

# Motivation-targeted personalized UI design: a novel approach to enhancing citizen science participation

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**Abstract.** We report a preliminary exploration of the effectiveness of motivation-targeted UI design - a novel personalized approach to enhance online participation. The empirical setting was Butterflies and Moths of North America (BAMONA), a large-scale citizen science project. Using a combination of design intervention and classification of users based on their collective identification motivation, we show that stating the community's mission on its website increases the likelihood of contribution among those who strongly identify with the project, but decreases likelihood of contribution among those with weak identification with the project. The findings contribute to theory and practice of social systems design by demonstrating how motivation-targeted design that can enhance online participation.

## Introduction and background

In this paper we report a preliminary exploration of a novel approach to enhancing web-based citizen science participation: building on insights from social psychology, we explore the effectiveness of personalized UI design targeting users' motivations.

Extant HCI and CSCW research use insights from social psychology to inform the design and development of social participation technologies (Dabbish, Farzan, Kraut, and Postmes, 2012; Farzan, Dabbish, Kraut, and Postmes, 2011; Kraut and Resnick, 2011). In such design-based studies, controlled experiments are often used to test the effect of UI design features on user behavior (Dabbish and Kraut, 2008; Ling et al., 2005). In particular, such studies often focus on identifying effective ways to encourage volunteered contribution of public goods in online settings (Burke, Marlow, and Lento, 2009; Choi, Alexander, Kraut, and Levine, 2010). This approach enables researchers to draw conclusions about design effectiveness. However, to a large extent, studies based on this approach do not account for differences in users' personal attributes, such as their personalities or motivation.

A highly complementary stream of research involves individual differences and online engagement. Studies in this field showed how participants' personal attributes are correlated with online contribution. In particular, the role of motivational factors in has been explored and demonstrated in studies of a wide range of settings (Chen, 2007; Fugelstad et al., 2012; Peddibhotla and Subramani, 2007; Zhang, 2008), such as Wikipedia (Bryant, Forte, and Bruckman, 2005; Nov, 2007), open source software projects (Hertel, Niedner, and Herrmann, 2003; Lakhani and Wolf, 2005), and citizen science projects (Nov, Arazy, and Anderson, 2011b; Raddick et al., 2010; Wiggins and Crowston, 2011). This stream of research is different from the design-centered stream in term of the methodologies used, drawing primarily on survey-based data rather than experimental studies.

Building on these two streams of research, in the present study we examine the effectiveness of design features targeting users' motivations, as a method to increase participation. In other words, we explore the effects of the interaction between user motivation and a UI design feature on user online behavior. To follow a medical metaphor, this approach is analogous to a medical treatment that is applied to an individual based on her specific genetic profile, and may therefore be more effective than treatment applied to the entire population.

Relevant to our research is the literature on personalization (e.g., (Chu and Park, 2009; Felfernig, Mandl, Tiihonen, Schubert, and Leitner, 2010; Liu, Dolan, and Pedersen, 2010)). Work in that area often involves user models based on users' task-specific interactions. Our motivation-targeted UI design approach, on the other hand, involves classifying users based on pre-existing categories informed by psychology research (motivations, in this case). In other words, while personalization often involves defining user personas based on task-specific prior activities, we define user profiles based on more fundamental user attributes such as their motivations.

In the related field of adaptive UI, there has been prior experimental work on the interaction between personality traits and UI design features (Goren-Bar,

Graziola, Pianesi, and Zancanaro, 2006; McGrenere, Baecker, and Booth, 2002). The primary objective of these studies has been to reduce users' cognitive load and make their interaction with the computer more efficient. The differences in goals between such studies and ours (reduce cognitive load vs. influence online participation), make them different in terms of the applicable design manipulations.

Two recent papers we explored the effectiveness of personality-targeted design (Nov and Arazy, 2013; Nov, Arazy, Lopez, and Brusilovsky, 2013). For example, they showed how users' extroversion levels determine their response to a particular design intervention (manipulating an indicator presenting the number of past visitor in a social recommender system). In the present study we build on and extend this line of research by moving beyond targeting personality traits to targeting users' motivations. Motivation was shown to be an important driver of participation in volunteer-based collaborative efforts online, and therefore in the present study we explore the feasibility of catering to users' motivations through UI design features.

## Interaction between motivations and UI design intervention

In the present study we address the following general research question: can differences in users' motivation explain the effects of design interventions on users' contribution to an online volunteer-based collaborative effort?

A motivational factor which is highly relevant to understanding users' response in collaborative efforts is identification with the online community (Hertel et al., 2003; Nov et al., 2011b; Rotman et al., 2012). As a person develops an appreciation of the social groups he belongs to and attributes significance to this group membership, he develops a social identity (Tajfel, 1978). And when an individual is identified with an organizations or a group he will tend to define herself in terms of the defining features of that group (Hogg and Abrams, 1988) and exhibit a more autonomous motivation, resulting in both higher quality of engagement and a more positive experiences (such as enjoyment, sense of purpose, and well-being) (Ryan and Deci, 2001).

In the context of computer-mediated communication, it has been argued that technology mediation causes de-individuation, which in turn gives rise to a strong social identification (Postmes, Spears, and Lea, 1998; Spears, Lea, Corneliussen, Postmes, and Ter Haar, 2002). In online communities, identification was linked to a social influence exerted from the collective, such that the individual defines himself in terms of the membership in the group (Bagozzi and Dholakia, 2002). Since online communities are usually sustained by voluntarily user-created content, identification has also been used to explain participation and knowledge

contribution (Dholakia, Bagozzi, and Pearo, 2004; Schroer and Hertel, 2009). It is interesting to note that some prior empirical studies did not find a significant correlation between identification and participation in online communities (Hertel et al., 2003), including recent works in the particular context of our study – voluntary participation in citizen science projects (Nov et al., 2011b).

We speculate that such inconsistencies in terms of the effects of identification may result from the interaction between identification and other contextual factors. Our focus is on the interaction between identification and messages displayed on the community's web site, in particular messages stating the community's mission.

The effects of such a UI design feature could be explained through the theory of Attraction-Selection-Attrition (ASA), which describes how individuals become assimilated in organizations (with a focus on work settings) (Schneider, 1987). According to ASA, people often self-select into situations consistent with their personality, and leave situations inconsistent with their personality. While part of a group (or community), individuals still maintain stable self-views, which provide them an essential source of coherence and a means of defining their existence (Swann, Rentfrow, and Guinn, 2003). In the selection process, individuals make implicit judgments of the congruence or fit between their own aspiration, motivation and ideology, and the group's goals. Those individuals who fit with the organization are more motivated and committed, and their overall performance is high (Schneider, 1987). In the context of online communities, ASA has been applied to explain the formation of online groups (Templeton, Luo, Giberson, and Campbell, 2012) and participation levels (Kuk, 2004).

Viewed through ASA, displaying on the community's website a message that states the community's identity acts to make fit (or misfit) more salient, by prompting members to contrast this collective identity with their own values (Postmes, Spears, Lee, and Novak, 2005). Individuals unconsciously self-categorize on the basis of available cues related to the social identity; the more an identity information dominates a person's working memory, the more salient self-categorization processes are (Hogg and Terry, 2000). In computer-mediated communication, members tend to be more sensitive to any salient social identity cues, because they seek to reduce the uncertainty in social interaction (Lea, Spears, and de Groot, 2001).

Identity salience is most often elicited by external factors (Forehand, Deshpandé, and Reed II, 2002). Prior research has investigated various contextual factors, such as: visual images and words (Aquino and Reed, 2002), group symbols and priming (Devine, 1989). In the context of online communities, these contextual factors are mainly integrated into the design of the community's website. For example (Shen and Khalifa, 2010) showed that messages on a community's website can influence members identification.

In the present study we investigate a particular UI design feature: presenting a message stating the community's mission on the website. Such a message establishes the community identity as stable, significant and a salient target for identification. When features of social context serve to make a given social identity salient, individuals are triggered to contrast that identity with their own, producing pressure to comply with the group norms and values (Tajfel, 1978; Turner, 1982). We hypothesize that when the fit between person and the community is revalidated, the likelihood of participation becomes higher; on the other hand, when misfit becomes apparent, dissonance increases, resulting in lower participation.

## Methodology

The setting of the present study is citizen science. Citizen science projects enable members of the public to take part in scientific research (Cohn, 2008; Wiggins and Crowston, 2011), often through web-based contribution (Hand, 2010). As such, citizen science offers a participatory approach for conducting scientific research, and requires good understanding of user motivation (Hand, 2010; Nov et al., 2011b; Rotman et al., 2012; Wiggins and Crowston, 2009; Wiggins and Crowston, 2011).

As citizen science is based both on computer systems to manage large amounts of distributed resources on the one hand, and on attracting and retaining volunteers who contribute their time and effort to a scientific cause, recent research explored the motivations of citizen scientists (Nov et al., 2011b; Raddick et al., 2010; Rotman et al., 2012; Wiggins and Crowston, 2010). In the present study, we build on these studies to apply the knowledge gained on the factors that drive citizen science participation to offer motivation-targeted UI design insight.

In this experimental study, we focused on Butterflies and Moths of North America (BAMONA) – a large-scale citizen science project that collects and makes available expert-verified butterfly and moth distribution in North America (Opler, Lotts, and Naberhaus, 2009). The BAMONA website contains data contributed by more than 3000 volunteers on more than 5,000 species, including species profiles, photographs, and dynamic distribution maps showing verified species occurrences (see Figure 1 for an example). More than fifty collaborating lepidopterists volunteer as regional coordinators tasked with quality control. They utilize an online system to review each individual submission and determine the species identification. The BAMONA database contains nearly 300,000 individual records.

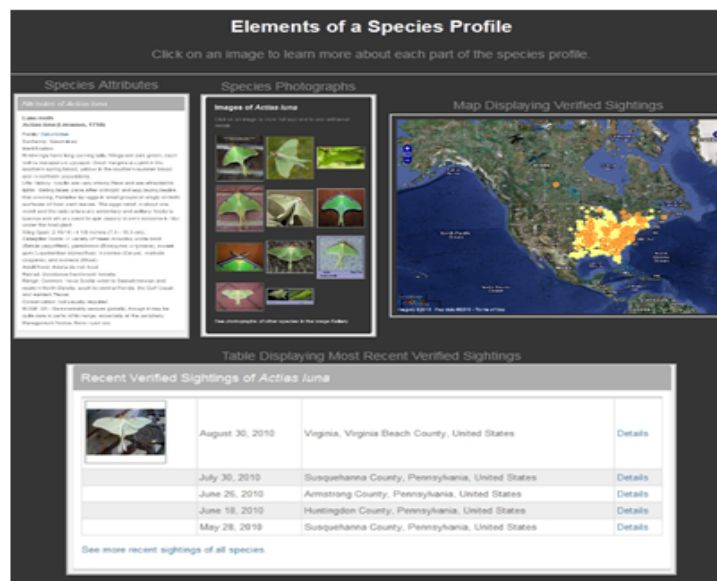


Figure 1. BAMONA screenshot

During the experiment period, the BAMONA landing page invited participants to answer a short questionnaire which included motivation items. Self-report surveys are commonly used in social science research to identify personal attributes, and have been used extensively in HCI and CSCW studies (McElroy, Hendrickson, Townsend, and DeMarie, 2007; Seay and Kraut, 2007). The questionnaire items used a 7-point Likert scale and were adapted from social psychology research of voluntary participation in social movements (Klandermans, 1997; Simon et al., 1998). The same questionnaire items were used in studies of participation in open source software development (Hertel et al., 2003), Wikipedia editing (Schroer and Hertel, 2009), and citizen science (Nov, Arazy, and Anderson, 2011a; Nov et al., 2011b). We classified high and low-identification volunteers by performing a median split: respondents whose identification score was above the sample median were classified as high- identification and those below the median as low-identification respondents. The experimental manipulation included a presentation of the project's mission at the top of the website's landing page.

During the 45 days in which the experiment ran, we recorded the participation levels of participants in the four experimental conditions (above vs. below identification median X presentation of the community's mission vs. no presentation).

In order to examine the effects of motivation, UI design, and the interaction between them, we used a factorial logistic regression in the statistical analysis. The independent variables in the analysis included identification (high = 1, low = 0), community mission UI design feature intervention applied (intervention = 1, control (no intervention) = 0), and the interaction between them.

We used system log data to identify users who made at least one contribution in the 45 days prior to the experiment. Many citizen scientists contribute very little and we therefore wanted to focus on regular contributors – those who together make up the bulk of contributions. As an illustration, the top 10% of the sample's volunteers contributed more than 88% of its content.

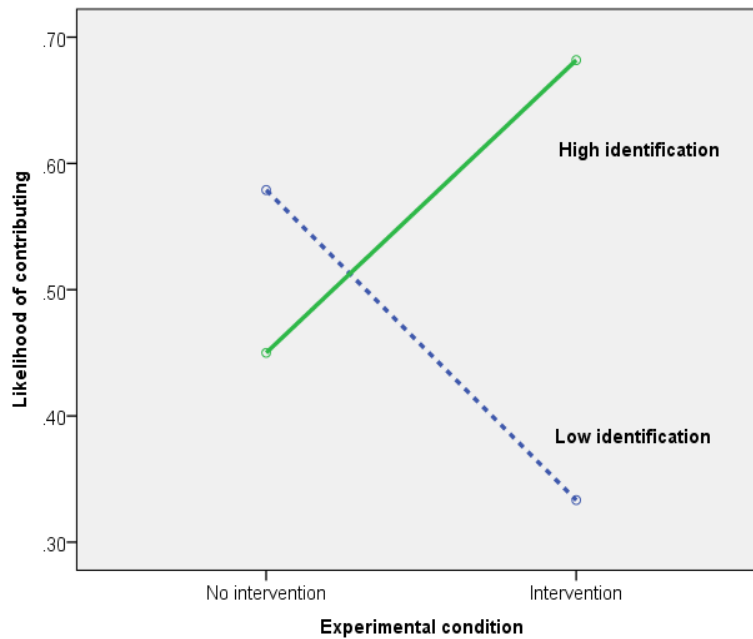
Since we were interested in understanding how the independent variables affect the likelihood that a user will keep contributing content, the outcome variable was contribution, defined as providing at least one contribution during the 45 days of the experiment, when the design feature intervention was active (contributed = 1, not contributed = 0).

## Results

Of the 462 volunteers who took part in the study, 73 made at least one contribution in the 45 days prior to the experiment and were included in the data analysis. Of these, 53% were in the UI intervention condition and 47% were in the no-intervention condition. As is common in many large scale volunteer-based projects, contribution made by volunteers was characterized by a power-law distribution, in this case with an average contribution of 8.44 photos (S.D. = 17.9).

There were no statistically significant effects of either the design intervention or the level of identification on the likelihood of contribution. That is, identification levels across the entire population were not correlated with participation; similarly, when considering the entire population, the UI design feature was not correlated with participation. The results of the logistic regression showed that the main effects of the independent variables were statistically insignificant ( $B=-1.46$ ,  $Wald=3.62$ ,  $p>.05$  for identification and  $B=-0.96$ ,  $Wald=2.25$ ,  $p>.05$  for the UI intervention).

However, as hypothesized, when examining the interaction between the independent variables a more intricate relationship was revealed (see Figure ): the interaction between identification and the UI intervention and its effect on contribution, was found to be significant, ( $B=1.97$ ,  $Wald=3.89$ ,  $p<.05$ ).



**Figure 2. The interaction of UI intervention and the identification motivation: the combined effect on the likelihood of contribution**

The results of the logistic regression showed that the main effects of the independent variables were statistically insignificant ( $B=-1.46$ ,  $Wald=3.62$ ,  $p>.05$  for identification and  $B=-0.96$ ,  $Wald=2.25$ ,  $p>.05$  for the UI intervention). The interaction between identification and the UI intervention – the focus of our analysis – was found to be a significant predictor of contribution ( $B=1.97$ ,  $Wald=3.89$ ,  $p<.05$ ).

## Discussion and conclusions

The findings support the hypothesis that the effectiveness of a UI design intervention whereby the project’s objective is made visible depends on users’ level of collective identification. In other words, in line with our hypothesis, making the community’s mission visible to contributors leads to increased likelihood of contribution among those who strongly identify with the project, but to decreased likelihood of contribution among those with weak identification with the project (see Figure ).



The findings inform the research on collective identification in computer-mediated communication (Postmes et al., 1998; Postmes et al., 2005; Spears et al., 2002) and in online communities (Dholakia et al., 2004; Hertel et al., 2003; Schroer and Hertel, 2009; Shen and Khalifa, 2010). Our primary contribution to this literature is in demonstrating that external factors – a UI design feature that presents a message stating the community’s mission – can moderate the relationship between identification levels and online participation, such that the UI design feature would strengthen the positive effects of identification in some users, but reverse its effect in others.

In terms of CSCW research, the results highlight the potential effectiveness of a more nuanced, targeted approach to UI design in general, and the practice of making a community’s mission visible in particular: providing cues that highlight the mission in a large collaborative project may be an effective way to increase participation among those identify with the project, but should be avoided when users do not identify with it.

More broadly, our proposed approach to targeted design highlights the need to tailor design features to idiosyncratic personal characteristics, such as their motivations, and as such, it complements the literature on use of personal attributes in design, such as the work on motivational affordances (Zhang, 2008) personality-targeted design (Nov and Arazy, 2013; Nov et al., 2013). In recent years, a number of studies have investigated the effects of users’ personal traits on UI design. For example, studies of persuasion have shown how personality determines people’s reaction to persuasive messages (Kaptein and Eckles, 2012) and suggested that this approach is applicable to the design of system interfaces (McElroy and Dowd, 2007). Studies on adaptive UI have demonstrated that personality-based design can reduce users’ cognitive load (Furnham, Boo, and McClelland, 2012; Goren-Bar et al., 2006). Our study builds on such prior work, showing that motivation-targeted design can enhance contribution.

Another implication of the results is the need to develop systems that can automatically adapt their features to users’ personal attributes – such as their motivations. Recent research explores possibilities for unobtrusive adaptation to user personal attributes. In particular, recent research has demonstrated the feasibility of identifying user personal traits based on their activity in social networking sites (Golbeck, Robles, Edmondson, and Turner, 2011). A combination of such methods and the motivation-targeted design approach has the potential to dramatically increase contribution to online communities in general, and citizen science in particular.

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