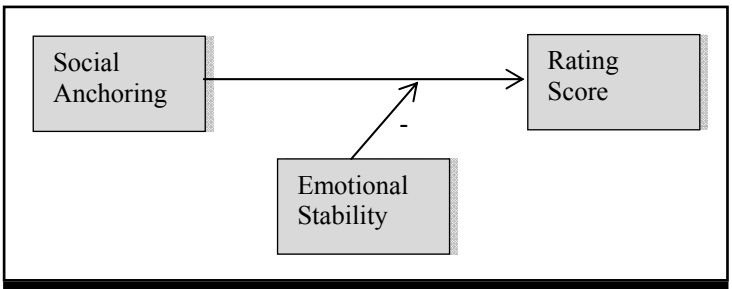


**Figure 1. Hypothesis: Emotional Stability moderates (negatively) the relationship between Social Anchoring and participants' Rating Score.**

**Research Method.** The study's hypothesis was tested using PetLink (the simulated online recommender system described above). Participants in the study were recruited via Amazon Mechanical Turk. They received $0.05 and took part in the study only once. PetLink's landing page invited participants to answer a very short questionnaire to measure emotional stability, using two items (on a 7-point Likert scale) that were adapted from the Ten Item Personality Instrument (Gosling et al. 2003): "I see myself as calm, emotionally stable" and "I see myself as anxious, easily upset" (revered code). In

line with the experimental design presented in Table 1, a median split was performed to classify respondents as high or low on emotional stability.

The experimental manipulation consisted of high and low social anchor level, whereby respondents were presented with information about the community's average rating for the particular pet image presented to them (along the lines of UI design common on popular recommender systems such as Amazon or Netflix). This "average rating" value, representing the social anchor, was experimentally manipulated and randomly assigned either high level (4.5 stars) or low level (1 star) (see Figure 2). After the respondents were presented with their purported "best match" and the social anchor, they were requested to rate the quality of the match on a five-star scale. The outcome variable was the average rating (ranging between 1-5 stars) provided by the participants.


**Figure 2. Experimental manipulation: two anchor values**

**Results.** 249 participants (66% of those who answered the personality survey) rated the quality of the match. Cronbach's alpha value for Emotional Stability was 0.74, above the 0.70 threshold, demonstrating good composite reliability (Hair et al. 1998). The Average Variance Extracted (AVE) for Emotional Stability was 0.737, well above the 0.50 threshold measure (Fornell and Larcker 1981), and the square root of AVE (0.859) was higher than the correlation with other factors; inter-construct correlations were well below the threshold (the highest, 0.223, for Social Anchoring – Rating Score pair); together, these results demonstrate discriminant and convergent validity (Straub et al. 2004). Each

user was assigned to one of the four cells presented in Table 1: based on the UI manipulation (i.e. the type of anchor) and emotional stability level (based on the median split). The average rating among participants in all experimental conditions was 3.04. Consistent with prior research, ratings were biased toward the anchors, with mean rating = 3.36 among high-anchor participants and 2.71 and among low anchor participants. The results of an ANOVA comparing the four experimental bins (high and low emotional stability X two experimental interventions) revealed an insignificant main effect of emotional stability on participants' rating score and a significant effect for the social anchor ($p < 0.01$). The study's primary hypothesis was therefore supported, as the interaction effect between the independent variables was significant ($p < 0.01$) (see Figure 3). The results suggest that while anchoring may be a universal phenomenon, its magnitude is moderated by the personality trait of emotional stability. In order to gain a deeper insight into the interaction between emotional stability and social anchoring, we performed a Bonferroni post-hoc analysis (Holm 1979). The analysis revealed that for people with below average emotional stability, changes in the social anchor make a significant difference in participation ($p < 0.01$); on the other hand, for people with above average emotional stability, the effect of social anchors was insignificant. From a HCI design perspective, using anchors as a way to influence behavior is more effective among some users and less for others. Taking our study's findings into consideration, the UI should be adapted to present the social anchoring cues to people with low emotional stability.


**Figure 3. Social anchoring UI manipulation moderates the relationship between emotional stability (ES) and participants' ratings**

### 4.2 Study #2: Conscientiousness, Perceived Critical Mass, and Online Participation

The design problem addressed in the second study was to provide personalized UI design intended to increase online participation in social recommender systems. Particularly, the goal of this study was to use UI indicators of the community size as a means to entice incoming users to provide their own rating (Nov and Arazy 2013). We investigated how user participation is affected by the interaction between the personality trait of conscientiousness and a design intervention of perceived critical mass. Following, we briefly review the theoretical grounding guiding the design (in terms of the choices regarding the relevant personal attributes and the appropriate UI design interventions), describe the research methodology, present the study's findings, and discuss their implications for HCI research.

**Related Studies.** Extant organizational literature provides a complex view regarding the effects of group size in collective action: although larger groups are able to draw on the expertise and skills of a broader membership base, group size can negatively affect members' motivation to contribute to the collective action (Oliver et al. 1985). Research shows that the higher the number of people present in a situation or taking part in a collective effort, there is a higher likelihood of social loafing (Karau and Williams 1993) and diffusion of responsibility (Darley and Latane 1968; Garcia et al. 2002), such that each one of the users present feels less personal responsibility, and less compelled to help. This phenomenon applies to online settings as well (Alnuaimi et al. 2010; Butler 2001; Counts 2007). Prior studies have tried to reconcile these conflicting views by focusing on intervening factors, such as group homogeneity (Oliver and Marwell 1988) and group interaction (Esteban and Ray 2001).

Within the context of online participation, studies have shown that 'perceived critical mass' – a user's subjective belief that there is a large number of other users who participate in a community or adopt a new technology – has a positive effect on user's own participation behavior (Markus 1987;

Raban et al. 2010; Van Slyke et al. 2007). Our second study builds on this prior work and extends it to explore whether some people are more sensitive to perceived critical mass than others.

**Theoretical context**. Our focus in this study is on the personality trait of conscientiousness, (being responsible, dependable, planful, organized, and persistent, (Barrick et al. 1993)). Prior studies of personality and social behavior showed the important role the conscientiousness trait plays in explaining helping behavior that is relevant to the present study. Specifically, it was found that organizational citizenship behavior (OCB), a discretionary behavior which promotes the effective functioning of the organization but is not part of the formal reward system (Organ 1988; Podsakoff et al. 2000), was highly affected by conscientiousness (Hoon and Tan 2008; Organ 1994). Other studies have shown that conscientiousness was negatively related to social loafing (Hoon and Tan 2008). Participation in social recommender systems could be perceived as an act of citizenship behavior, and thus we expect a user's conscientiousness level to influence his online participation.

**Hypothesis Development.** The main hypothesis of this study was that conscientiousness has the potential to explain user response to critical mass UI indicators. In particular, we hypothesized that perceived low level of critical mass will discourage diffusion of responsibility among participants characterized by high conscientiousness, resulting in increased participation; in contrast, we expect that one's perception of the existence of critical mass will decrease the participation of highly conscientiousness users. The reasoning was that people characterized by high conscientiousness tend to be responsible and self-disciplined (Costa et al. 1992; Renn et al. 2011), and therefore were expected to act more responsibly in the face of a request for help (e.g. the researchers' request to rate users' pet match as part of a research project) when they see that there are fewer others who may be available to do so (i.e. low critical mass experimental condition). When facing a situation in which there is an indication that others have already provided help (i.e. high critical mass condition), the need for help would seem less important, and highly conscientious people are expected to feel less obliged to help, leading to

decreased participation. Participants characterized by low conscientiousness, on the other hand, are more likely to exert effort when there is social pressure on them from others to do so (Bolino et al. 2010; Grant 2008). Therefore, we hypothesized that they will be more likely to participate when faced with an indication of a large number of other participants who already rated (i.e. high critical mass indicator), but less likely to participate in the absence of such indication (i.e. low critical mass indicator). Formally stated:

> *Hypothesis #2: We expect that a participant's conscientiousness will moderate the effect of critical mass cues on the participant's likelihood of rating, such that people low on the conscientiousness scale would react more strongly (when compared to those with high conscientious) as a response to the cue, increasing their likelihood of rating.*

Figure 4 below illustrates this study's hypothesis.

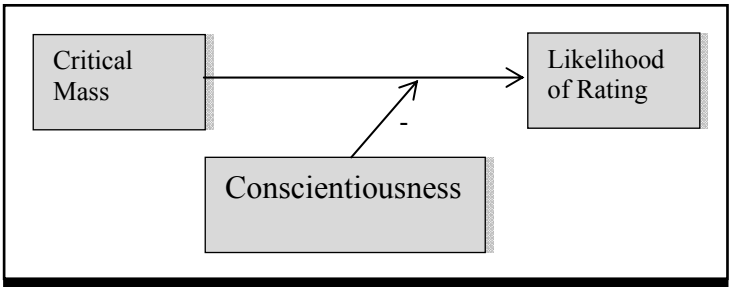


**Figure 4. Hypothesis: Conscientiousness moderates (negatively) the relationship between Critical Mass and participants' Likelihood of Rating.**

**Research Method.** The study's hypothesis was tested using PetLink (the simulated online recommender system described above). Participants were recruited in the authors' universities among undergraduate and graduate students. In addition, students were asked to share the invitation to participate in the study with their friends and family, and many of them shared the PetLink link with their contacts via social media. Participants were not compensated for their participation. PetLink's landing page invited participants to answer a very short questionnaire to measure conscientiousness, using two items (on a 7-point Likert scale) that were adapted from the Ten Item Personality Instrument

(Gosling et al. 2003): “I see myself as dependable, self-disciplined” and “I see myself as disorganized, careless” (revered code). In line with the experimental design presented in Table 1, a median split was performed to classify respondents as high or low on conscientiousness.

The experimental manipulation consisted of high and low critical mass levels. In addition to the image, respondents were also presented with information about the number of previously reported ratings for the particular pet image presented to them (along the lines of UI design common on popular recommender systems such as Amazon or Netflix). Perceived critical mass is a subjective and context-specific concept (Lou et al. 2000; Van Slyke et al. 2007), and we therefore set two levels of critical mass in the study, assigned randomly to participants: a high value of prior ratings (2,127) represented a high level of critical mass, and a low value (26 ratings) represented a low level of critical mass.

To validate the low and high values in the experiment, we administered an additional experiment using Amazon Mechanical Turk. In this experiment, participants were directed to a webpage describing a simple scenario which is fairly similar to PetLink (i.e. a participant heard about a web site where users rate movies, and proceeds to visit the site and check out a movie). The participant, then, finds that the movie received the rating of 3.5 stars out of 5, based on X reviews (where X is manipulated by the researchers and is randomly assigned the values of either 2,127 or 26 ratings, corresponding to the low and high critical mass values in PetLink). Having seen this rating, the participant is asked to what extent they agree with a statement that the movie reviews website has reached a critical mass of users. Responses range from 1 to 7 on a Likert scale (1 = strongly disagree; 4 = neutral; 7 = strongly agree). 78 people took part in this validation experiment. The low critical mass anchor (26 ratings) received the average score of 2.44 out of 7, while the high critical mass anchor (2,127 ratings) received the average score of 5.11. A t-test was used to compare the means, and the difference between them was found to be statistically significant ($p < 0.001$). Moreover, both scores were significantly ($p < 0.001$) lower and

higher (respectively) than a "Neutral" perceived critical mass value. These results corroborate our assumption that the two anchors represent high and low anchors for perceived critical mass.

In addition to the image indicators described, respondents were presented with two participation opportunities: (1) a request to rate the quality of the match on a five-star scale, and (2) a request to provide verbal feedback: a comment or a link to a better match. Respondents' decision on whether to perform these actions or not served as a measure of the participation outcome variables.

**Results.** 459 people used PetLink. 46.8% provided rating and 21.7% provided verbal feedback. Cronbach's alpha value for conscientiousness was 0.72, above the 0.70 threshold, demonstrating good composite reliability (Hair et al. 1998). The Average Variance Extracted (AVE) for conscientiousness was 0.740, well above the 0.50 threshold measure (Fornell and Larcker 1981), and the square root of AVE (0.860) was higher than the correlation with other factors; inter-construct correlations were extremely low (the highest was 0.009); together, these results demonstrate discriminant and convergent validity (Straub et al. 2004). In order to test the hypothesis, we studied two metrics of participation as our dependent variables: (i) whether respondents rated or not (Rated=1, Not Rated=0), and (ii) whether they provided verbal feedback (Feedback=1, No Feedback=0). The independent variables were conscientiousness level (high and low - above and below the median, respectively) and perceived critical mass (high and low). We created an interaction variable (UI intervention x personal attribute) to analyze the moderating effect of the personal attribute on the relationship between the intervention and the outcome. Since the outcome variable is binary (whether or not the user provided rating), we analyzed the data using Logistic regression. Regression analyses were performed to test a full model, including: independent variables, interaction between them, and control variables (age and gender). Table 3 presents the regression results (outcome variable whether users rated or not).

| Table 3: Logistic regression result for Experiment #2 | | | | | |
|---|---|---|---|---|---|
| Independent Variables | Beta | S.E. | Wald χ2 | P value | Odds Ratio |
| Age | .012 | .011 | 1.165 | .281 | 1.012 |
| Gender | -.280 | .246 | 1.292 | .256 | 0.756 |
| Conscientiousness | 1.023 | .383 | 7.131 | .008 | 2.781 |
| Critical mass | .518 | .395 | 1.716 | .190 | 1.679 |
| Conscientiousness X Critical mass | -1.115 | .506 | 4.860 | .027 | 0.328 |

As hypothesized, the interaction (see Figure 5) was such that participants characterized by high conscientiousness were more likely to rate when there was perceived low critical mass (i.e. when participants perceived that few others were available to rate). Low conscientiousness participants, on the other hand, were more likely to rate when faced with an indication of a large number of other participants (i.e. perceived high critical mass). Table 3 lists the odds ratios for the corresponding beta coefficients. Similar results were obtained for the alternative outcome variable: the decision on whether to provide verbal feedback.

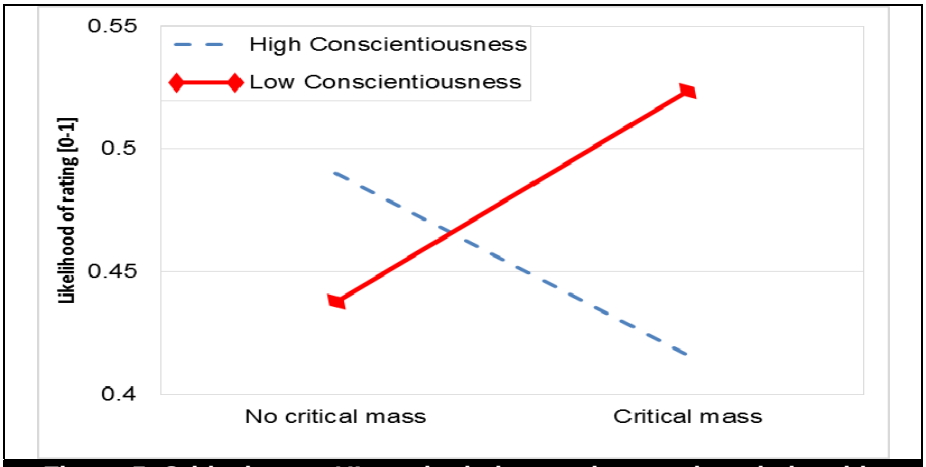


**Figure 5. Critical mass UI manipulation moderates the relationship between conscientiousness and the likelihood of rating**

## 4. Implications for Research on HCI Design

In recent years, a number of studies have investigated the effects of users' personal traits on HCI design. Studies on persuasion strategies have shown how personality determines people's reaction to persuasive messages (Kaptein and Eckles 2012) and have suggested that this approach is applicable to the design of system interfaces (Halko and Kientz 2010). The field of personalized UI has established that contextual data about the user (and task) is invaluable for their successful implementation. This contextual information comes from a variety of unconventional and unrelated sources aggregated together using sophisticated algorithms to form a profile of the user. The Gartner Group (Clark and Lapkin 2010) identified four salient categories of contextual information – business process (information about the user through direct interactions with the user), environment (such as location, directional orientation, possible distractions, mood, network and device capabilities/constraints among others), community (information from social media) and identity (reputation, privacy preferences, personal preferences and traits among others). Our work focuses on contextual information that could be used for learning about a user's personality traits. Given that personality traits are relatively stable, personalityzation could alleviate the concerns for diminished predictability, comprehensibility and controllability that are associated with adaptive UI design (Jameson 2008), as illustrated by prior studies on personality-based design (Goren-Bar et al. 2006; McGrenere et al. 2002). Our work builds on and extends such prior research, showing that personalityzation is also an effective design strategy, such that variations in personality result in different responses to UI designs.

In the studies described here, we provide a proof-of-concept for the effectiveness of personalityzation as a way to influence users' online behavior. Specifically, the social anchoring and critical mass UI design cues were shown to have a differential effect on participants with different levels of *emotional stability* and *consciousness* (respectively). For example, results from Study #1 show that people with below average emotional stability react differently to social anchoring cues than those

higher on the emotional stability scale (i.e. anchoring cues significantly increase participation for the former group, but for the latter group the effect is not as strong), suggesting that this design feature is effective for only a subset of the population. The results from Study #2 provide an even stronger justification for personalityzation, showing that the effect of a particular design feature (i.e. critical mass) can have *contradicting effects*: people low on the conscientiousness scale react positively to indicators of the community's size, while those highly conscientious react negatively to this same indicator. Beyond the particular implications to the relevant literatures for each of the studies, a more general implication from our recent experimentation is that we cannot necessarily expect UI design features (such as indicators of community's activity) to equally affect all participants; instead, a more nuanced, personalized approach to HCI design is needed, where design features are catered to users' particular personality traits.

The contribution of this work to HCI is in that it informs research on UI design by demonstrating how insights from psychology research can guide the design of more effective interfaces of social technologies. For example, we demonstrate how an understanding of personal differences in terms of emotional stability could guide the design of a personalized interface, which helps to increase participation in recommender systems. It should be noted that personalityzation could be used in a variety of contexts beyond that of social recommender systems. Consider the effect of anchoring for instance, where designers of web based systems can encourage users to take a particular course of action (say, follow certain hyperlinks) by providing indications that this particular path is popular amongst prior visitors to the web site. Our results suggest that such designs are more effective for particular personalities. Personalityzation could be applied to personality traits beyond those investigated in the current paper. Table 4 below explores some possible future research directions with personalityzation in HCI, providing examples for conceivable adaptations of UI design elements around the 'Big 5' personality traits. Beyond personality traits, additional personal characteristics – for instance, motivation

– could be employed in the design of adaptive UI (Nov et al. 2013b). A second contribution of our work is in showing how HCI design can serve as a large-scale experimental tool for testing hypotheses from psychology (e.g. the interaction between personality and social anchoring; see (Eroglu and Croxton 2010; Furnham et al. 2012)).

**Table 4: Possible future research directions for personalityzation**

| Big Five Personality Trait | Sample HCI Research Possibilities |
|---|---|
| *Openness to Experience* (inventive/curious vs. consistent/cautious) | Given the potential negative relationship between personalization and predictability (Jameson 2008), HCI research could investigate the impact of contextual menus such as those used by software programs (for example, MS Office 2013). For example, one potential research direction might investigate whether individuals who are high on *Openness to Experience* prefer more personalized (and hence less predictable) contextual menus when compared to those low on this trait. |
| *Conscientiousness* (efficient/organized vs. easy-going/careless) | Past research in HCI has looked at the impact of persuasive technologies through the theoretical prism of Elaboration Likelihood Model (Petty and Cacioppo 1986) (for example in studying web site credibility (Fogg et al. 2003)). One potential direction is to explore whether individuals who are very *conscientious* are more susceptible to persuasion through the central rather than peripheral route. |
| *Extraversion* (outgoing/energetic vs. solitary/reserved) | Individuals who are introverted tend to be less social (but not anti-social) than extroverts. Hence, HCI research might explore whether interface cues that stimulate the senses (for example, use of specific color patterns, immersive multimedia) might specifically get the introverts more socially engaged in cases where that is the desired outcome. |
| *Agreeableness* (friendly/compassionate vs. analytical/detached) | In community participation sites (bulletin boards, comments section), individuals may need to be shown different sets of interface features to reduce trolling behavior. For example, empirical research can be conducted to test whether the 'thumbs down' (or down-vote) button should not be shown to those who are disagreeable (whereas other individuals might be shown both 'up-vote' and 'down-vote' buttons). |
| *Neuroticism* (sensitive/nervous vs. secure/confident) | Individuals who are emotionally stable (not neurotic) tend to be less susceptible to the influence of others. Hence, social networking sites such as Facebook can measure the impact of the UI features such as sponsored posts (while being mindful of the ethical implications) for different personalities. For example, HCI research could attempt to measure the differential effectiveness of advertisements endorsed by friends on these sites by individuals high and low on *neuroticism*. |

A more practical implication of our results concerns the survey-based method for extracting and modeling users' personality (to be used for personalityzation). Such an approach has already become popular in the area of e-learning (Ford and Chen 2000). The advantage of this approach is that the user model maps directly to constructs from psychology theory. To reduce users' burden of answering long personality questionnaire, designers may survey new users as part of their joining the system, or make it

part of a game-like activity (such as PetLink). If one can successfully elicit this information via explicit feedback (for example, by following gamification design principles), it has the potential to significantly improve the quality of the underlying intervention.

An alternative approach is to automatically (and unobtrusively) detect aspects of users' personality based on their online behavior. A partial combination of personal data outlined in these four categories above – both online and offline - is already being collected by an extensive ecosystem of companies in the information aggregation industry. While some of this information is collected by explicitly asking users for information (for example, personal preferences on Facebook page), most of this information is being collected implicitly and automatically. A report by Wall Street Journal found that the top 50 websites in the U.S. installed about 64 distinct pieces of tracking technology on average on visitors' computers (Angwin 2010). These tracking technologies can aggregate users' browsing behavior over time and can develop in-depth profiles of individuals that can be bought and sold on market exchanges. Such methods may help infer traits and dispositions by creating a user profile. They may also capture users' transient preferences and attitudes such that the UI is not only personalized across users but also tailored to a users' particular attitude at particular points in time. Prior research has demonstrated the feasibility of recognizing user traits in "rich" multi-modal and dialog interfaces (Goren-Bar et al. 2006; Lepri et al. 2009; Mairesse et al. 2007) and in Web and mobile phone interfaces (Chittaranjan et al. 2012; Golbeck et al. 2011). Such techniques could possibly be employed in building a profile of users' personal traits, to be used as part of personalityzation.

Once designers are able to profile users based on their personality, they could adapt the interfaces such that users with dissimilar personalities are exposed to different UI features. For example, to encourage participation in recommender systems, only people low on conscientiousness should be presented with UI features indicating the size of the community. Similarly, social anchoring cues need to be emphasized for individuals with low emotional stability.

## 5. Implications for Design Research

Our secondary goal for this paper is to inform the discussion on theoretical grounding within design research (DR) in information systems (IS). Above we have explained that extant personalization approaches are largely divorced from psychology research on personality, and argued for constructing a user model that is grounded in the theory of personality. Now, we seek to generalize the lessons learned through the development of our personalityzation framework, and advance the discourse on theoretical grounding in the design of information systems. We note that a broader discussion regarding the relation between HCI and DR is beyond the scope of the current paper.

### 5.1 Theoretical Grounding in Information Systems Design Research

Design Research seeks to develop prescriptive design principles through building and evaluating innovative IT artifacts (Hevner et al. 2004). HCI Research, on the other hand, is concerned with the ways humans interact with information, technologies, and tasks; especially in business, managerial, organizational, and cultural contexts (Zhang and Li 2004). Carroll (1997) argues that research in the field of Human-Computer Interaction (HCI), too, could be viewed as a 'science of design'. Despite the similarity in goals and methods, design research in IS and HCI have proceeded as two almost independent research streams[1]. However, in recent years, we are witnessing a move towards convergence. For example, Hevner and Zhang (2011) argued that design research and HCI "are inherently related and highly overlapping" (p. 56), and provided an initial attempt at mapping HCI research to DR conceptualization (Hevner 2007).

Our discussion here focuses on one aspect of information system design – theoretical grounding – that is a salient feature of HCI research, yet has not received sufficient attention within the DR

[1] We note that there is an active research stream on HCI within the IS field, but this research has been primarily concerned with the 'soft' aspects of HCI (namely impact of artifacts), rather than with the design of human-computer interfaces (Zhang and Li 2004).

community (Iivari 2007a). Research in HCI is deeply rooted in behavioral theory, primarily from the fields of Cognitive Psychology, Social Psychology and Industrial and Organizational Psychology (Carroll 1997; Shneiderman 1998)[2]. The rationale for employing cognitive and social science theories as sources of principles for innovation is that it yields superior designs (Ling et al. 2005). Such strong emphasis on theoretical grounding is not a common feature of DR within IS, and the explication of the theoretical basis for making the design effective is often absent in DR studies (Arazy et al. 2010; Gregor and Hevner 2011; Iivari 2007b; Kuechler and Vaishnavi 2008; Venable 2006). Nonetheless, there is a growing recognition within DR for the importance of theoretical grounding, and we argue that this stream of design research could benefit by drawing insights from our work in the area of HCI.

The theory-directed design approach in DR is best explicated by the early conceptualization of Walls et al. (1992) who introduced the IS Design Theory as a prescriptive statement of how to develop design paths that rigorously derive their rationale from more fundamental research in the natural or social sciences (referred to as kernel theories). Some DR scholars have adopted (and further developed) Walls' et al. ideas, arguing that grounding systems design in behavioral theory not only increases the designer's understanding of the problem domain, but also helps formulate high-level design principles that are independent of technological constraints and specific implementation details (Arazy et al. 2010; Gregor and Jones 2007; Kuechler and Vaishnavi 2008; Kuechler and Vaishnavi 2012; Sein et al. 2011).

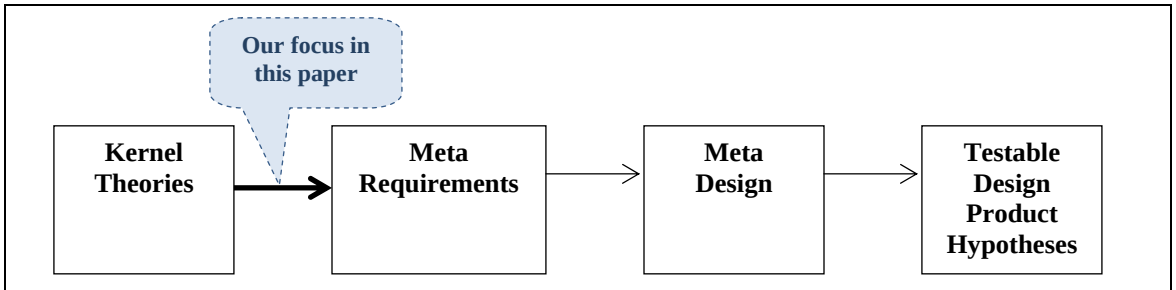


**Figure 6. An illustration of IS design theory, adapted from Walls et al. (1992)**

[2] The disconnect between psychology theory on personality and personalization research within HCI is the exception to the norm.

A key challenge for theory-directed design in both IS and HCI is in creating the linkage between theoretical foundations and system design. Walls et al.'s (1992) formulation provided little direction on how the linkage between kernel theory and design could be achieved. Kernel theories are at such a high level of abstraction that their relationship to design are frequently difficult to discern, thus providing insufficient prescriptions for artifact construction (Kuechler and Vaishnavi 2008; Kuechler and Vaishnavi 2012). As a result, when system design is informed by theory, the deduction from kernel theories to design is often not a process of logical derivation; instead, theories are only used as sources for inspiration (Goldkuhl 2004).

Two approaches have been proposed for guiding the transition from kernel theories to design principles in DR, and both of these approaches rely on the introduction of an intermediate model or a "midrange theory", that is explanatory theories of a restricted scope that could more readily suggest actions; (Merton 1968). Within the context of IS design, mid-range theories can provide a conceptual bridge between high-level explanatory kernel theories and highly prescriptive design theories construction (Arazy et al. 2010; Kuechler and Vaishnavi 2008; Kuechler and Vaishnavi 2012). Mid-range theories in IS design are informed by both kernel theories and design. In moving from kernel to mid-range theories we descend a level of abstraction, arriving at a more concrete model. With the first approach for bridging kernel and design theories, the intermediate model lies within the domain of kernel theories (Arazy et al. 2010), while the second approach suggests that the newly-introduced mid-range theory lies within the realm of design (Kuechler and Vaishnavi 2012). Although the solutions recently proposed in DR offer a possible solution for bridging theory and design, these solutions are very complex and require complicated procedures. To date, there is little evidence to indicate whether the approaches for the introduction of an intermediary model could generalize and help guide the transition from kernel theory and design in design problems other than the examples in (Arazy et al. 2010; Kuechler and Vaishnavi 2008; Kuechler and Vaishnavi 2012).

## 5.2 Personalityzation: Insights for Design Research

As illustrated through the example studies presented in Section 3, our proposed approach advocates the application of theory from psychology to guide HCI design[3]. A reflection on our experiences offers some insights regarding how to tightly link theory to design. Interestingly, the way in which we have grounded UI design in theory did *not* require the development of an intermediary mid-range theory (as proposed by Card in his early works in HCI (Card 1989; Card et al. 1983) and prescribed by recent DR conceptualizations (Arazy et al. 2010; Kuechler and Vaishnavi 2012)). Below we recap the challenges for theory-directed design highlighted by (Arazy et al. 2010), and discuss how they were addressed in our research on personalityzation.

Challenge 1: "it is not easy to find relevant kernel theories for a specific design problem at hand". Our personal experience has taught us that identifying a relevant kernel theory for HCI design problems is often less challenging than when designing the internal workings of an IS. In particular, our interest in adapting systems' UI to users' personality points directly to the relevant theoretical foundation: theories of personality. In addition, we had to identify a relevant theoretical basis for the particular UI design feature under investigation (e.g., in the first example study, social anchoring). This, of course, is not straightforward; yet given our experimental design and the narrow focus of the design problem (only one UI feature at a time) the search for a theoretical basis is quite constrained, and our experience shows that the challenge of identifying a relevant kernel theory for a particular set of UI features is surmountable. Take for example our study in which we experimentally manipulated the UI indicator of the number of prior raters; in order to explain the effect of this UI design feature we considered framing this manipulation in terms of 'group size', eventually turning to the theory of critical mass (Lou et al. 2000; Van Slyke et al. 2007). We note that identifying relevant theoretical foundations for directing the

[3] Our personalityzation framework is in line with recent DR works on 'user-centeredness' (Iivari and Iivari 2011).

design of non-UI components may be more challenging as the scope of the search is less constrained. For example, designers of Artificial Intelligence algorithms have sought inspiration in areas as diverse as neurology (e.g. neural networks) and evolutionary biology (e.g. genetic algorithms).

Challenge 2: "the scope of the existing kernel theories is often too narrow". Our experimental design was able to mitigate this concern. In our case, the design problem involved an interaction between a personalization and a UI feature. Thus, we sought prior behavioral studies that have investigated the combination of the relevant personality trait and the UI design feature under investigation. For example, in the first study presented in the paper, we searched for prior work on the interaction between emotional stability and social anchoring. Interestingly, we were able to identify relevant prior studies on the anchoring effect that considered personality (Furnham et al. 2012; McElroy and Dowd 2007); such studies directly informed our design. More broadly, we suspect that concerns for the scope of kernel theories may not be a critical issue for research on personalityzation, since personality is a well-established scholarly field offering a breadth of theories for consideration.

Challenge 3: "the theoretical model guiding the design should employ a level of abstraction that is suited to the design problem at hand". Here too, our experimental design allowed us to sidestep the challenge concerning abstraction level. For the personality constructs, our current method relies on existing survey instruments for estimating users' personality, thus the abstraction level for theory directly matches that of the design (this, of course, may be a bit more problematic when employing automatic data mining methods for constructing users' personality profile). For the UI feature, it may be more difficult to associate a design feature with a behavioral construct, but our experience shows that if a behavioral theory is considered during the design process, it is often possible to design the UI feature such that it maps to a behavioral construct (at the appropriate level of abstraction). For example, in the first study, the anchoring effect is operationalized through a presentation of the community's average rating (illustrated using stars).

Challenge 4: "kernel theories are not adequate for guiding design, as they commonly specify only the direction of effects, whereas making design choices requires that we also consider the effects' magnitude". In the context of our work, we notice that kernel theories of personality often do include information about effect size. In addition, in the particular context of personalityzation, the magnitude of effect is of lesser importance, and often the direction of effect is sufficient to guide design. For instance, it is sufficient to know that extroverts respond differently from introverts to a UI feature (e.g. presenting others' ratings); the direction of effect would allow HCI designers to decide on whether to display the feature under consideration for a particular person. The magnitude of effect (e.g. how much this is likely to impact the average extrovert), however, is less critical for designing the user interface.

Table 5 below lists the four primary areas of concern for theory-directed design that were identified by Arazy et al. (2010), and summarizes the way in which these concerns were mitigated in our research on personalityzation.

In sum, there is a long tradition of theory-directed design in HCI research, which demonstrates that a tight linkage between theory and design is feasible (and extremely useful). In line with this tradition, we sought to ground the design of personalized UI in theory of personality. In our studies of personalityzation, we were able to sidestep many of the challenges associated with theory-directed design. Above, we reflected on how the concerns for theory-directed design described by Arazy et al. (2010) were alleviated. We stress that the lessons drawn from our experience in personalityzation may not necessarily apply to other UI design problems.

| Table 5. Theory-directed design | | |
|---|---|---|
| Challenge (Arazy et al., 2010) | Examples in social recommender systems: associating a recommendation recipient with a source (Arazy et al., 2010) | Addressing the challenges – Our experience in personalityzation |
| 1. It is not easy to find relevant kernel theories for a specific design problem at hand. | There may be several potential relevant theoretical streams: Theory of Interpersonal Attraction (Social Psychology); Reinforcement Theories (Social Psychology); Word-of-Mouth Influence Theories (Marketing, Social Psychology); The Tie Strength Theory (Sociology); Social Influence Theories (Social Psychology, Marketing and Knowledge Sharing) | The design problem (personalizing the UI) points directly to the relevant theoretical foundation: theories of personality.<br><br>Relevant theoretical basis for the UI design features (social anchoring, critical mass):<br>Given the narrow focus of the design problem (only one UI feature at a time), identifying a relevant kernel theory did not present a real challenge. |
| 2. The scope of the existing kernel theories is often too narrow. | Various types of data regarding users' online interaction could be used to associate a recipient with recommenders; each type of relationship data points to a different theoretical basis, e.g.: interaction frequency data point to Tie Strength Theory, while social network data point to Word-of-Mouth theories. Thus, there is no one single kernel theory that maps to the full design problem | We were able to identify few prior studies that have integrated the two theoretical foundations relevant for our study: (a) theory of the particular personality trait and (b) frameworks linked to the design feature.<br>The breadth of prior research on personality offered us a large range of theoretical frameworks to choose from. |
| 3. The theoretical model guiding the design should employ a level of abstraction that is suited to the design problem at hand. | Tie Strength Theory treats interaction frequency, tie duration, and closeness as indicators of a single Tie Strength construct.<br>However, each of these indicators is associated with a distinct metric that could be extracted from online data. Thus, in order to direct design, we require a kernel theory that treats interaction frequency, tie duration, and closeness as distinct constructs, and provides predictions regarding the effects of each of these constructs. | Our experimental design allowed us to sidestep this challenge. For the personality constructs, our current method relies on existing survey instruments for estimating users' personality, thus the abstraction level for theory directly matches that of the design.<br><br>For the UI feature, although more challenging, we found that if a behavioral theory is considered during the design process, it is often possible to design the UI feature such that it maps to a behavioral construct at the appropriate level of abstraction. |
| 4. Kernel theories are not adequate for guiding design, as they commonly specify only the direction of effects, whereas making design choices requires that we also consider the effects' magnitude | Tie Strength Theory predicts that strong ties are not useful for advice seeking, and Word-of-Mouth theories suggests that trust in the recommender is an antecedent the recipient willingness to take advice.<br>However, given distinct metrics – some linked to Tie Strength while others to Trust – it is not clear how they should be combined for optimal recipient-source matching. | Kernel theories of personality often do include information about effect size.<br>In addition, in our particular context of personalityzation, the magnitude of effect is of lesser importance, and often the direction of effect is sufficient to guide design. |

Nonetheless, we suspect that some of our lessons apply more broadly to HCI research. Notably, in line with our work on personalityzation, we observe that research in HCI is often able to ground the design without requiring the introduction of an intermediate model. We can offer possible explanations for how the HCI field is able to mitigate the four areas of concern discussed above and employ theoretical framework to guide the design. First, the search for relevant kernel theories is more constrained in HCI (addressing Challenge #1 above). The design of human-computer interaction (user interfaces, user experience) lends itself naturally to theories from psychology. The field of HCI is inherently interested in human information processing and [cognitive, social, organizational] psychology has served as the primary theoretical basis for directing design in HCI (Grudin 2006). Second, HCI design is often modular such that the design of UI features is not tightly coupled, and thus the concern surrounding the restricted scope of kernel theories (Challenge #2) is less critical in the case of HCI. Third, HCI researchers are often interested in discrete (rather than continuous) levels in UI design features and frequently employ A/B testing methods; in these situations, the direction of effect is most important (addressing Challenge #4). For example, knowing that users prefer one design over another may be sufficient for UI designers (how much one is superior to the other may be of lesser importance). Finally, the close synergy between psychologists and designers that characterizes many HCI research teams helps in mitigating the concerns around theory-directed design. While HCI researchers face similar challenges to DR scholars in overcoming the mismatch between design problems and the corresponding theoretical frameworks (primarily issues of scope and abstraction level) (Card 1989; Carroll and Kellogg 1989; Ling et al. 2005), a close interaction between theorists and designers allows moving between theory and design with less effort, finding creative ways for bridging the gap (addressing Challenges #2 and #3 above). As argued by others (Arazy et al. 2010; Kuechler and Vaishnavi 2008; Kuechler and Vaishnavi 2012; Nunamaker et al. 1991; Orlikowski and Barley 2001), we believe that a close synergy between the behavioral and the design science research communities –

such as the one often observed in HCI research teams - is essential for DR researchers seeking to ground their design in theoretical foundations.

The contribution of our work to design science research is, thus, in highlighting some techniques for alleviating the concerns that plagued prior efforts to derive design principles from theory. Theoretical grounding of IS design is imperative because it: (a) leads to the construction of better artifacts and thus to more valuable prescriptive knowledge (Arazy et al. 2010; Goldkuhl 2004); (b) furthermore distinguishes DR from what practitioners do (Gregor 2006). We believe that bridging the gap between theory and design could contribute to our discipline's constant search for identity (Benbasat and Zmud 2003), and could potentially create synergies and help overcome the problems associated with two distinct bodies of knowledge within the IS field (i.e. "theoretical knowledge" and "design knowledge"). While few recent studies in DR have proposed ways for bridging theory and design through the construction of an intermediate model, our experience with theory-directed design in HCI suggests that such an intermediate model may not always be warranted, and that alternative solutions are possible. We acknowledge that not all design problems lend themselves to theory-directed design and we are *not* implying that DR should always seek a tight linkage between kernel theories and design. Rather, we propose that for those design problems that could benefit from theoretical grounding, lessons drawn from our personalityzation studies can offer insights on how to bridge the gap between theories from the natural and behavioral sciences and design principles.

## 6. Conclusion

In this paper we introduced our personalityzation approach to HCI design and provided a proof-of-concept through two distinct studies. In these studies, personalityzation was applied to different personality traits and design features. We stress that different design features may call for 'personalityzation' around a different trait. The most relevant personality trait for the problem at hand is

selected primarily based on theoretical considerations. In the absent of theoretical guidance, a researcher may start by surveying subjects on an array of personality traits – using proven measurement instruments for the Big 5 or Big 10 personality traits – and test which traits interact with the UI design; findings could then help direct the search for theoretical explanations.

Our personality-based UI design framework addresses many of the limitations facing the design of personalized interfaces. Since personality traits are relatively stable, personalityzation can help users cope with the sense of reduced control and diminished predictability that plague personalized systems. The cumulative evidence brought here suggests that not only does personality help users cope with UI adaptability, but this approach is also very effective in influencing online behavior. Our primary contribution is, thus, to HCI research. IS scholars have traditionally focused their efforts on analyzing the impacts of IT artifacts, and less effort has been put into innovative design contributions (Te'eni et al. 2007; Zhang and Li 2004; Zhang and Li 2005; Zhang et al. 2009). Recently, there is a move within the IS HCI community to place greater emphasis on design (Benbasat 2010; Hevner and Zhang 2011; Lyytinen 2010). Thus, there is a particular value in bringing novelties in UI personalization to the IS audience interested in human-computer interaction.

In addition, the proposed approach to UI design also informs research in the area of design science. Hevner and Zhang (2011) discuss the relation between HCI and design research and suggest that "it is important to encourage active research efforts to make progress and research contributions at the intersection of these two streams" (p. 56). We have followed up on their suggestion and tried to show how our proposed HCI framework informs DR conceptualizations. While the DR literature stresses the difficulty in theory-directed design, the two studies described here demonstrates the feasibility of grounding design in theories from the behavioral sciences. In particular, we show that under certain conditions (simple interface design decisions that focus on one UI feature at a time), it is possible to forego reliance on mid-range theories entirely and rely instead on granular theories to direct UI design.

To that end, we contribute to the ongoing debate in the DR community regarding theory's role in guiding design.

Our exploration of personalityzation suffers from many limitations, which can be addressed in future research. In terms of the contribution to HCI research, first, we plan to extend our framework by employing other theoretical frameworks of personality (beyond the Big 5) and by considering other types of enduring individual traits, such as dispositions. Second, we intend to extend our investigation beyond social participation systems, focusing on design interventions that enact mechanisms other than social influence, and testing alternative outcome variables (e.g. flow, engagement, satisfaction). Third, in terms of research methodology, future research could extend our work by assessing users' personality at multiple points in time and using alternative data collection methods especially for contextual data (using industry practices outlined in an earlier section). For example, recent work has demonstrated that some of the profile information – especially information posted on Facebook – can also be used to make algorithmic predictions about personality characteristics of users (Alam et al. 2013). We believe that it is crucial to use personality characteristics as the basis for UI design – either on their own or in conjunction with other contextual data - as they help improve performance, as demonstrated in our work. Finally, we hope to be able to generalize our findings to different settings and to multiple types of devices and interfaces (e.g. mobile and haptic interfaces). In terms of design research, extending our work in HCI would allow us to draw new insights regarding the relationship between HCI and DR. For example, we are interested if the lessons discussed here re the linkage between theory and design would still be applicable when designing complex, multi-feature, user interfaces.

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