Personality, Motivations, and Information Quality: A Comparative Study across Games for Human Computation

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ABSTRACT
The popularity of games has motivated their adoption for pursuits beyond entertainment. One of the emerging strategies is the Human Computation Game (HCG) which channels players’ time spent on games toward problem solving. Unlike entertainment-oriented games, players of HCGs contribute output as a byproduct of gameplay. In this paper, we investigate the relationships between personality traits and motivations, and the differences in perceived information quality across HCGs with collaborative and competitive gameplay styles. Using a within-subjects experimental design, 125 participants were recruited from two local universities. The findings demonstrate that the interaction between personality traits and gameplay styles influenced players’ satisfaction of the need for autonomy, competence, and relatedness. Further, perceived information quality was found to differ across HCG types.

Keywords
Human computation games, information quality, motivation, personality, collaboration, competition.

INTRODUCTION
Games and their constituent elements have been pervaded tasks that are trivial for humans but difficult for computers to solve alone. This phenomenon is known as Human Computation Games (HCGs) which harness human intelligence through enjoyable gameplay (Goh, Ang, Lee, & Chua, 2011). HCGs have been utilized in various application domains including image and music retrieval, website indexing, ontology building, natural language translation, geospatial knowledge creation, and many more (e.g., Lee, Kim, & Lee, 2014; Procyk & Neustaedter, 2014; von Ahn & Dabbish, 2004).

Given that the primary purpose of HCGs is to produce meaningful output, prior studies have paid much attention to the quality of the output generated. In particular, most previous studies investigated players’ perceptions and output quality between HCGs with collaborative and competitive gameplay styles (e.g., Siu, Zook, & Riedl, 2014; von Ahn & Dabbish, 2008). For instance, Goh et al. (2011) found that output generated by collaborative HCGs were more generic than that of competitive ones. Similarly, Ho et al. (2009) reported that the competitive HCG generated more diverse image labels compared to the collaborative one. In addition, collaborative and competitive HCGs seem to induce different perceptions in players. For instance, players perceived that they were able to accomplish challenges better in competitive HCGs than in their collaborative counterparts (Pe-Than, Goh, & Lee, 2015). The authors also found that collaborative HCGs appeared to be better at establishing relationships among, and fulfilling the autonomy need in, players. In fact, autonomy, competence, and relatedness needs are regarded as primary sources of human motivations that activities need to offer to heighten users satisfaction and fulfillment (Ryan, Rigby, & Przybylski, 2006).

The above findings imply that certain factors may contribute to the differences in perceptions and quality across HCG types. One possible factor is gameplay style which dictates how the game system behaves (Siu et al., 2014). In particular, collaborative style requires players to work together as a team, and the outcomes are shared among team members. In contrast, competitive games allow players to develop strategies and compete with others, and only one player at a time can achieve the winning condition (Waddell & Peng, 2014). It was found that collaboration and competition affected users commitment and behaviors differently in performing tasks (e.g., Tauer & Harackiewicz, 2004). Therefore, individuals may have a preference for certain HCG play styles, which may, in turn, determine their motivations and perceived output quality.

Further, prior studies suggested personality as an influential factor that predicts media genre preference, and players’ motivations and behaviors in entertainment-oriented games and applications with user-generated content (Chorley, Whitaker, & Allen, 2015; Johnson, Wyeth, Sweetser, & Gardner, 2012). In fact, personality drives the way an individual thinks, behaves and approaches a particular situation (John, Naumann, & Soto, 2008). It is, therefore, possible that people with certain personality orientations may be more motivated to play HCGs with certain gameplay styles which may, in turn, impact their perceived quality of output generated by these games. However, research examining the effects of interaction between personality traits and HCG play styles on motivations and perceived output quality is lacking.

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This study is, therefore, timely and that it examines the relationships between personality traits and motivations, and the differences in perceived output quality across collaborative and competitive HCGs. This study was conducted in the context of location-based content sharing. The output generated by such HCGs are information about real world locations, and hence, the terms “output” and “information” are used interchangeably in this study. Three mobile applications were developed, namely, Collabo or a collaborative HCG, Clash or a competitive HCG, and Share or a non-game application. A total of 125 participants was recruited for a mixed-design experiment where participants used assigned application for a day. Findings are beneficial to game designers who sought to promote and sustain usage and engagement in an enjoyable way by embedding computational tasks into games.

LITERATURE REVIEW
In this section, the relevant literature in the area of HCGs for location-based information sharing is firstly reviewed. This is followed by a review of personality, motivations, and information quality in collaborative and competitive contexts.

Collaborative and Competitive HCGs
HCGs have been used to tackle problems that are usually trivial for humans, but difficult for computers (von Ahn & Dabbish, 2004). Put succinctly, HCGs are dual-purpose artifacts which generate computation and offer entertainment at the same time, and hence can be called ‘games with a purpose (GWAPS)’. As HCGs enlist online players to help perform computation, they have also been called crowdsourcing games in recent literature (e.g., Doan, Ramakrishnan, & Halevy, 2011).

One well-known example is the ESP Game (von Ahn & Dabbish, 2004) which embeds image labeling task into gameplay in which two randomly-paired players create labels for given images within a time limit. They will earn points for every matching label. In contrast to the ESP Game, KissKiss (Ho et al., 2009) approaches the image-labeling problem from a competitive perspective. Here, a player acts as a blocker and competes with a group of two players with a rule that the blocker prevents the group from reaching an agreement (i.e., matching image labels).

Location-Based HCGs
Recently, HCGs have begun to be employed in the mobile context to garner georeferenced content that could later be used by locative applications to enhance their services. The Gopher Game (Casey et al., 2007) is one such example in which players collaboratively create content through creating a game agent called gopher with information-related tasks and picking up a gopher to solve tasks.

In contrast, players conquer a city segment by placing the markers for their chosen categories, such as food, café and so on, in CityExplorer (Matyas et al., 2008). A player who created the most categories will win the game. Next, GEMS or Geolocated Embedded Memory System (Procyk & Neustaedter, 2014) is another mobile HCG that allows players to document location-based stories for personal reflection, and for future generations to find.

Motivations, Personality, and Gameplay Styles
Motivation is an important factor that has been studied extensively in the context of games. In particular, Battie (1996) contended that game players can be classified into four player types based on their motivations and gameplay styles. These are achievers, explorers, socializers, and killers. However, it has been argued that such player types are not independent and derived from the analysis of discussions made in a singel game. In contrast, Yee (2006) suggested that players engaged in games for three overarching reasons: achievement, social, and immersion, based on a survey of 3,000 players of massively-multiplayer online games. In the context of HCGs for location-based information sharing, Lee et al. (2010) found that players experienced different gratifications such as information discovery, entertainment, and relationship maintenance. Furthermore, Przybylski, Rigby and Ryan (2010) argued that the enjoyment of games depends on their ability to fulfill three psychological needs which are autonomy, competence, and relatedness. Autonomy need refers to the extent to which an individual perceive a sense of freedom when performing an activity. Next, competence need is regarded as the extent to which an individual perceives the feelings of effectiveness while dealing with challenges. Finally, relatedness need is defined as the extent to which an individual perceives the feelings of being connected to others in an activity (Deci & Ryan, 2000).

While most games are intrinsically motivating, prior research suggests that motivation may vary depending on personality and gameplay styles (e.g., Johnson et al., 2012). Personality is regarded as “the unique psychological qualities of an individual that influence a variety of characteristic behavior patterns, both overt and covert, across different situations and over time” (Gerrig & Zimbardo, 2009). With the considerable support of empirical research, the Big Five personality traits have been regarded as one of the most widely accepted and comprehensive model of personality (Bean & Groth-Marnat, 2014; Hughes et al., 2012). These traits are applied successfully to various contexts including organizations, traditional and social media, and entertainment-oriented games (e.g., Graham & Gosling, 2010; Jadin, Gnambs, & Batinic, 2013). Among these traits, extraversion, agreeableness, and openness were found to be related to users’ online behaviors in most prior studies (Hughes et al., 2012; Jeng & Teng, 2008). It is, therefore, reasonable to expect that these three personality traits will relate to players’ motivations in HCGs.
Furthermore, research following an interactionist perspective regards personality as a factor to consider in explaining individuals’ perceptions toward a particular type of media (e.g., Nov, Arazy, Lopez, & Brusilovsky, 2013). In the context of entertainment-oriented games, Johnson et al. (2012) found that motivations in simulation, actions, and adventure games varied by players’ level of personality traits. In their study on HCGs for image tagging, Goh et al. (2011) found that players’ motivations differ between collaborative and competitive games. The authors further assert that personality may be a factor that can explain their findings, and call for further research. In fact, collaborative and competitive games have their own specific gameplay style and goal structure (Waddell & Peng, 2014), and hence, motivations for playing these games may correspond to players’ personality traits. Therefore, this study aims to examine the relationships between motivations, personality, and HCGs with collaborative and competitive play styles for location-based content sharing.

**Extraversion**

This personality trait is typically characterized as an individual’s level of comfort in interpersonal relationships (John et al., 2008). As such, extraverts enjoy activities which offer interpersonal relationships among participants. Introverts, on the other hand, are reserved, and distant toward other people and hence they are more likely to be involved in solo activities (Ryan & Xenos, 2011).

Extraverted individuals were found to use social media to maintain relationships with friends and family, and to meet new people online (Ryan & Xenos, 2011). Since extraverts are known to be effective in interacting with others, it is not surprising that they preferred Facebook to Twitter to share and seek information (Hughes et al., 2012). Extraverts were also found to encounter a lower number of conflicts with their friends in social media environments (Quercia, Lambiotte, Stillwell, Kosinski, & Crowcroft, 2012). While playing entertainment-oriented, extraverts were more likely to participate in group activities where they cooperate with other players to accomplish the challenging tasks (e.g., Jeng & Teng, 2008). On the other hand, introverts were found to be involved in more solo gameplay activities, and they had more duel-winning statuses than extraverted individuals when playing online games (e.g., Yee et al., 2011). Thus, extraverts may experience a greater level of satisfaction for autonomy, competence, and relatedness than introverts in collaborative HCGs. In contrast, introverts may have a greater satisfaction of these needs in competitive HCGs. Accordingly, this study proposes the following hypotheses:

**Hypothesis 1A:** Players who score high on extraversion will experience a greater degree of satisfaction for autonomy, competence, and relatedness in collaborative HCGs.

**Hypothesis 1B:** Players who score low on extraversion will experience a greater degree of satisfaction for autonomy, competence, and relatedness in competitive HCGs.

**Agreeableness**

Agreeableness is typically characterized as the level of an individual’s ability to get along with other people (John et al., 2008). As such, individuals who score high on agreeableness would perform better in group settings as they are more likely to adapt to group norms and collaborate with group members. In contrast, people who score low on agreeableness tend to be unfriendly, hard-hearted, quarrelsome and competitive (Tobin, Graziano, Vanzan, & Tassinary, 2000).

In the workplace, agreeable people were found to prefer working together with others (Judge & Cable, 1997). Furthermore, they chose to take part group-based challenges or non-combat activities while playing entertainment-oriented games. These findings imply that agreeable individuals may be more motivated to be involved in collaborative activities. However, those who scored low for this trait were more likely to enjoy killing their opponents and challenging them to a duel (Yee et al., 2011). Therefore, less agreeable individuals may experience a greater satisfaction of psychological needs when they are exposed to competitive activities. Hence, the following hypotheses are proposed:

**Hypothesis 2A:** Players who score high on agreeableness will experience a greater degree of satisfaction for autonomy, competence, and relatedness in collaborative HCGs.

**Hypothesis 2B:** Players who score low on agreeableness will experience a greater degree of satisfaction for autonomy, competence, and relatedness in competitive HCGs.

**Openness**

This personality dimension characterizes someone in terms of imagination, sensitivity, curiosity and thoughtfulness (John et al., 2008). As such, high scorers of openness are more likely to be behaviorally flexible, give attention to others’ opinions, seek new and innovative ideas. In contrast, people who score low on openness are considered to be conventional and traditional, and hence less receptive to others’ perspectives (Park & Antonioni, 2007).

Due to their appreciation for variety and novelty, people who are open to experience were motivated to seek out diverse and varied experiences by exchanging opinions with others on blogs and social media (Hughes et al., 2012). This finding implies that people with high openness are responsive to others’ opinions. Hence, they may seek opportunities for collaboration rather than competing with others. This assertion received support from the findings of studies in the gaming context which suggests that players
with high openness tend to spend a great deal of time on non-combat and group-based activities (Johnson et al., 2012). Thus, players scoring high on openness may be more motivated to play collaborative HCGs. In contrast, in the organizational context, people scoring low on openness were found to attempt to achieve their goals at the expense of others (Park & Antonioni, 2007). Thus, players with low levels of openness are more likely to achieve a greater level of needs satisfaction in competitive HCGs. Hence, the following hypotheses are proposed:

**Hypothesis 3A:** Players who score high on openness will experience a greater degree of satisfaction for autonomy, competence, and relatedness in collaborative HCGs.

**Hypothesis 3B:** Players who score low on openness will experience a greater degree of satisfaction for autonomy, competence, and relatedness in competitive HCGs.

**Output Quality**

This has been an important issue in HCGs, which are meant to harness players’ problem-solving abilities to yield high-quality output for the intended purposes (Goh et al., 2011). Output quality is regarded as a judgment made by observing intermediate or end products of using the system (Davis, Bagozzi, & Warshaw, 1992). As HCG players generate computational output as byproducts of gameplay, perceived output quality is likely to be significant in determining players’ behaviors and attitudes toward these games. Furthermore, the extant literature suggests that output quality is a multidimensional construct, hence necessitating the use of multiple quality dimensions to capture its various aspects (Lee, Strong, Kahn, & Wang, 2002). Using a meta-analysis of existing quality frameworks, Alkhattabi, Neagu, and Cullen (2010) revealed accuracy, completeness, relevancy and timeliness as the most frequently appearing dimensions in these frameworks.

Multiple scholars have argued that collaboration, compared with competition, should increase positive behaviors among individuals, thereby facilitating performance (e.g., Ladley, Wilkinson, & Young, 2015). Waddell and Peng (2014) found that individuals in a collaborative setting exhibited more cooperative behaviors and trust in their partners that may, in turn, lead to higher levels of performance. Similarly, Peng and Hsieh (2012) found that collaboration led to the greater effort put into the gameplay than competition. In contrast, Tauer and Harackiewicz (2004) found no differences in performance between individuals working with others collaboratively or competitively. Although inconsistent, these findings indicate the potential difference in the effects of collaboration and competition on individual performance which may further influence their quality judgment. Previous research also suggests that the type and quality of output seemed to differ depending on HCG genres, and this may induce varying levels of perceptions about information quality (e.g., Goh et al., 2011; Ho et al., 2009). Thus, this study proposes the following research question:

**RQ1:** How do perceived output quality vary across collaborative and competitive HCGs in terms of A) accuracy, B) completeness, C) relevancy and D) timeliness?

**METHODOLOGY**

**Introducing Collabo, Clash, and Share**

Three mobile location-based applications were developed: Collabo, a collaborative HCG; Clash, a competitive HCG; and Share, a non-game application. The reasons for developing our own applications were that we would have better control over the look-and-feel of the interfaces and the accessibility of the generated data. All three applications have a similar purpose of supporting the contribution of location-based information (called comments). They offer a map-based interface that indicates locations with content, which are overlaid with mushroom houses (see Figure 1). Each house has a number of units, and each of these holds comments created inside. These applications allow players to create new comments, as well as browse and rate comments created by others. A comment comprises the title, tags, descriptions, media elements (e.g., photos) and ratings.

Collabo enables sharing of location-based content through player collaboration. Inspired by the virtual pet game genre, Collabo asks players to search for starving pets in their vicinity and to form a team with other players to rescue these pets. The starving pets appear sad and have a darker tone compared to healthier pets (refer to Figure 2). To rescue the pets, players need to feed them with comments or rate those created by others on a five-star scale. The pets being rescued are highlighted by a “star” which signals to other players to join the rescue team. All activities of players are displayed on the “Activities Tab” (refer to Figure 3). Once a pet is rescued, the game allocates an equal amount of points to the team members and at the same time, a winning message is displayed.

Clash allows players to compete with others for pet ownership. Once a player has entered a house, a list of pets residing inside is shown. The player can challenge the current pet owner to a duel (see Figure 4), and he/she will win if the total his/her strength and daily luck (i.e., a random number generated at the first login of each day) is greater than that of the challenged player. The game computes each player’s strength based on the quantity, the rating value, and recency of comments. The recency value of comments decreases by 10% to ensure that the pet is winnable by new players. The game allows owners to retain the ownership status securely for a 15-minute period. This feature was included by the results of the pilot testing in which players reported that it was very easy to lose a pet.
**Participants**

One hundred and twenty-five participants (67 males and 58 females) with an average age of 23.5 were recruited from two local universities. The majority of the participants (76.7%) indicated that they were game players. Among our participants, 50.5% of them had a background in computer science, information technology or related disciplines, 36.3% were from engineering disciplines while the remainder were from disciplines such as arts, social sciences, and business. Furthermore, 75.2% had used social network applications and shared text and multimedia information using mobile devices, and 61.0% used the location check-in feature of such applications.

**Experimental Design and Procedure**

The study adopted a within-subjects design where participants used all three applications (Collabo, Clash, and Share). The experiment utilized a counterbalanced design to minimize the effects of confounding variables. Participants were divided into subgroups with each performing a different combination of the applications. It was conducted across separate sessions with each session having three to nine participants. During the briefing session, participants were given instructions on how to use the applications together with a short practice session. They then completed a questionnaire that elicited demographic information, mobile phone use, experience with games and location-based applications, and personality traits. Participants were asked to use all applications on Android-based mobile phones on three different days; each spaced one day apart. They were also provided with usage scenario for each application which includes joining a rescue team to save a pet (for Collabo), winning a pet (for Clash), and creating, viewing, and rating comments (for Share). At the end of each day, participants completed a questionnaire that measured satisfaction of motivational needs, and information quality regarding the application they used. Participants were paid an incentive of $20.

A pilot study was carried out with 24 graduate students to uncover deficiencies in the questionnaire and study protocol, and to check whether the two experimental conditions (i.e., collaboration and competition) differ significantly. Participants were divided into two groups and randomly assigned to play either Collabo or Clash. Two of them reported the difficulty in maintaining the pet ownership in Clash. The game was revised accordingly, and the revised version was used in the actual experiment. All participants reported that the entire questionnaire was clear and comprehensive. Participants were also asked to what extent they agreed with the two statements: “I felt that I was collaborating with other players in Collabo”, and “I felt that I was competing with other players in Clash”. Responses ranged between 1 (strongly disagree) to 5 (strongly agree). A t-test was used to compare the means, and the difference between Collabo (M = 2.64) and Clash (M = 3.80) was found to be significant (p < 0.01), supporting the assumption that these games represent collaboration and competition respectively.

**Measures and Statistical Analysis**

To measure personality, 8 items for extraversion, 9 items for agreeableness, and 10 items for openness were adapted from Big Five Inventory (BFI) (John et al., 2008). Next, the measures of motivational needs satisfaction were adapted from Players Experience Need Satisfaction (PENS) items (Ryan et al., 2006), and Basic Psychological Need Satisfaction items in general (Deci & Ryan, 2000), and modified to fit the HCG context. A total of 12 items were developed to measure the satisfaction of motivational needs. Finally, to evaluate output quality, a total of 12 items...
were adapted from a number of previous studies (e.g., Lee et al., 2002; Kim & Han, 2009). All items were measured on a 5-point Likert scale ranging from 1-Strongly Disagree to 5-Strongly Agree.

Factor analyses were conducted to evaluate the multidimensionality of the scales while Cronbach’s alpha was used to test the internal consistency of the scales. As expected, three factors emerged respectively from personality scales—extraversion (E), agreeableness (A), and openness (O), and motivational needs scales—autonomy (AUTO), competence (COMP), and relatedness (RELA). The factor analysis of output quality scales yielded four factors—accuracy (ACCU), completeness (COML), relevancy (RELV), and timeliness (TIML). The alpha values of all factors ranged from 0.78 to 0.98, demonstrating good internal reliabilities (Tabachnick & Fidell, 2007).

To test Hypothesis 1-3, this study firstly distinguished between low and high scorers of each personality trait by performing a median split. This approach has been widely used in prior personality research (e.g., Nov et al., 2013). Secondly, for each personality trait, three two-way ANOVAs were conducted to evaluate the interaction effects of three applications (Collabo vs. Clash vs. Share) and two personality trait scores (low vs. high) on the need for autonomy, competence, and relatedness. To address RQ1, four one-way ANOVAs were conducted on accuracy, completeness, relevancy, and timeliness.

RESULTS

**Influence of Personality and HCG Type on Motivations**

The results of the two-way ANOVAs indicated significant interactions between the levels of extraversion, agreeableness, and openness and the HCG type on the satisfaction of all three motivational needs: autonomy, competence, and relatedness. Table 1 shows the effects of personality traits and HCG type on three motivations.

<table>
<thead>
<tr>
<th>Effect</th>
<th>AUTO (F(2,369))</th>
<th>COMP (F(2,369))</th>
<th>RELA (F(2,369))</th>
</tr>
</thead>
<tbody>
<tr>
<td>E x HCG type</td>
<td>261.92</td>
<td>51.57</td>
<td>61.12</td>
</tr>
<tr>
<td>A x HCG type</td>
<td>313.06</td>
<td>134.02</td>
<td>131.82</td>
</tr>
<tr>
<td>O x HCG type</td>
<td>45.09</td>
<td>19.03</td>
<td>18.45</td>
</tr>
</tbody>
</table>

*Interactions are significant at p < 0.001.

**Table 1. Effects of personality traits and HCG type on three motivations.**

The interaction comparisons using a tetrad contrast test were performed to address the study’s hypotheses. The order of value treated to the test was the difference in mean scores of motivational needs between Collabo and Clash for participants who scored low on a personality trait, followed by that of participants who scored high on this trait. Table 2 shows the results of contrast tests.

As expected, the results indicated that participants who scored low on extraversion/agreeableness/openness experienced a higher satisfaction of motivational needs in Clash more than those who scored high on these traits. In contrast, participants who scored high on these traits perceived a greater satisfaction in Collabo. These findings support Hypothesis 1A, 1B, 2A, 2B, 3A, and 3B proposed by this study. Figure 6 shows the influence of personality trait and HCG type on autonomy need.

**Influence of HCG Type on Output Quality**

The one-way ANOVA results indicated that there were significant differences with respect to three output quality variables—accuracy [F(2,477) = 15.48, p < .01], completeness [F(2,477) = 9.92, p < 0.01], and relevancy [F(2,477) = 15.36, p < .01]. There was, however, no statistically significant difference among the three applications for perceived timeliness F(2,477) = 1.10, p = 0.33. Post-hoc comparisons using Tukey’s test were then conducted (see Table 3) which uncovered the following:

- Accuracy. Participants felt that the information from Share was more accurate (M = 3.45) than from Collabo (M = 2.83) and Clash (M = 3.13). Furthermore, participants recognized a higher level of accuracy in Clash than in Collabo. Therefore, in order of perceived accuracy, Share ranked first, followed by Clash and Collabo.

<table>
<thead>
<tr>
<th>Effect</th>
<th>AUTO</th>
<th>COMP</th>
<th>RELA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE, F (1, 369)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUTO</td>
<td>CE</td>
<td>F</td>
<td>CE</td>
</tr>
<tr>
<td>E</td>
<td>−2.84</td>
<td>522.84</td>
<td>−1.90</td>
</tr>
<tr>
<td>A</td>
<td>−3.65</td>
<td>625.96</td>
<td>−3.16</td>
</tr>
<tr>
<td>O</td>
<td>−2.02</td>
<td>77.91</td>
<td>−1.44</td>
</tr>
</tbody>
</table>

*Note: CE = Contrast estimate.
  a. Test results are significant at p < 0.001.

**Table 2. Results of comparisons between low and high scores of personality and HCG type on motivations.**

![Figure 6. Influence of HCG type and personality on autonomy.](image-url)
• Completeness. Share (M = 3.36) was again perceived to generate more complete information than Collabo (M = 2.93) and Clash (M = 2.98). This time, there was no significant difference in ratings between Collabo and Clash.

• Relevancy. Similar to completeness, participants felt that the information from Share (M = 3.44) was more relevant than from Collabo (M = 2.80) and Clash (M = 3.12), suggesting that Share would be better at generating more relevant information for them. Like accuracy, the ratings between Collabo and Clash were statistically significant.

• Timeliness. There were no statistically significant differences between the pairwise comparisons among the three applications. Put differently, participants’ perception of the timeliness of information was comparable across Share, Collabo, and Clash.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type (1)</th>
<th>Type (2)</th>
<th>Mean Difference (1 - 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCU</td>
<td>Share</td>
<td>Collabo</td>
<td>0.62*</td>
</tr>
<tr>
<td></td>
<td>Share</td>
<td>Clash</td>
<td>0.32*</td>
</tr>
<tr>
<td></td>
<td>Collabo</td>
<td>Clash</td>
<td>-0.30*</td>
</tr>
<tr>
<td>COML</td>
<td>Share</td>
<td>Collabo</td>
<td>0.42*</td>
</tr>
<tr>
<td></td>
<td>Share</td>
<td>Clash</td>
<td>0.37*</td>
</tr>
<tr>
<td></td>
<td>Collabo</td>
<td>Clash</td>
<td>-0.04</td>
</tr>
<tr>
<td>RELV</td>
<td>Share</td>
<td>Collabo</td>
<td>0.63*</td>
</tr>
<tr>
<td></td>
<td>Share</td>
<td>Clash</td>
<td>0.31*</td>
</tr>
<tr>
<td></td>
<td>Collabo</td>
<td>Clash</td>
<td>-0.32*</td>
</tr>
<tr>
<td>TIML</td>
<td>Share</td>
<td>Collabo</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Share</td>
<td>Clash</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Collabo</td>
<td>Clash</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

Note. *p < 0.025. Type (1) and Type (2) refer to HCG being compared.

Table 3. Comparison between means of perceived output quality variables.

DISCUSSION
This study determines whether the interaction effect between personality trait and HCG type influences players’ motivations and whether perceived information quality differ across HCG types. In general, this study found the differential effects of personality and HCG type on participants’ perceptions. The findings are discussed in detail in the following subsections.

Influence of Personality and HCG Type on Motivations
With regard to the collaborative HCG, the mean values of the satisfaction of the need for autonomy, competence, and relatedness were significantly higher in participants who scored high on extraversion, agreeableness, and openness, compared to those who scored low on these traits. In contrast, low scores of such personality traits were found to experience a greater satisfaction of motivational needs in the competitive HCG. As enjoyment can be attributable to the satisfaction of these needs (Przybylski et al., 2010), these findings suggest that personality traits determine players’ enjoyment of HCGs with certain gameplay style.

First, the results indicate that extraverts experienced a higher degree of fulfillment of the need for autonomy, competence, and relatedness while generating computations in collaborative HCGs. This finding may be attributable to extraverts’ willingness to establish effective communication with others in social settings (Hughes et al., 2012). Here, the ability to use Collabo’s sharing information feature as a form of collaboration seemed to be a natural fit for extraverted participants, which in turn leads to a greater satisfaction of motivations. In particular, the challenge presented by Collabo, which requires players to form a group to rescue the starving pets, was able to facilitate a team-oriented environment favored by extraverts (van Meurs, 2007). However, given that introverted people are socially distant from others (Ryan & Xenos, 2011), it is not surprising that they were motivated to play the competitive HCG. Here, Clash provides a solo gameplay experience with an option to defeat pet owners. This feature of Clash was able to induce low-extraverted participants to feel more independent and competent, thereby increasing satisfaction with its gameplay style.

Second, the high scorers of agreeableness perceived the collaborative HCG in a more favorable light than the competitive HCG. One possible explanation is that due to their tendency of being kind and supportive (Jadin et al., 2013), agreeable participants succeeded in working together with other players in the collaborative HCG, which in turn gave rise to a higher level of satisfaction for motivational needs. Here, Collabo emphasizes collaboration among players by asking them to help each other in rescuing the pets and this game feature seemed to be a natural fit for those who are inherently empathic and cooperative (John et al., 2008). As expected, a lower level of agreeableness was associated with a greater tendency to be satisfied with competitive gameplay. As in other competitive games that require players to devise strategies that would allow them to outplay their opponents (Velez, Greitemeyer, Whitaker, Ewoldsen, & Bushman, 2014), Clash encourages players to think not only about how to defeat a current pet owner but also how to maintain the ownership status for as long as possible. Since lower scorers of agreeableness were less sympathetic and antagonistic (Tobin et al., 2000), the Clash gameplay seemed to be compatible with them, thereby increasing their satisfaction of motivational needs.

Finally, participants who scored high on openness perceived the collaborative HCG more favorably than those who scored low on this trait, demonstrated by a significantly higher level of satisfaction in need for autonomy, competence, and relatedness in Collabo than of Clash. This finding contradicts prior studies which found no relationship between openness and individuals’
preference for team-oriented cultures in task-oriented environments (e.g., Judge & Cable, 1997). Perhaps due to the entertainment-output generation duality of HCGs, participants who scored high on openness perceived the novelty of being entertained while working together with others for information creation as supported by the collaborative HCG. Such an experience may have prompted them to become more involved in the game, which in turn increased satisfaction.

In contrast, the competitive HCG evoked a higher level of satisfaction in low scorers of openness. This finding may be attributable to the individualistic nature of Clash play in which players are not required to dynamically team up with other players to progress in the game. This gameplay approach in Clash, therefore, favors participants who rated low on openness, in turn triggering a higher level of satisfaction in it. Taken together, these findings underlines how collaborative and competitive gameplay styles could be use to enhance the satisfaction of HCG players with different personality orientations.

### Influence of HCG Type on Information Quality

**Share** was perceived to offer higher levels of accuracy, completeness, and relevancy than both Collabo and Clash. Perhaps participants felt that being able to focus solely on information creation in the non-game variant resulted in higher information quality. In contrast, both HCGs required players to perform gaming activities, and such extra work could have been perceived to be deviating from information generation, leading to a lack of confidence in the quality aspect. Interestingly, timeliness was found to be similar across all three applications. Perhaps due to the assumption that online environments provide current information (Kim & Han, 2009), HCGs appeared to instill confidence that their information was as timely as that of the non-game application. Put differently, in the mobile context, content about current events would get noticed by other users easily which, in turn, increases the likelihood of receiving higher ratings. As such, participants may have contributed timely information regardless of the application type.

Our results showed that the information in Clash was perceived to be higher in accuracy and relevancy than that of Collabo. It is also possible that competition that drives players to strive for victory (Peng & Hsieh, 2012) conveyed an impression that more accurate and relevant information must be generated to outperform the rivals. Perhaps in Clash, participants were aware that they needed to continually improve their strength either to win or retain the pets, thereby generating more accurate and relevant information. Another possibility is the nature of the relationship among team members may have affected information quality in Collabo. For instance, players may perform better when playing with real or social media friends (Peng & Hsieh, 2012). The lack of features that allow participants to play with their friends in Collabo may have been a hindrance for them to be fully involved in the gameplay, influencing their perceived accuracy and relevancy negatively.

### CONCLUSION

This study provides several important implications for both research and practice. First, our results suggest that an appropriate fit between players’ personality and game genre could drive them to enjoy HCGs via the fulfillment of the need for autonomy, competence, and relatedness. This informs researchers of the potential effectiveness of a more nuanced interactionalist approach to HCG design to tailor the optimal gameplay experience to each individual.

Second, this work also offers design implications for HCGs and similar applications that are not just for pure entertainment. For instance, organizations that wish to make tedious or everyday tasks more engaging need to understand the personality of their target audiences so as to effectively leverage collaborative and competitive gameplay styles. More specifically, these findings imply that designers should create competitive HCG play to increase satisfaction of individuals scoring low on extraversion, agreeableness, and openness. Examples include direct, indirect, and social competition. In addition, collaborative HCG play styles are essential to promote satisfaction of players who rated high on such personality traits. Examples include group-based challenges and promotive interaction mechanisms whereby players support each other’s success by helping and praising each other.

Consequently, the automatic detection of players’ personality characteristics is essential. Designers and developers of HCGs should, therefore, consider less intrusive or implicit approaches for automatic detection of personality traits. Examples may include recognizing personality based on profile information, communication logs, and data collected via multimodal sensing interfaces (e.g., Chittaranjan, Blom, & Gatica-Perez, 2013). Here, privacy may be an issue of concern for players as they may not be aware that their personality is being assessed and captured. Accordingly, developers need to draw proper privacy guidelines for their games, as well as give players control over their privacy settings.

Third, the present findings suggest that the non-game application was perceived to yield better quality information than both HCGs. However, the latter was found to offer a higher level of enjoyment in prior studies which would, in turn, motivate individuals to continue playing them (Goh et al., 2011; Pe-Than et al., 2015). This informs researchers and designers in HCGs and similar contexts that a conundrum may exist—games could serve as a motivator to encourage participation though they might not always be effective in harnessing human intelligence for problem-solving. Thus, the perceived effectiveness of HCGs may be dependent on how one can effectively manage its
entertainment-output generation duality. To achieve this, designers should consider how to integrate quality control mechanisms into HCG play. Examples include employing paid specialists, automatic program, and other features used in applications with user-generated content such as ratings, review, and abuse reports.

Although this study yields meaningful findings, it is not without limitations that offer opportunities for future research. First, this study collected data only from the domain of location-based content sharing. The findings may not be generalizable to other human computation domains. Second, this study relied on basic, but commonly used, gameplay mechanics in HCGs. Future research may investigate the differential effects of a larger set of gameplay mechanics such as those used in adventure and simulation games. Finally, a wider range of motivational factors, beyond needs satisfaction and information quality may be considered since our findings imply that people are motivated to play HCGs for achievement and social interaction. Each of these warrants further exploration.

REFERENCES


