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Mitigating Impacts of Appearance-Based Social Cues to Facilitate Balanced Participation in Virtual Environments Across Age and Gender

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ABSTRACT

As the importance of innovation increases, generating innovative ideas through the balanced participation of individuals from diverse backgrounds has become a challenge for organizations. However, groups composed of members with diverse backgrounds can be susceptible to the effects of social categorization based on social cues, which can lead to the suppression of balanced participation. Previous CMC studies suggest that avatar-mediated communication could be a promising approach to mitigate these effects. Still, this has not been fully explored. We experimented with 16 groups of four people of different ages and genders in this study. We divided them into two conditions: (1) avatars with social cues of appearance, in which group members' social cues of appearance are maintained, and (2) avatars without social cues of appearance, in which group members' social cues of appearance are removed. The results showed that, unlike the avatars with social cues of appearance, avatars without social cues of appearance improved both objective balance of participation and subjective balance of social influence.

Keywords: CSCW, Group Discussion, Avatar, CMC, VR

Index Terms: Human-centered computing → Empirical studies in collaborative and social computing

1 INTRODUCTION

As remote work becomes the new normal, it is now normal for organizational communication to transpire both in face-to-face and online contexts. Regardless of the shifting dynamics of these communication modalities, the consistent requirement across corporations, non-profit organizations, and community groups is the generation of innovative ideas [1]. Balanced representation of opinions from individuals with diverse backgrounds (henceforth, balanced participation) has been found to be effective for the generation of innovative ideas [2-6]. While much of the prior research has focused on supporting balanced participation with computer-supported facilitation in face-to-face environments [7-10], the online environment has been insufficiently explored.

One potential impediment to balanced participation is the cognitive influence of social norms and stereotypes driven by social categorization [11]. Generally, individuals formulate social categories based on social cues [12] from their interlocutor's appearance (skin color, clothing, hair, etc.), which subsequently impacts their communication [13]. This effect is especially pronounced in teams consisting of members from diverse backgrounds, as the complexity of within-group categories increases. This work seeks to explore whether it is possible to promote more balanced participation if the aforementioned influencing factors are removed.

Bordia [14] analyzed comparing face-to-face communication with computer-mediated communication (CMC), such as text and audio mediums, and found that balance of participation is promoted in CMC without most social cues including appearance. They also pointed out that groups working with CMC displayed uninhibited behavior resulting from an induced state of deindividuation. Therefore, reducing the social cues of group members can promote a balance of participation, but removing all of the social cues of the conversation partner does not lead to smooth communication. In contrast to this communication via text, communication via avatars in virtual environments can easily manipulate the number of social cues [15]. Thus, it is considered a promising approach to mitigate the effects of social categorization [16-17]. For example, similarity in group members' avatars promotes positive impressions of group members, which increases performance [18-19], and self-avatar dissimilarity promotes self-disclosure [15].

Based on the background and previous research presented above, this study aimed to examine the effect of appearance-based social cues of avatars on balanced participation. We compared two avatars with different social cues, using both objective and subjective measures. In this study, two different types of avatars were used in a group discussion: (1) avatars with social cues of appearance, in which group members' social cues of appearance are maintained, and (2) avatars without social cues of appearance, in which group members' social cues of appearance are removed (Figure 1). The group discussion context in this study is the more realistic, online (virtual space) discussion context between colleagues who have communicated face-to-face, as described in the introduction. To simulate this context, in both avatar conditions, an icebreaker session in real space preceded the discussion session in virtual space.

Figure 1: Avatars with social cues of appearance (left), and avatars without social cues of appearance (right).

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2 METHODS

2.1 Study Design

The study employed a 1 × 2 design in which the factor, the avatar appearance, was either (1) avatars with social cues of appearance (SC avatar), in which group members' social cues of appearance are maintained, or (2) avatars without social cues of appearance (no_SC avatar), in which group members' social cues of appearance are removed (Figure 1). We employed a between-subjects design in which each group of four people had group discussions using one of the avatar appearances mentioned above.

2.2 Tasks

The tasks of this study consisted of three sessions. A face-to-face icebreaker session aimed to ease tension and form impressions based on each member's social categories. Two group discussion sessions were conducted in the VR space.

2.2.1 Face-to-face Icebreaker session

Group members listed things that are common among group members within 2 min. Then, the group was asked to choose their favorite common thing in 30 s, which was used as the group name.

2.2.2 Group discussion session 1

The ideation task in group discussion session 1 was called the unusual uses task (UUT). This commonly used creativity task requires participants to generate ideas for unusual uses of a particular item. In this study, participants were asked to create many ideas for unusual uses of a specific item [20]. In this study, participants were instructed to create as many ideas for unusual uses of wire hangers as possible in 5 min in a group. After the UUT, the decision-making task continued. Participants were asked to rank and agree on the first to the third-best idea in 5 min.

2.2.3 Group discussion session 2

In the ideation task of the group discussion session 2, we set the theme of "Think of as many concrete actions and improvement ideas as possible that you can put into practice tomorrow to lead a good life in the stressful environment of the Corona disaster" because there were few differences in the knowledge of each participant and ideas can be easily generated. The participants were given 1 min to think individually before the discussion and 10 min to generate ideas with group members.

At the end of the 10 min of idea creation, an in-session questionnaire asked for the top three ideas that each participant thought were good at the time of idea creation; the other participants could not hear them.

In the decision-making task, the group was instructed to discuss and decide on the first three ranked ideas created in the ideation task. The discussion time for the decision-making task was set at a maximum of 10 min. The group was instructed that if they reached a consensus sooner than 10 min, they could end the discussion at that point. Finally, the participants were asked to avoid easy compromises when ranking ideas in order of priority and to discuss the ideas reported in the in-session questionnaire so they would be selected as much as possible.

2.3 Participants

A total of 64 participants were recruited from the public. The criteria for participants were: (1) age between 20–58 years, (2) ability to speak Japanese, and (3) naked or corrected visual acuity ≥ 1.0. The participants were divided into 16 groups. Each group consisted of four members of different genders and ages (Figure 2). The members did not know each other. The 16 groups were divided into 8 groups per condition (Table 1).

The study took approximately 2 h, and each participant was paid 6000 yen (55 USD). The study was approved by the Research Ethics Review Committee of Tokyo City University (Approval No. 2020-h01).

Table 1: Basic attributes of participants

	SC avatar	no_SC avatar
N	32	32
N of groups	8	8
Age, mean (SD)	40.8 (12.8)	35.8 (11.9)
Age, N		
20s–30s	16	16
40s–50s	16	16
Gender, N		
Male	16	16
Female	16	16

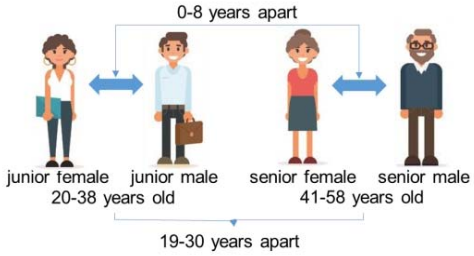

Figure 2: Four group members of different genders and ages

2.4 Experimental Environment

This section describes the environment where each task was performed and the data collected.

Face-to-face environment (icebreaker session): We prepared a face-to-face environment for the icebreaker session so the participants could get to know each other before starting the task in the VR space. The face-to-face environment consisted of desks and chairs for four people. The desks were separated from each other by acrylic panels to prevent infection.

VR environment (group discussion sessions 1 and 2): The study in the VR space was conducted in a soundproof room. The participants sat in chairs in their respective soundproof rooms which were physically separated and had group discussions

Participants wore an Oculus Quest HMD. The movements of the avatars' heads, upper bodies, arms, and fingers were linked to the movements of participants using the 6DoF tracking and hand-tracking functions of Oculus Quest. The avatar's mouths moved along with the participants' speech using the lip-sync function of Oculus. We implemented the VR system on Unity, based on TIS's VirtualCollaboBase [21].

For the experimental environment in the VR space, we constructed a simple room with the same size of desk and chairs as in the face-to-face experimental environment as much as possible. The participant avatars were seated in the same arrangement as in the face-to-face environment.

2.4.1 SC avatar condition

Avatar heads, including their faces, were generated using Avatar SDK [22] from the participants' photos. Avatar bodies were generated using Autodesk's character generator [23]. The avatar's clothes were the same for all the participants. The head and body of the avatar were combined using Blender [24]. The height of the avatars was unified to be 165 cm in the VR space.

2.4.2 No_SC avatar condition

All the variables in this condition were the same as in the previous one, except for the avatar's appearance. Here, the avatar's appearance was the same for all participants. The appearance was designed to be simple and not reflect any specific age, gender, or other personal attributes of the participants. The avatars were generated using Pixiv's VRoid Studio [25].

2.5 Procedure

The procedure of the study is shown in Figure 3. The participants were individually briefed about this study in a soundproof room before the start of the experiment. The icebreaker session was held in a face-to-face environment to find common interests and choose a group name. We conducted a questionnaire after the icebreaker session and participants watched a tutorial video of HMD. Participants then met the other group members in the VR space. They had two group discussion sessions, with a 5 min break between the two group discussion sessions, during which one questionnaire was completed. Post-experimental questionnaires were obtained after all group discussion sessions, and a 10 min semi-structured interview was conducted after the questionnaires were completed. system.

3 Measures

We collected behavioral and psychological data to address our research questions and employed the following measures.

3.1 Coding with the Discussion Coding System

To analyze the group discussion quantitatively and qualitatively, we used the discussion coding system (DCS) [26] to code the group discussion videos. DCS codes the interaction for analysis into content (speaker, partner, content of statement, action-by-action), post-action response (agreement, rejection), the functions of a statement (main categories: socio-emotional, content, regulation, subcategories: questions, proposals), and relational influence on friendly–hostile and dominant–submissive scales.

Four hired coders were trained to use the DCS for this coding process. They shared the task of transcribing the 320 min of video recordings to be analyzed and coded the statements.

3.2 Objective Balance of Participation

3.2.1 Balance of participation

The balance of participation was calculated based on the number of spoken words. The number of spoken words was calculated by morphological analysis of the statement content of each participant transcribed during the coding of the DCS using Mecab [27], a Japanese morphological analysis tool, and the number of morphemes was counted.

Then, to measure the balance of participation in group discussions, the balance of participation based on the number of spoken words was calculated for each ideation task and decision-making task in group discussion session 2 according to previous research [8-9]. The index of the balance employed in this study is a variant of the Gini coefficient [28]. A Gini coefficient of 0 indicates a perfect balance, and inequality increases when the value approaches 1. In this study, we define the index of the balance with a value of 1 minus the Gini coefficient.

3.2.2 Turn-keeping

The number of turn-keeping instances was employed as an index to measure the balance of conversational turns. For the index of turn-keeping, the number of consecutive actions of the same speaker in each group was counted from the DCS coding data. As the task time for each group differed, the number of turn-keeping instances was totaled for each group and then divided by the task time (minutes).

3.3 Subjective Balance of Participation

3.3.1 Balance of social influence

A questionnaire about the influence of the members was used to measure the balance of social influence of each group member as perceived by the participants. The questionnaires were collected three times: after the icebreaker, after the group discussion session 1, and after the group discussion session 2.

The questionnaire asked participants to rate the influence of the four participants, including themselves, on a scale of -3 to 3, with the sum of the four participants' values equal to zero. The mean value for each participant in the group was calculated based on each participant's rating. It was then used as the value of each participant's influence in the group. This value was calculated for each of the three times it was collected. We calculated the index of the balance of social influence in each group based on the value of the influence of each participant. The calculation procedure is the same as for the balance of participation.

4 Results

The analysis results for each measure are shown in Figure 4–Figure 5. Error bars in the graphs in each figure represent the standard errors of the mean. Asterisks in each figure and table represent significance levels (*: $p < 0.05$, **: $p < 0.01$)

4.1 Objective Balance of Participation

4.1.1 Balance of participation

The results of the analysis showed that the scores in the no_SC avatar condition were significantly higher than those in the SC avatar condition in both the ideation and decision-making tasks in terms of the balance of participation in the number of spoken words (Figure 4).

4.1.2 Turn-keeping

The analysis showed that the SC avatar condition had significantly more turn-keeping than the no_SC avatar condition

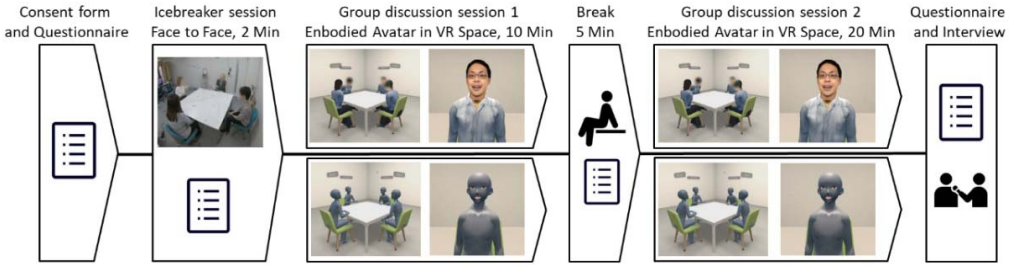

Figure 3: The procedure of the study

in both ideation and decision-making tasks (Figure 4).

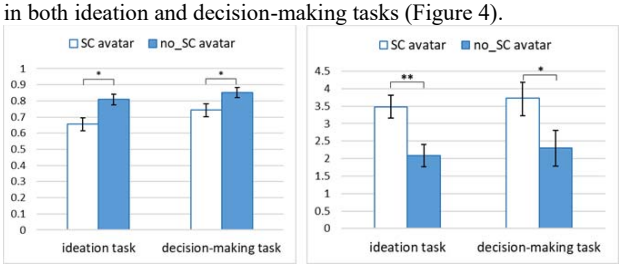

Figure 4: Balance of participation in the number of spoken words (left) and Number of turn-keeping(right)

4.2 Subjective Balance of Participation

4.2.1 Balance of social influence

The analysis results for the index of the balance of social influence showed that there was no significant difference between the questionnaires obtained after the icebreaker and after group discussion session 1 (Figure 5). Analysis of the questionnaire obtained after group discussion session 2 showed that the balance of the social influence index for the no_SC avatar condition was significantly higher than that for the SC avatar condition.

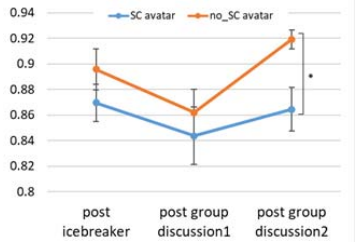

Figure 5: The score of the balance of social influence

5 Discussion

5.1 Objective Balance of Participation

The balance of participation based on the number of spoken words was significantly more even in the no_SC avatar condition than in the SC avatar condition, and the SC avatar condition had a significantly higher value of turn-keeping than the no_SC avatar condition. The balance of participation in the no_SC avatar condition was better than that in the SC avatar condition in the ideation and the decision-making tasks of the group discussion session 2, indicating that the effect of the no_SC avatar was effective in the different tasks of ideation and decision-making. In the same way, the turn-keeping results were significantly higher for the SC avatars in both the ideation and decision-making tasks, suggesting that the speaker with the strongest power continues to provide the topic. This may be one of the reasons why the SC avatar condition had a worse measure of participation balance than the no_SC avatar condition.

5.2 Subjective Balance of Participation

In the questionnaire after group discussion session 2, when the participants had become familiar with the task and the group, the perceived social influence from group members in the no_SC avatar condition was significantly more balanced than that in the SC avatar condition. The questionnaire responses obtained after the face-to-face icebreaking session and after the group discussion session 1 conducted in the VR space did not show any significant difference. The balance of social influence decreased in both conditions after the group discussion session 1. However, the balance of social influence in the questionnaire after group discussion session 2 for the no_SC avatar condition was the highest in the experiment. This result suggests that despite knowing the other participants from the face-to-face environment, continuing to communicate using no_SC avatars can decrease social influence perception.

To gain a deeper understanding of the results of the balance of participation, we discuss the results of the post-experimental interviews in which participants were asked about their attitudes toward participating in group discussions. Participants who answered that they were able to speak more actively than usual were 8 participants with SC avatar and 12 participants with no_SC avatar. By contrast, participants who answered that they were more passive than usual were 11 participants with an SC avatar and 6 participants with a no_SC avatar. These results indicate that subjectively, more participants in the no_SC avatar condition were able to participate in group discussions actively. In comparison, more participants in the SC avatar were suppressed in their participation.

There were several comments in the no_SC avatar condition that the avatar appearance flattened the members' perception of their influences. "I think it might be better to have a flat, alien-like avatar like this one because if the avatar's face were real, it would give rise to the preconceived notions of what people with this kind of face are supposed to look like..." (P8, senior, male) and, "I thought it would be nice to be able to choose an avatar, but on the other hand, I could talk without worrying about my age, so I didn't feel any generation difference." (P63, senior, female). The participants with the no_SC avatar often commented on as an alien. Still, the lack of social cues in appearance flattened the perception of the age and gender of the members.

Next, in the SC avatar condition, junior members commented that they restrained their statements because of the presence of senior members. "I felt that the other members were senior to me, so I tried to tone down my participation a bit. I acted a little consciously not to lead the discussion too much." (P45, junior, female). In the comments about the SC avatar, there were many comments stating that there was not much change in communication between the face-to-face icebreaker and the VR environment, suggesting that the relationship from the face-to-face environment was maintained in the VR space.

The results of this study are consistent with prior studies on CMC [14]. These effects of CMC apply to the appearance of avatars in virtual environments.

6 Conclusion

In this study, to investigate how the social cues of the avatar's appearance affect the balanced participation, we conducted group discussions with 64 participants in 16 groups of four people of different genders and ages, using avatars with two different appearance social cues. The two appearance-differentiated avatars were avatars with social cues of appearance and avatars without social cues of appearance. We then analyzed the data for effects on the participants' behavior and psychological aspects.

As a result, the group using avatars without social cues of appearance had a flatter perception of member influence and a better balance of participation based on the amount of speech than the group using avatars with social cues. We found that reducing the appearance of social cues of avatars promotes equality of participation even among members of different ages and genders with diverse backgrounds, leading to positive group dynamics.

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