



# Playing Well with Virtual Classmates: Relating Avatar Design to Group Satisfaction

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## ABSTRACT

Virtual environments facilitate group collaboration through avatars. While many studies have examined the effects of avatar attributes on users' behaviors and attitudes, few have explicitly tested how elements of avatar design relate to group satisfaction. The present study fills this gap using data from a field study with student groups in a collaborative virtual environment. Customizing an avatar to express identity was found to relate to more satisfaction with group collaboration, while similarity between the avatar and user's gender traits was related to less group satisfaction. Further, groups with fewer active members reported higher group satisfaction. Unexpectedly, number of customizations and using a face-similar were not related to group satisfaction, potentially due to limitations in the present design for which future research can account. These findings suggest that avatar design elements play an important role in collaborative virtual environments.

## Author Keywords

Avatars; avatar body-connectedness; avatar identity-expressiveness; avatar gender-likeness; group collaboration; group satisfaction; collaborative virtual environments

## ACM Classification Keywords

K.3.1 Computer Uses in Education; K.4.3 Computer-supported collaborative work; H.5.1 Multimedia Information Systems

## General Terms

Human Factors

## INTRODUCTION

Virtual environments are being increasingly used as group collaboration tools. Such environments present excellent platforms for collaborative group processes because they

can bring people together from geographically and culturally diverse locations and facilitate the sharing and construction of knowledge within these groups [14, 10]. Such virtual group interactions are often mediated by customizable virtual self-representations (i.e., avatars), and the attributes of these avatars are likely to relate to such interactions, given that various elements of avatar use have been found to influence users' behaviors and attitudes in single-user contexts. For example, the extent to which an avatar resembles its user has been found to influence the users' eating [11] and exercise [12] behaviors, while avatar height and attractiveness have been found to influence negotiation acumen and social confidence, respectively [35].

The present paper extends this research into group contexts and focuses on the role of users' avatar design decisions and psychological connections to an avatar. Users design their avatars in a variety of ways according to the specific virtual environments in which the avatars exist [7]. Some virtual environments offer only a few choices of preset avatars, while others facilitate highly realistic avatars about which the user can make many design decisions. Some of the latter even allow users to paste digital pictures of their own faces onto the avatars' heads. However, individuals vary in the psychological connections they have to their avatars [26, 32], and so a given avatar design type will be experienced differently across individuals. The present paper extends the research on avatar design type and psychological connection to an avatar to the group collaboration context. Specifically, this study examines the relationship of these avatar-related attributes with one element of this group context: satisfaction with the collaboration process, which is an important factor in computer-supported group collaboration [2, 34, 23].

## AVATARS, GROUPS, AND CUSTOMIZATION

Just as avatar attributes influence user behaviors and attitudes in solitary or interpersonal contexts, they also influence group collaboration. For example, participants who were assigned to use an avatar with a black cloak reported lower group cohesion than those who were assigned to a white cloak avatar, presumably because the color black carries negative associations and thus primed participants with negative emotions [24]. Another series of

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studies has found that people who were assigned to use uniform avatars in a group context reported more group cohesion because they felt deindividuated and thus more similar to the other group members [17-19]. However, this line of research also suggests that the lack of uniqueness invoked by the uniform avatars leads group members to strive for individuality by disagreeing with group members about the task at hand. These studies suggest that avatar attributes assigned in an experimental context affect the ways that users interact in the group, but they do not provide insight into such effects in practice, where users often make choices about their avatar's attributes.

Such choices over avatar characteristics, even as simple as choosing one avatar from a small set, has been found to influence the avatar use experience [21]. One important distinction in the way that users make choices about, or customize, their avatars is the extent to which the avatar reflects an ideal self versus an actual self [15]. For example, Bessiere [3] found that online gamers with high depression or low self-esteem designed avatars that emphasized the ideal self, while online gamers with low depression or high self-esteem designed avatars that emphasized the actual self. Similarly, Dunn and Guadagno [8] found that people designed avatars that are consistent with male and female body ideals and that certain personality characteristics predicted numerous aspects of avatar design, such as attractiveness and skin tone variability. Further, Ducheneaut et al. [5] found that across multiple virtual contexts, hairstyle is one of the most important facets of avatar customization, though different styles of avatar presentation are associated with different demographics of avatar users. These studies suggest that avatar customization is an important factor of avatar use, but do not provide insight into how such customization may relate to the actual experience of using the avatar.

In an attempt target the intersection of these two lines of research – on group interactions related to avatar attributes and on avatar customization – the present research examines the relationship between avatar customization and group collaboration. Given that avatar attributes are related to group behaviors, and that avatar customization focuses on changing an avatar's attributes, then it follows that avatar customization may be related to avatar-based group collaboration. In order to examine whether this is the case, we pose the following question.

RQ1: Is the amount that an individual customizes an avatar for use in a virtual group associated with group satisfaction?

There is one specific type of customization that is becoming increasingly popular, due to the proliferation of digital cameras in computing devices, that has not received much attention in previous literature: putting one's own face onto the avatar. This type of customization leads to a high level of similarity between the avatar and the user's facial appearance, thereby allowing the users to project their "real" identity [29]. Previous research has found that avatar anthropomorphism, realism, and gender similarity

contribute positively to avatar homophily (the extent to which an avatar is rated as similar to or representative of the self), which in turn contributes positively to the desirability of using the given avatar in a virtual environment [13, 22]. Further, Shami et al. [28] found that participants preferred, as reflected by duration of use, avatars that were paired with a face picture (in comparison to no-picture avatars, no-avatar pictures, or neither avatar nor pictures), likely because the combination of an avatar with a face picture provided the most cues to identity and intentions. This suggests that such face-similar avatars would contribute positively to the avatar use experience. Further, using a face-similar avatar may be positively related to collaborations with group members because it may increase the feeling of having a persistent identity, which is a contributor to trust between group members in virtual environments [27]. However, in contrast to this argument, a face-similar avatar does not allow the user to selectively self-present, and thus the user may not feel as comfortable using this avatar in a social context [33], which could detract from satisfaction with group collaboration. The present research examines this question.

RQ2: Is the use of a face-similar avatar related to group satisfaction?

## PSYCHOLOGICAL CONNECTION TO AVATAR

Given the large range of customization options often provided in the avatar-design process, people psychologically connect to their avatars in different ways and to different extents [26, 31]. For example, people who have "chronic", close psychological connections to their avatars were found to incorporate their avatars' attributes in their self judgments (of body size) more than people with distant psychological connections to their avatars [4]. Thus, psychological connections to avatars may also be related to satisfaction with avatar-based group collaboration. The present study examines three types of psychological connections to avatars: avatar body-connectedness, avatar identity-expressiveness, and avatar gender-likeness.

### Body and Identity Avatar Connections

The notions of avatar body-connectedness and avatar identity-expressiveness presented here are derived from a one particular approach to understanding the concept of self-presence, which is broadly defined as the extent to which the self is "present" in an avatar [26]. Given that there have been numerous disparate explanations and operationalizations of self-presence, this study utilizes two of the three subfactors of self-presence offered by the aforementioned approach and then describes them using terminology that we believe more accurately reflects their essence. Specifically, avatar body-connectedness is based on the concept of body-level ("proto") self-presence, which is defined as the extent to which an avatar is integrated into body schema. In other words, an avatar user experiences some amount of an avatar body-connectedness when she feels as though the avatar is integrated with her body in a way that allows her to naturally interact with the virtual environment through the avatar, to some extent. Avatar

identity-expressiveness is based on the concept of identity-level (“extended”) self-presence, which is defined as the extent to which the avatar reflects the user’s personal identity outside of the virtual environment. In other words, the more an avatar user expresses elements of his personal identity (e.g., name, race, age) through the avatar, the more he should feel a sense of avatar identity-expressiveness. It is important to note that this is distinct from the concept of identification [5], which describes how people understand and empathize with media characters that have existing identities.

There has been some work comparing avatar customization to these two types of avatar connections. For example, participants who designed an avatar to resemble themselves reported more avatar identity-expressiveness than participants who were assigned to use a generic avatar, and those who designed an avatar of the same gender reported stronger avatar body-connectedness than participants who designed an opposite-gender avatar [25]. The former finding is straightforward: as participants customize an avatar to look like themselves, they imbue their own identity characteristics into the avatar and thus the avatar expresses the user’s identity more. The latter finding is potentially explained by the physical similarity between the avatar and the user, i.e., the more the avatar looks like the user, the more she feels a connection between the avatar and her body schema. This explanation is consistent with neuroscientific research findings that non-body parts are integrated into the user’s body schema more easily when those non-body parts resemble the actual body part in appearance or are oriented realistically [1, 9, 31]. In other words, people are generally more capable of embodying an avatar of a matched gender than an oppositely gendered avatar because of the physical similarities in body schema.

### Gender-based Avatar Connections

The other type of psychological connection to avatars examined here relates to the similarity between the avatar and the user’s gender. In addition to being treated as a binary identity attribute (i.e., male versus female), gender is also considered to be an element of personality that exists on sliding scale (i.e., from masculine to feminine) [6]. This understanding of gender as a continuous construct can apply to avatars as well as their users. Thus, avatar gender-likeness is defined as the extent to which the avatar’s gender is perceived as similar to the user’s own gender.

Previous studies have examined the similarity between users and avatars for other elements of personality (e.g., extroversion). Specifically, participants responded to versions of the Big Five personality inventory with respect to their own and their avatar’s personality [3, 7]. The researchers then took the difference between the personality measures for the individual and the avatar. Smaller differences indicated greater avatar personality similarity between the user and the avatar. In both studies, participants idealized their avatars’ personalities more than their own. Further, Duchenaut et al. [7] found that people with greater avatar personality similarity were more

satisfied with and attached to their avatar and also spent more time playing as their avatar.

The present study utilizes a similar approach to building a construct based on the similarity between two continuous trait-level characteristics, one regarding the avatar and the other regarding the user. However, this study focuses on gender instead of other personality constructs. Unlike these other constructs, gender is more clearly associated with customizable avatar characteristics (e.g., hairstyle, clothing color) and thus is easier to attribute to an avatar than psychological traits that are more vaguely apparent in the avatar’s customizable characteristics.

### Psychological Connections and Group Satisfaction

Just as amount or type of avatar customization may relate to group satisfaction, as explored through RQs 1 and 2, the types of psychological connection to avatars explored here may also relate to group satisfaction. On the one hand, having a closer psychological connection to an avatar may increase the comfort that the user has while using this avatar, which would put the user more at ease in group collaboration and thus may increase group satisfaction. Or alternatively, having a close psychological connection to the avatar may increase the extent to which the user feels as though she has a unique or persistent identity in the group, which, as described with respect to RQ2, may contribute to trust and thus satisfaction between group members. On the other hand, the closer psychological connection to the avatar may hinder the user’s ability to selectively self-present through the avatar and thus may detract from group communication. This potential relationship is explored through a research question.

RQ3: Is group satisfaction associated with any of the types of psychological connections to avatars (i.e., body-connectedness, identity-expressiveness, or gender-likeness)?

### METHOD

We conducted an uncontrolled field study within the context of a semester-long online course that included interactions between students through avatars in a virtual environment. While this method offered limited control over the participants’ experiences and the variables of interest, thereby limiting our ability to establish causal links, this type of natural setting provides a high level of ecological validity (e.g., students had real learning motivations), which is valuable given the increasing popularity of online teaching environments. Further, given the 10-week duration of the study, participants were able to develop a strength of interpersonal relationships with each other that is impossible in a single-session, controlled social interaction. Also, by using a diverse, intercultural selection of participants (details below), the study generalizes to a wider population. In summary, by sacrificing control over the variables, the present study provides higher levels of ecological and external validity.

### Participants and Procedure

Participants included 154 students (119 male, 35 female) between the ages of 19 and 42 ( $M = 23.53$ ,  $SD = 2.69$ , inner quartile range 22-24) who collaborated in 62 virtual teams of four to six members each throughout the 10-week Fall 2010 semester. The study was conducted in the context of a global lecture series called “The ShanghAI Lectures” (<http://shanghailectures.org>; see [20] for more details) on embodied – natural and artificial – intelligence. The lecture series by the Artificial Intelligence Lab of the University of Zurich (presented for the first time in Fall term 2009 from Shanghai Jiao Tong University) connects about 15 universities worldwide every year via videoconference. The students represented over 25 nationalities, with the top three being Chinese ( $N = 56$ ), Swiss ( $N = 26$ ), and German ( $N = 17$ ). Student teams were comprised of members from the same continent (i.e., either Asia or Europe), but most team members were unacquainted with each other prior to the course.

In addition to the traditional elements of the online class (e.g., viewing video-recorded lectures), students were required to participate in virtual discussion sessions every other week and, in between these meetings, to engage in group exercises in the virtual environment as well. The present study focuses on the group exercises, which included activities such as building a “cozy and unique” virtual team room in which the group could meet, assessing the artificial intelligence of a virtual robot, and examining sets of virtual self-assembling objects.

The virtual collaboration platform used in this course, “UNIworld” (screenshot in Figure 1), which was developed

based on the open-source toolkit “Open Wonderland” (version 0.5) (<http://openwonderland.org>). Open Wonderland offers public and private chat and “spatial audio” (i.e., automatic volume adjustment according to the distance between avatars). Further, students could perform a set of 14 basic postures and gestures through their avatars using keyboard commands and by clicking corresponding buttons. Collaborative work was supported by in-world application sharing tools, such as web browsers, video-players, PDF viewers, text editors, and whiteboards. It should be noted that teams could use additional media to schedule meetings and coordinate tasks.

Students were given the option to use a default avatar or a customized avatar using in-world tools. Further, they could put a picture of their own face on the avatar’s head (screenshot examples in Figure 2). Participants began with a cartoon-style default avatar and could customize gender, clothing accessories, and color of skin, hair, pants, shirt, and shoes. In comparison to other virtual world applications (e.g., Second Life), freedom to customize avatar appearance was limited in UNIworld. These customizations were categorical and did not allow for gradual changes. Face-pic avatars were created with a special website that facilitates the creation of photorealistic avatars (<http://evolver.com>). Students could upload a photograph of themselves, export the avatar file from evolver.com, and then import it into UNIworld and use it as any other Wonderland avatar (i.e., navigate, speak, and write).



Figure 1: Screenshot of the collaborative virtual environment.





Figure 2: Avatar options: default (left); customized example (center); personalized example (right).

Upon registration for the lectures, the students were requested to choose an avatar name and to fill in a profile page on the course website. The online registration form contained a description of the purpose of the research project, the kind of data to be collected, and privacy protection procedures. The students were also required to read and respond to an informed consent form. Participation in the research project was an optional part of the lectures, which had no bearing on their academic evaluation.

Participants responded to two surveys throughout the course of the project. The first, which was administered after the first group exercise, included questions about technology use habits and psychological personality traits of the participant. The second survey was administered after the final group exercise, about six weeks after the first survey. This included questions about self-presence and psychological personality traits of each participant's avatar. There were also numerous questions in both surveys not discussed presently. Students received extra credit points for completing the surveys, which led to a high response rate (83%).

### Measures

Avatar customization count, derived from logs of the participants' behavior in the virtual world, was simply the raw count of the number of times a change was made to any of the avatar's attributes.

Because the behavior logs did not record whether a participant used a face-similar avatar, the measure of such use was determined from the responses to the question "How often did you use a personalized avatar that you created on evolver.com based on your photograph?" Participants who responded with "occasionally" ( $N = 36$ ), "often" ( $N = 2$ ), or "always" ( $N = 3$ ) were classified as face-similar avatar users, where those who replied "never" ( $N = 113$ ) were not.

The measures of avatar body-connectedness and avatar identity-expressiveness were drawn from a previously validated questionnaire designed to measure the subfactors of self-presence [26]. Participants used a 5-point Likert scale, ranging from "not at all" to

"absolutely" to respond to the questions about their connections to their avatars. The items for each construct (see Figure 3) were averaged to form composite measures, with Cronbach's alphas of .91 for avatar body-connectedness and .83 for avatar identity-expressiveness.

Avatar gender-likeness similarity was measured in a similar method as in the aforementioned studies [7, 3]. Participants responded, on 5-point Likert scales ranging from "not at all" to "extremely", to 22 adjectives about gender traits ([6], see Figure 4) as they applied to themselves (first survey) as well as their avatars (second survey). The absolute value of the difference between these scores indicates the extent to which the avatar ratings differed from the self ratings. We performed this calculation for the masculine and feminine gender items separately, resulting in two separate measures. These scores were reverse coded so that larger values indicated greater similarity between the two related ratings.

#### Avatar Body-Connectedness

1. When using the virtual environment, how much do you feel your avatar is a part of your body?
2. When using your avatar, to what extent do you feel like your arm is elongated into the virtual environment through your avatar?
3. When using your avatar, to what extent do you feel like you can reach into the virtual environment through your avatar?
4. When using the virtual environment, how much do you feel like your avatar is an extension of your body within the game/virtual environment?
5. When using the virtual environment, to what extent do you feel like your hand is inside of the game/virtual environment?

#### Avatar Identity-Expressiveness

1. To what extent is your avatar's gender related to some aspect of your personal identity?
2. To what extent is your avatar's race related to some aspect of your personal identity?
3. To what extent is your avatar's clothing related to some aspect of your personal identity?
4. To what extent does your avatar's profile info represent some aspect of your personal identity?
5. To what extent does your avatar's name represent some aspect of your personal identity?
6. To what extent is your avatar's appearance related to some aspect of your personal identity?

Figure 3. Self-presence questionnaire items [26].

Group satisfaction was operationalized through a measure of satisfaction with the process of in-world collaboration tasks using Suh's [30] Performance Perception Questionnaire. Participants rated five semantic differentials with respect to the group collaboration process in response to the question "How would you describe the problem solving (or negotiation) process you and your team members used?" on a 7-point scale: efficient – inefficient, uncoordinated – coordinated, fair – unfair, understandable – confusing, dissatisfying – satisfying. Cronbach's alpha for this measure was .87.

Two measures of technology use habits, computer use time and video game frequency, were included as controls because of the potential effect that they may have on choice of avatar type and psychological connections to avatars. Specifically, people who are more comfortable with technology may be more willing to customize or personalize their avatar and may also feel a different type of connection to their avatars than people who are less comfortable with technology. Participants estimated the number of hours per week they spend on a computer and the frequency with which they play computer or video games on a 5-point scale ranging from "I do not play computer/video games" to "every day".

The extent to which students were actively engaged in the class varied, especially because some students were not taking the class for credit. Such variance in individual engagement (e.g., showing up for virtual group meetings) was likely to influence the experience for the students. For example, being on a team with only two active members would be more intimate than being on a team of four active members. In order to account for this variance at the group level, and given that only active team members were likely to complete the final survey, we included a count of such completions ("active member count") in our analysis.

|  |
|--|
| <b>Personality</b>   |
| (M) Competitive, daring, adventurous, aggressive                                   |
| (F) Affectionate, sympathetic, gentle, sensitive                                   |
| <b>Cognitive</b>   |
| (M) Good with numbers, analytical, good at problem solving, quantitatively skilled |
| (F) Imaginative, intuitive, artistic, creative                                     |
| <b>Physical</b>  |
| (M) Rugged, muscular, physically strong, burly                                     |
| (F) Cute, gorgeous, beautiful, pretty  |

Figure 4. Subconstructs and adjectives for gender measure [6]

|                                  | N   | M     | SD    | Min | Max |
|----------------------------------|-----|-------|-------|-----|-----|
| Group Process Satisfaction       | 154 | 4.85  | 1.21  | 1   | 7   |
| Customization Count              | 140 | 9.42  | 9.55  | 0   | 57  |
| Avatar Body-Connectedness        | 152 | 2.38  | 0.96  | 0   | 4   |
| Avatar Identity-Expressiveness   | 152 | 2.75  | 0.97  | 0   | 5   |
| Avatar Gender-Likeness_Masculine | 144 | 8.69  | 3.07  | 0   | 12  |
| Avatar Gender-Likeness_Feminine  | 144 | 8.70  | 3.18  | 0   | 12  |
| Computer Hours per Week          | 146 | 37.78 | 20.42 | 1   | 120 |
| Frequency Video Games            | 146 | 3.10  | 1.29  | 1   | 5   |
| Response Rate                    | 154 | 3.08  | 1.18  | 1   | 6   |

Table 1. Descriptive Statistics

The descriptive statistics for all measures can be found in Table 1. For the analysis, in order to account for variance in the distribution of this data, we mean centered all of the independent variables, except for the face-similar avatar use, which was calculated as a binary metric, as described above.

## RESULTS

Multilevel modeling was used to examine the effects on group satisfaction. This approach accounts for interdependence among the observations. Specifically, it controlled for team effects, given the potential for dependency among team members, when examining the relationship between an individual's customization or avatar connections with group satisfaction.

In order to determine the degree of within-group interdependence, we calculated the intraclass correlation coefficient (ICC). The intercept estimate was .54, and the residual was 1.03, and so the ICC was calculated to be .34. This suggests that 34% of the variance in group satisfaction is explained by the team structure, which confirms the importance of multilevel modeling.

The fixed factors of interest in this model included customization count, use of a face-similar avatar, avatar body-connectedness, avatar identity-expressiveness, and the two measures of avatar gender-likeness (masculine gender-likeness and feminine gender-likeness). Further, as fixed factor control variables, we included computer hours per week and frequency playing of video games. Active member count for each group was included as a random factor because of the potential influence on group satisfaction.

The results of this analysis (Table 2, Fixed Effects) indicate no difference in group satisfaction related to customization (RQ1) or using a face-similar avatar (RQ2). However, group satisfaction was positively related to avatar identity-expressiveness and negatively related to the masculine avatar gender-likeness measure (RQ3).

| Fixed Effects                       |          |            |         |          |        |
|-------------------------------------|----------|------------|---------|----------|--------|
|                                     | Estimate | Std. Error | df      | t        | p      |
| Intercept                           | 4.87     | 0.12       | 39.63   | 42.10    | 0.00   |
| Customization Count                 | 0.01     | 0.01       | 115.33  | 1.38     | 0.17   |
| Face Similar Avatar                 | -0.14    | 0.25       | 130.96  | -0.56    | 0.58   |
| Avatar Body-Connectedness           | -0.10    | 0.13       | 120.65  | -0.76    | 0.45   |
| Avatar Identity-Expressiveness      | 0.25     | 0.12       | 119.59  | 2.14     | 0.03 * |
| Avatar Gender-Likeness_Masculine    | -0.16    | 0.07       | 121.19  | -2.26    | 0.03 * |
| Avatar Gender-Likeness_Feminine     | 0.06     | 0.06       | 122.57  | 0.93     | 0.36   |
| Computer Hours per Week             | 0.00     | 0.00       | 124.86  | -0.82    | 0.41   |
| Frequency Video Games               | 0.00     | 0.07       | 126.86  | 0.04     | 0.97   |
| Random Effects                      |          |            |         |          |        |
|                                     | Estimate | Std. Error | Wald Z  | p        |        |
| Residual                            | 0.83     | 0.13       | 6.55    | 0.00     |        |
| Intercept                           | 0.08     | 0.17       | 0.49    | 0.63     |        |
| Active member count (AMC)           | 0.377162 | 0.207808   | 1.81495 | 0.0695 † |        |
| Intercept-AMC correlation           | -0.18    | 0.09       | -1.93   | 0.05 †   |        |
| Note: †p < .10, *p < .05, **p < .01 |          |            |         |          |        |

Table 2. Multilevel model on group satisfaction

We also found an unexpected negative relationship between active member count and group satisfaction, as indicated by the negative correlation between the random effects intercept and the active member count ( $p = .05$ ). This suggests higher group satisfaction for smaller groups.

## DISCUSSION

Building on research about the effects of avatar use on behaviors and attitudes, the present study examines how avatar design and psychological connections to avatars relate to group satisfaction (i.e., satisfaction with the group collaboration process). Data collected from a virtual world-based lecture series in which students collaborated on small group projects suggest that psychological connection to the avatar as measured by avatar identity-expressiveness was associated with more group satisfaction, while psychological connection to the avatar as measured by masculine avatar gender-likeness was associated with less group satisfaction. The opposing direction of these relationships is interesting and suggests that psychological connections to an avatar do not relate to avatar-based group collaboration in uniform ways. The unexpected finding that groups with smaller active member counts were associated with more group satisfaction suggests that collaborative virtual environments may be inefficient for larger groups, perhaps due to limitations in the channels used for communication. Our expectations of a relationship of group satisfaction with avatar customization and with using a face-similar avatar were not supported, but we believe this was due to specific aspects of the present study and thus that differently designed research may discover such relationships in the future. Below, we examine the implications of the specific findings and non-findings as well as considerations for design of collaborative virtual environments platforms.

The positive relationship between avatar identity-expressiveness and group satisfaction may suggest that customizing an avatar to express identity may increase the comfort with using with that avatar within the group

setting. Or alternatively, using an avatar that closely reflects an individual's offline identity may increase the user's feeling of accountability to others, which is consistent with other research on trust between group members in virtual environments [27]. However, such causal interpretations should be treated cautiously because it is also possible that elements of the group interactions influenced the extent to which the user customized the avatar as expressive of identity, or that a third variable affected both. In either direction, as cause or effect, this finding still highlights the importance of being able to express personal identity through an avatar within the group collaboration process. But if the causal link from avatar identity-expressiveness to group satisfaction were accepted, this would suggest that collaborative virtual environments could improve group satisfaction by allowing (or encouraging) users to imbue aspects of their offline identity into their avatars.

The negative relationship between masculine avatar gender-likeness and group satisfaction does not lend itself to a clear interpretation. It is possible that having a close psychological connection to the avatar's gender hinders the user's ability to selectively self-present through the avatar and thus constrains group communication. However, this does not seem likely, given that a similar relationship was not found for the feminine avatar gender-likeness measure. Another explanation, which is more consistent with research on gender differences in gaming [15], is that masculine avatars tend to be used for more competitive and less social activities. Given that people sometimes conform to their behavioral expectations regarding their avatar's identity [35], it may be that masculine participants who customized masculine avatars conformed to the expectation that masculine avatars are unfriendly. However, as with the previous finding, such a causal explanation should be treated with caution. It is also possible that negative elements of the group interactions encouraged participants to customize their avatars to be consistent with their own masculine gender, or that a third variable influenced both masculine customization and group satisfaction in the same direction. Another important consideration is the gender skew of the sample (77% male). If there had been more female participants, perhaps the relationship feminine avatar gender-likeness and group satisfaction would have been significant, possibly in the opposite direction, or would have cancelled out the relationship between masculine avatar gender-likeness and group satisfaction. In any case, the present finding still suggests that avatar gender plays a meaningful role in the experience of avatar use and may be related to the outcomes of such use. If the causal link from masculine avatar gender-likeness to group satisfaction were accepted, this would suggest that collaborative virtual environments could improve group satisfaction by not providing avatar customization options that are strongly masculine or otherwise anti-social.

The finding that group satisfaction was higher for groups with smaller active member counts, though unexpected, provides interesting implications. Namely, it suggests that the quality of communication in collaborative virtual environments decreases as the number of communicators increases. This is consistent with a media richness theory argument – that as the number of channels decreases, the quality of communication decreases – though this theory has not received consistent support [30]. The communication channels provided by the collaborative virtual environment (e.g., text chat) may privilege communication between smaller groups, for example, by not providing clear cues to help users distinguish who is communicating to whom. An alternative explanation in the opposite causal direction is that strongly positive communication between a small number of group members alienated the other group members, resulting in those members withdrawing from the group or continuing on but being displeased with the group. This would have led the average group satisfaction to be high for those groups in which the alienated members departed, and low for those groups in which the displeased members stayed on. While such dynamics were not the focus of the present study, they are interesting to note and future research may be better equipped to examine them directly. And regardless of the directionality, one potential implication for the design of collaborative virtual environments is that the communication channels should be examined for groups of varying sizes.

The lack of a significant relationship between group satisfaction and avatar customization and may suggest that the amount of customization alone does not play a role in the way the avatar is used in a group setting. Similarly, using a face-similar avatar compared to a typical avatar may not relate to differences in the uses of the avatar. However, such claims cannot be supported by the present null findings. Further, the present design was an uncontrolled field study and so there were many potential aspects of the participants' experience that may have detracted from this relationship. Most notably, the groups were not required to communicate only in the virtual environment. Some groups used external communication tools (e.g., Skype, email) to coordinate their group activities. It is possible that such communication influenced group satisfaction and thus added noise to the data. Alternatively, the customization options provided in the environment may have seemed unnatural, while face-similar avatar use may have seemed too intrusive or time consuming for some users. Future research could tease out these limitations by utilizing a controlled experimental design. Specifically, by assigning participants to customize their avatars at differing amounts of input and face-similarity, such research may discover a relationship between these conditions and elements of group collaboration that results from using these avatars.

This relates to another limitation of this study that would have been notable if avatar customization had been found significantly related to group satisfaction. Namely, although the avatar customization measure came from a log-based count taken throughout the course of the study, well before these self-report variables were measured, it would still have been possible for variables unaccounted for in this analysis to have influenced both the amount of customization as well as the self-report variables. For example, an individual's choice to engage in more avatar customization may be caused by a specific personality trait, such as extroversion, and this trait may also contribute to more positive group collaboration. Similarly, students who were more excited about the class may have put more energy into customizing their avatars as well as engaged more in the group collaboration, thereby increasing their satisfaction. Thus, a relationship between avatar customization and group satisfaction would have been potentially spurious and instead the result of a third variable that was unaccounted for in the dataset. Future research could address this through a controlled experimental design. One approach would be to compare three conditions of avatar design: undirected customization, forced high customization, and forced low customization.

In general, this uncontrolled field study was unable to make strong claims of causation in the observed relationships because of the limitations of using cross-sectional data (e.g., questionnaire response habits). Another limitation relates to context in which the participants interacted. Specifically, given that it was an AI course, it attracted technologically-oriented students who had a fair amount of gaming experience. On the positive side, this context is generalizable to other online courses that focus on technology-related content. On the negative side, this means that generalizability is limited for virtual collaborative work that occurs outside of a learning environment, for online courses that focus on non-technology topics, and for virtual collaborations between people who are less adept at or interested in using technology.

While recognizing these limitations, the present approach allowed for the examination of avatar design in a natural setting, thereby providing a higher level of ecological and external validity than usually offered by most controlled experiments. The findings suggest that avatar design matters in the implementation of real collaborative virtual environments and that the users' psychological experience with their avatars play an important role in the outcomes of such use.

## CONCLUSION

Overall, this research offers a novel examination of how avatar customization and psychological connection to avatars relate to group satisfaction in virtual environments. As part of the growing body of research



on how avatar attributes influence their users, this study contributes to the understanding of the phenomena of avatar use as well as to some simple principles for the implementation of avatar design systems in collaborative virtual environments.

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## REFERENCES

1. Armel, K. and Ramachandran, V. Projecting sensations to external objects: Evidence from skin conductance response. *Proc. of the Royal Society B: Biological Sciences*, 270 (2003), 1499-1506.
2. Baltes, B. B., Dickson, M. W., Sherman, M. P., Bauer, C. C. and LaGanke, J. S. Computer-mediated communication and group decision making: A meta-analysis. *Organizational Behavior and Human Decision Processes* 87, 1 (2002), 156-179.
3. Bessiere, K., Seay, A. and Kiesler, S. The ideal elf: Identity exploration in World of Warcraft. *CyberPsychology & Behavior* 10, 2 (2007), 530-535.
4. Chandler, J., Konrath, S. and Schwarz, N. Online and on my mind: Temporary and chronic accessibility moderate the influence of media figures. *Media Psychology* 12, 2 (2009), 210-226.
5. Cohen, J. Defining identification: A theoretical look at the identification of audiences with media characters. *Mass Communication and Society* 4, 3 (2001), 245-264.
6. Diekmann, A. B. and Eagly, A. H. Stereotypes as dynamic constructs: Women and men of the past, present, and future. *Personality and Social Psychology Bulletin*, 26 (2000), 1171-1188.
7. Ducheneaut, N., Wen, M. H., Yee, N. and Wadley, G. Body and mind: a study of avatar personalization in three virtual worlds. *Proc. of the 27th International Conf. on Human Factors in Computing Systems*. 1151-1160 (2009). ACM.
8. Dunn, R. A. and Guadagno, R. E. My avatar and me - Gender and personality predictors of avatar-self discrepancy. *Computers in Human Behavior* 28, 1 (2012), 97-106. doi: 10.1016/j.chb.2011.08.015
9. Ehrsson, H., Spence, C. and Passingham, R. That's my hand! Activity in premotor cortex reflects feeling of ownership of a limb. *Science* 305, 5685 (2004), 875-877.
10. Erickson, T., Shami, N. S., Kellogg, W. A. and Levine, D. Synchronous Interaction Among Hundreds: An Evaluation of a Conference in an Avatar-based Virtual Environment. *Proc. CHI 2011*, ACM Press (2011), 503-512.
11. Fox, J., Bailenson, J. and Binney, J. Virtual experiences, physical behaviors: The effect of presence on imitation of an eating avatar. *Presence: Teleoperators and Virtual Environments* 18, 4 (2009), 294-303.
12. Fox, J. and Bailenson, J. Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors. *Media Psychology* 12, 1 (2009), 1-25.
13. Hamilton, M. A. and Nowak, K. L. Advancing a Model of Avatar Evaluation and Selection. *PsychNology Journal* 8, 1 (2010), 33-65.
14. Hasler, B. S. Intercultural collaborative learning in virtual worlds. In R. Hinrichs & C. Wankel (Eds.), *Transforming virtual world learning. Cutting-edge technologies in higher education* (Vol. 4, pp. 271-310) (2011). Bingley, UK: Emerald Publishing.
15. Huh, S. and Williams, D. Dude looks like a lady: Gender swapping in an online game. *Online worlds: Convergence of the real and the virtual*. Springer London (2010), 161-174.
16. Jin, S. A. Avatars mirroring the actual self versus projecting the ideal self: The effects of self-priming on interactivity and immersion in an exergame, Wii Fit. *CyberPsychology & Behavior* 12, 6 (2009), 761-765.
17. Kim, J. Balancing uniqueness and assimilation in computer-mediated groups. *Computers in Human Behavior* 26, 4 (2010), 778-784.
18. Kim, J. and Park, H. S. The effect of uniform virtual appearance on conformity intention: Social identity model of deindividuation effects and optimal distinctiveness theory. *Computers in Human Behavior* 27, 3 (2011), 1223-1230.
19. Kim, J. Two routes leading to conformity intention in computer-mediated groups: Matching versus mismatching virtual representations. *Journal of Computer-Mediated Communication* 16, 2 (2011), 271-287.
20. Labhart, N., Hasler, B. S., Zbinden, A. and Schmeil, A. The Shanghai Lectures: A global education project on artificial intelligence. *Journal of Universal Computer Science*, 18 (2013), 2542-2555.
21. Lim, S. and Reeves, B. Being in the game: Effects of avatar choice and point of view on psychophysiological responses during play. *Media Psychology* 12, 4 (2009), 348-370.
22. Nowak, K., Hamilton, M. and Hammond, C. The effect of image features on judgments of homophily, credibility, and intention to use as avatars in future interactions. *Media Psychology* 12, 1 (2009), 50-76.
23. Olaniran, B. A. A model of group satisfaction in computer-mediated communication and face-to-face meetings. *Behaviour & Information Technology* 15, 1 (1996), 24-36.

24. Pena, J., Hancock, J. and Merola, N. The priming effects of avatars in virtual settings. *Communication Research* 36, 6 (2009), 1-19.
25. Ratan, R. A. *Self-Presence: Body, emotion, and identity extension into the virtual self*. Unpublished doctoral dissertation (2011). University of Southern California.
26. Ratan, R. A. Self-presence, explicated: Body, emotion, and identity extension into the virtual self. In R. Luppigini (Ed.), *Handbook of Research on Technoself* (2012). New York, NY: IGI Global.
27. Ratan, R., Chung, J., Shen, C., Williams, D. and Poole, M. Schmoozing and Smiting: Trust, social institutions and communication patterns in an MMOG. *Journal of Computer-Mediated Communication*, 16(1), (2010), 93-114.
28. Shami, N. S., Cheng, L.-T., Rohall, S., Sempere, A. and Patterson, J. Avatars Meet Meetings: Design Issues in Integrating Avatars in Distributed Corporate Meetings. *Proc. GROUP 2010*, ACM Press (2010), 35-44.
29. Shami, N. S., Erickson, T. and Kellogg, W. Common Ground and small group interaction in large virtual world gatherings. *Proc. ECSCW 2011*. Springer London (2011), 393-404.
30. Suh, K. S. Impact of communication medium on task performance and satisfaction: an examination of media-richness theory. *Information & Management* 35, 5 (1999), 295-312.
31. Tsakiris, M. and Haggard, P. The rubber hand illusion revisited: Visuotactile integration and self-attribution. *Journal of Experimental Psychology-Human Perception and Performance* 31, 1 (2005), 80-91.
32. Van Looy, J., Courtois, C., De Vocht, M. and De Marez, L. Player identification in online games: validation of a scale for measuring identification in MMOGs. *Media Psychology* 15, 2 (2012), 197-221.
33. Walther, J. B. Selective self-presentation in computer-mediated communication: Hyperpersonal dimensions of technology, language, and cognition. *Computers in Human Behavior* 23, 5 (2007), 2538-2557.
34. Walther, J. B. and Bazarova N.N. Validation and application of electronic propinquity theory to computer-mediated communication in groups. *Communication Research* 35, 5 (2008): 622-645.
35. Yee, N., Bailenson, J. N. and Ducheneaut, N. The Proteus effect: Implications of transformed digital self-representation on online and offline behavior. *Communication Research* 36, 2 (2009), 285-312.