Facilitative Agents with Deliberate Handicaps in Traditional Competitive Games for Improved Playability

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ABSTRACT

With the necessity of oral communication, traditional games have shown advantages in cultivating players' social skills. Recently with the widespread of consumer-oriented virtual reality devices, remote traditional games have also been introduced to the post-pandemic era. Meanwhile, individual difference in manipulation proficiency can lead to unintended gaps in play skills and thus jeopardize the communication quality between players. To compensate for such gap, we investigate the effectiveness of a facilitative agent. We conducted a Wizard of Oz experiment with an agent that is able to provide handicaps based on the game dynamics. This paper presents an evaluation of the impact of robot facilitator intervention on the improvement of social skills and entertaining, offering insight into novel methodologies for social skill development in an increasingly remote and digital society.

CCS CONCEPTS

• **Human-centered computing → Collaborative interaction**.

KEYWORDS

Facilitative Agents, Recreation

ACM Reference Format:

Sho Mitarai, Chang Liu, Goshiro Yamamoto, and Nagisa Munekata. 2024. Facilitative Agents with Deliberate Handicaps in Traditional Competitive Games for Improved Playability. In *Companion Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY Companion '24), October 14–17, 2024, Tampere, Finland*. ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3665463.3678804

1 INTRODUCTION

Recreation is not merely a way to pass the time, but rather a proactive activity that people voluntarily allocate free time for in their daily lives, with the purpose of relieving lack of exercise, and promoting social interaction. Within these recreational activities, facilitators have an important role. They provide activities that are appropriate for each participant and help them achieve their purpose. In other words, they understand the participants' condition and the specific recreation situation, adjust the game rules, and support for all participants engaged in the recreation activity.

One key problem with recreation is that it often involves differences in skill among participants. To achieve the intended recreational purpose, active participation is necessary, but participants with lower skill levels may lose motivation along the way. Gillet et al. [2] used robot-gaze interaction in a "with other words" game to promote participation by players with different skill levels. However, their approach does not bridge the skill gap between players, thus promoting participation but making it difficult to sustain motivation.

To address this issue, our study proposes facilitative agents that employ deliberate handicaps in traditional competitive games. Specifically, we attempt to improve participant playability by reducing skill disparities between participants through the dynamic assignment of handicaps based on the game situation by the facilitative agent. We develop a VR game based on "Daruma-san ga koronda", a traditional competitive game whose rules are easy to understand. Through this game, we study the effect of the facilitative agent dynamically handicapping the participants.

2 RELATED WORK

Human-human communication mediated by agents has been studied using several approaches. Many studies have utilized robots in small groups to maintain fairness in task distribution among teams with different skills [2], improve team productivity [1], and enhance learning effectiveness in educational environments [9]. In these studies, robots assisted groups of humans in acting efficiently by distributing appropriate tasks and encouraging speech, considering team members' skill levels and characteristics. Two main types of interactions influence small groups: verbal and nonverbal. Verbal interaction is used to design behaviors that mediate conflicts between humans [6, 11] and encourage passive participants to express their opinions in meetings [10]. For nonverbal interactions, gaze and eye contact are used for the facilitating implicit human interaction [2].

Humanoid robots that assist in social activities have also been studied. In the context of recreation, robots have been introduced

CHI PLAY Companion '24, October 14–17, 2024, Tampere, Finland

ACM ISBN 979-8-4007-0692-9/24/10
https://doi.org/10.1145/3665463.3678804

into elderly care facilities, particularly in light of Japan's aging society [7, 8]. Hamada et al. conducted a study aimed at promoting relaxation through recreation using robot therapy in such facilities [4]. Itai et al. confirmed that a scenario-based robot recreation program increased participation, communication frequency, and the amount of time spent expressing positive emotions in older adults with dementia [5].

In terms of improving playability, Graf et al. conducted the most relevant research [3]. Their work demonstrated that controlling the emotions of a virtual character in a single-player exergame can improve player motivation and performance. Our research aims to improve playability in competitive two-player games with humanoid robot agents. A key challenge in this context is addressing skill disparities between players. We propose solving this issue by implementing an intervention in which the robot agent assigns deliberate handicaps based on the game situation.

3 METHOD

3.1 Overview

Figure 1 presents an overview of the traditional competitive game setup and robot intervention strategy employed in this study. The game involves two participants, each assuming a different role: the game player or the disturbing player. The game player plays the VR game, while the disturbing player observes and disturbs the game player through a monitor. The participants switched roles and compete to obtain the highest score in the VR game. During the game, the robot acts to prevent either participant from gaining a one-sided victory by monitoring to the participants' scores and instructing the disadvantaged participant on how to disturb the game player while that the participant is acting as the disturbing player.

3.2 Facilitative Agent

We adopted Nao, a humanoid robot manufactured by SoftBank Robotics Group Corp. [12], as the facilitative agent. The facilitative agent was the host of the recreation. The robot announced the start of the recreation, the results of game, and assigned handicaps. All interactions with the participants were performed by speech only, and no physical movements were involved. To control the timing, and content of Nao's speech, we employed the Wizard of Oz (WOZ) method. The human operator selected the robot's speech content from the Table 1 based on the game score and had the robot speak.

3.3 Traditional Competitive Game

We developed a VR game based on "Daruma-san ga Koronda" a widely recognized traditional game that is easy for users to understand in Japan. The choice of game was made for several reasons. First, the VR game format quickly incorporates elements that allow users to move their bodies and play even in a small room, providing an experience similar to outdoor play. Second, because the game is played in a VR environment, it facilitates the acquisition of data such as player behavior and game logs.

3.3.1 Game design. The game is played by two players, one being the game player and the other the disturbing player. The disturbing player is located in a separate room from the game player and can

Table 1: The content of the robot's speech used by the operator. The original text was in Japanese and has been translated into English.

Situation	Speech content (Translate Japanese to English)
Start of the experiment	Today we're going to play "Daruma-san ga Koronda" in VR. We'll have a friendly competition to see who can clear the screen the fastest! I'll be your game host. Let's start with a quick tutorial to get you all set!
Result announcement	The winner is <Winner Player>! Congratulations! Alright, <Winner Player>, you'll be taking the first turn for the next round!
Handicap assignment	Looks like you had a bit of bad luck in that last round. But don't worry, <Loser Player> - I've got a fun surprise for you! See that keyboard over there? You can use it to shake things up in the game.
End of the experiment	We've now completed the experiment. Thank you very much for your participation and cooperation.

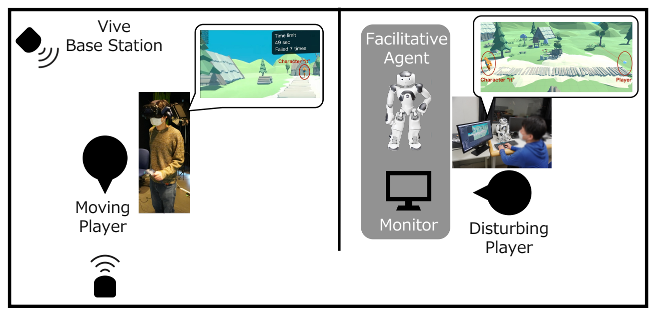

Figure 1: Overview of the game (left: game player, right: disturbing player). The left game image is a player's view. The right game image is an appearance of the game.

disturb the game at arbitrary moments while monitoring the game screen on a monitor (see Figure 1). Figure 1 (up right) shows the game screen. The white sphere on the right side of the game screen represents the player, while the character on the left represents the "it". The player faces the "it" character and attempts to proceed. The left game screen in Figure 1 is also game player's actual subjective viewpoint.

The character "it" initially faces the opposite direction from the player, but after calling "Daruma-san ga Koronda", it turns towards the player's direction. The game is considered failure if the player moves while the character "it" is looking back. Failure also occurs if the player touches an obstacle as a result of the disturbing player's actions, as described below. In the event of failure, the game restarts from its initial position, and a penalty is imposed when the game is subsequently cleared.

3.3.2 Interaction design. The disturbing player can perform two types of actions (see Figure 2): "placing an obstacle" or executing a

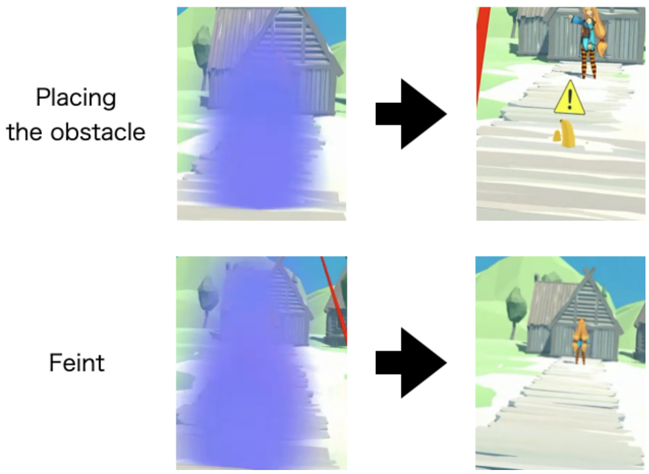

Figure 2: Disturbing actions.

"feint". The action "placing an obstacle" causes a banana-shaped 3D object covered in blue smoke to appear in front of the game player. In contrast, a "feint" action produces only blue smoke without an accompanying obstacle. When the disturbing player conducts "placing an obstacle", the obstacle is initially invisible to the game player. Consequently, the game player is unaware of whether the disturbing player's action is an instance of "placing an obstacle" or a "feint" until the smoke clears.

The game players can operate the game in two ways: "walking" and "jumping." Walking is executed by swinging the arm back and forth as if running while holding the controller. This action allows the player to get close to the character "it". Next, "jumping" is only possible when an obstacle appears. When an obstacle appears, a gauge appears in front of the player. To execute "jumping", the player moves both hands from the back to the front. Successful execution of "jumping" enables the player to avoid the obstacle that appeared during the game.

3.3.3 Obstacles. The game employed two types of obstacles: a yellow banana-shaped 3D object [1] and blue smoke. The banana-shaped object and was accompanied by a yellow warning displayed above it. While the obstacle's small size make it potentially difficult to perspective from the participant's view, additional cues ensured its visibility. These cues included blue smoke generated during the disturbance event (see Figure 2) and an accompanying warning sound. These features collectively guaranteed that participants would notice the obstacle. The disturbance action had the effect of alerting participants to the obstacle's presence while also causing them to pause, likely due to surprise.

4 EXPERIMENT

We investigated the effect of deliberate handicaps by a facilitative agent on the interaction between the players. We asked pairs of participants to play a game based on "Daruma-san ga Koronda," which we developed. After the participants were guided on playing the game, they each played thrice. The participants competed for a game score (the time taken to clear the game). After the experiment, we asked them to respond to a questionnaire on their impressions of the game. The experiment is approved by the ethical committee of Kyoto Sangyo University.

4.1 Apparatus

Figure 1 shows an overview of the experiment. The left side of the figure shows a participant playing the game (the game player). The game player wears a head-mounted display (HMD) and plays the game. The right side of the figure shows a participant disturbing the game player (disturbing player).

4.2 Participants

We had 24 participants, resulting in 12 pairs, who participated in the experiment (male: 17; female: 7, average age 21.1). They constituted seven pairs of males, two pairs of females, and three pairs of males and females. Each pair was recruited because they were close and enjoyed playing games together. All participants understood the rules of "Daruma-san ga Koronda." Therefore, no flaws occurred during the experiment due to a lack of understanding of the rules. Note that they received an Amazon gift card worth 1,000 yen as a reward for their participation.

4.3 Condition

We designed two conditions: one without deliberate handicaps (base condition) and the other with deliberate handicaps (with handicap condition). The conditions differed for each pair, with six pairs in the base condition and six pairs in the with handicap condition. The difference between the conditions is the timing of the instruction for the disturbing action.

Group A: Base Condition

- Participants are informed of the disturbing action with the instruction on how to perform it at the very beginning of the experiment.
- The disturbing action is composed of actual disturbance for only 1 time and feint for 3 times for each trial.
- The disturbing player is able to perform the disturbing action for all trials.

Group B: Handicap Condition

- Participants are informed of the disturbing action only when they after the first game.
- The disturbing action is composed of actual disturbance for only 1 time and faint for 3 times for each trial.
- The disturbing player is able to perform the disturbing action for all trials.

4.4 Procedure

(1) **Instruction of how to play the game:** Instruct the participants how to play the game. The game controls are "walking" and "jumping."
(2) **Instruction of how to disturb players (only base condition):** Instruct the participants who are base condition how to disturb the game player. Disturbing actions are "placing an obstacle" and "feint."

[1]We obtained the 3D model from the Unity asset store (URL: https://assetstore.unity.com/packages/3d/props/food/low-poly-fruit-pickups-98135).

(3) **Play the game:** Play one game each other until the game is cleared. The winner of the previous round becomes the game player first (the first round is decided by rock-paper-scissors). The disturbing player can perform a disturbing action at arbitrary moment (in the handicap condition, only the participant who has been instructed to perform the disturbing action can do).
(4) **Announcing the winner of the round:** After each player cleared the game, the facilitative agent announces which player is the winner of the round. The winner is determined by the following score, with the participant with the lowest score being the winner.

$$score = t_{clear} + 5 \times c, \quad (1)$$

where $score$ denotes the score of the game result, t_{clear} denotes the clear time [sec] of the game, c denotes the number of game failure. This means that five seconds are added for each failure from the game's clear time.
(5) **Instruction of disturbing behavior from facilitative agent (only handicap condition):** After the announcement of winners, only the losing participants are given instructions for disturbing action by the facilitative agent. Disturbing actions can be performed once for "placing an obstacle" and three times for "feint" during the game. If participants lose two times, they can perform "placing an obstacle" one additional time.
(6) Repeat (3) through (5) as one round until three rounds are played.

4.5 Questionnaire

After the experiment, we asked participants to complete a questionnaire. The questionnaire's objective was to investigate the difference in their proactivity in the game and their willingness to communicate with counterparts between conditions (base and with handicap). The items of the questionnaire are shown in Table 2. The questionnaire format was a 6-point Likert scale (0: not at all agree; 5: strongly agree). The exceptions were Q9 and Q10–multiple-choice questions, and Q11–a description.

4.6 Results

Figure 3 shows the questionnaire results. The horizontal axis represents the percentage of the scores on a Likert scale (0 = not at all agree, 5 = strongly agree). The results showed that the overall scores were high in both conditions, indicating that participants found the experience highly entertaining regardless of the condition. One-way ANOVA for between participants was used to clarify the relationship between the conditions (base and handicap) for each item in the questionnaire. As a result, no significant is found between the conditions.

The results for Q9 are shown in Figure 4, which explored participants' desired topics of discussion with their counterparts post-game. The findings suggest that participants were keen to discuss obstacles and other game elements, signifying that, from a communication standpoint, designing games that inspire users to discuss content and strategies with others takes precedence over celebrating outcomes, such as victory or defeat.

Q10 and Q11 aimed to assess whether the game adversely affected participants' physical and mental well-being. In Q10, 4 out of 24 participants reported feeling "uncomfortable" while playing. Q11 explored the discomfort factors further. One participant shared, "I felt uncomfortable moving forward in the VR space while standing still. My sense of balance was disturbed. Nevertheless, the game was fun. My arm also stuck in the cord of the HMD when executing one of the jump actions." This highlights the need for additional countermeasures against VR sickness and improved wiring arrangements when setting up VR games. Another participant experienced discomfort due to their counterpart's disturbance actions, stating, "when I lost the game, I did not like it that my counterpart had placed some obstacles." While disturbance by others can stimulate playability, it may also cause player discomfort depending on the nature of the disturbance. Consequently, careful consideration must be given to the design of disturbance.

The questionnaire results reveal that participants generally had a positive and engaging experience with the game across both conditions. High scores for concentration (Q1) and immersion (Q2) indicate that players were deeply involved in the gameplay. Participants reported experiencing a range of emotions, including joy when winning (Q3), frustration when losing (Q4), and a sense of tension and thrill during play (Q5), contributing to an emotionally rich experience. The game also sparked a competitive spirit, with many participants feeling motivated to win in subsequent rounds (Q6, Q7). Notably, the social aspect of the game was prominent, with a high percentage of participants expressing a desire to discuss the game afterwards (Q8), particularly regarding game elements and obstacles (Q9). For many, this VR game was a novel and exciting experience, though a few participants reported some discomfort related to VR sickness or game mechanics (Q10, Q11). Overall, the results suggest that the game successfully created an engaging, immersive, and socially stimulating experience for most participants, regardless of the experimental condition.

5 DISCUSSION

5.1 Effects of the facilitative agent on playability

First, we discuss the questionnaire results obtained from the experiments. Across the two conditions, the questionnaire results showed no differences for some of the questions. However, the distribution of participants' responses is different between condition. The most relevant questions were "I was frustrated when I lost (Q4)" and "I felt motivated to win the next round (Q6/Q7)." These questions constitute elements of "emotional movement" and "encouraging competition." Some participants in the base condition responded negatively to these questions, whereas no negative responses were obtained in the handicap condition. This finding suggests that motivation to win potentially decreased when a skill disparity was present in the base condition. In contrast, the intervention of facilitative agents that bridge skill gaps, may help to maintain motivation in such situations.

The results showed a possibility that the robot intervention effectively made the participants participate actively in the game. In the experiment, the difference between the base and handicap conditions was the timing of the instructing of the disturbance

Table 2: Post-Experiment Questionnaire.

	Question
Q1	I could concentrate on the game
Q2	I felt immersed in the game
Q3	I was glad when I won (if you did not win any round, please skip this)
Q4	I was frustrated when I lost (if you did not lose any round, please skip this)
Q5	I felt some tension and thrill when playing the game
Q6	After the first round, I felt like, "I have to win the next round"
Q7	After the second round, I felt like, "I have to win the next round"
Q8	I wanted to talk about the game with counterpart after the experiment
Q9	(For those who answered "strongly agree (5), agree (4), somewhat agree (3)" in Q8) What situations/elements of the game did you want to talk about? (Choose from 5 options (multiple answers allowed): Winning or losing, gimmicks such as obstacles, details of the game (e.g., scenes played well), score, others)
Q10	Did you feel any discomfort or unpleasant feelings during the experiment? (Choose from two options: I felt uncomfortable at times, I did not feel uncomfortable)
Q11	(For those who answered that they felt uncomfortable at times) Please describe the details of your discomfort.

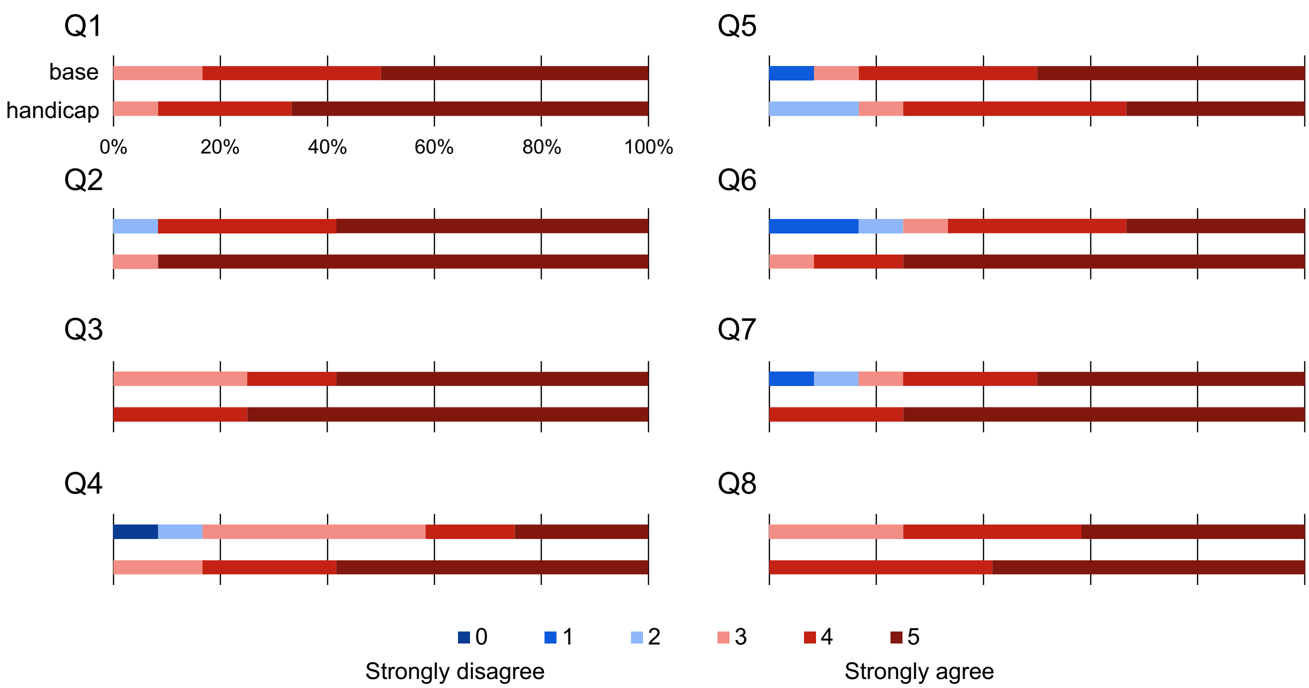

Figure 3: The results of questionnaire Q1-Q8.

action. In the base condition, the robot taught the disturbance action at the beginning of the experiment. While the handicap condition, the robot taught the participant who lost the game. The difference in robot behavior between the two conditions was subtle. Nevertheless, the differences between the two conditions suggest that even subtle differences in robot behavior can influence the game's intervention. In the experiment, the robot positively affected the participants by enhancing their motivation for the game, but the wrong interaction, even a subtle one, could have a negative effect. In the experiment, handicap condition, the disturbance action was taught only to the lost participant, and the winner did not know that the loser was performing the disturbance action. In verbal interviews, the winner thought that the computer randomly generated the disturbance action. If the winner knew during the experiment that only the loser was available for disturbance action, they might feel that this was unfair to the game and the robot. In such a case, we assume that their motivation for the game would not have improved.

Meanwhile, Q8, related to the activation effect of communication, did not show difference in this experiment. The points for Q8 were high under both conditions. The median points for each condition

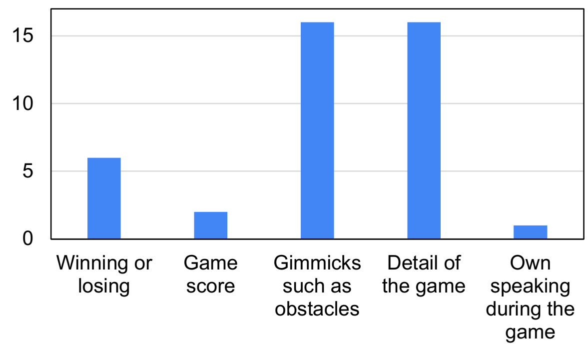

Figure 4: The results of questionaire Q9.

were 4 (agree, base condition) and 5 (strongly agree, handicap condition), indicating that participants wanted to communicate with their counterparts, regardless of the condition in the experiment.

5.2 Limitation

In our experiment, there were three limitations. First, the results did not show any significant difference between conditions. We consider that this is because the intervention of the robot was subtle and the effect size between conditions is small. This problem may be solved by increasing the sample size.

Second, there were two changes between the conditions: a change in game rules (the timing of the instruction of disturbing action) and robot intervention. Results showed that the handicap condition motivated participants more proactive for the game, but it is not possible to separate out which of the two changes was contributing. The results show that one (or both) of these two changes improved the participants' entertaining for the game, but what contributed needs should be investigated in the future work. Furthermore, to assess the robot's impact on participant motivation, it is essential to compare the results with a control condition where the agent robot was not present.

Third, the experiment did not use a standard questionnaire as the NASA Task Load Index (NASA-TLX). Instead a original questionnaire was used to assess participants' motivation and enjoyment of the game. For future studies, using a standard questionnaire like the NASA-TLX would be beneficial for more comprehensive user study.

Finally, the remote traditional game in the experiment was a positive experience for the participants, there might have been a cognitive bias in each participant's first round, making it difficult to evaluate it correctly. For all participants, playing the game in the experiment was their first experience, and for most of them, it was also their first VR experience. Therefore, participants may have overestimated expected satisfaction from the game. This bias should be eliminated in the future work by having participants experience the game in a long-term experiment.

6 CONCLUSION

We proposed the use of facilitative agents with deliberate handicaps in traditional competitive games. We conducted a Wizard of Oz experiment with an agent that is able to provide handicaps based on the game dynamics. Our findings suggest the possibility of improving the playability of the participants by reducing skill disparities between participants through the dynamic assigning of handicaps in response to changing game conditions. This paper presents an evaluation of a robot facilitator's intervention and its impact on the improvement of social skills and entertaining. The results offer insight into novel methodologies for social skill development in an increasingly remote and digital society.

ACKNOWLEDGMENTS

This work was supported by Hayao Nakayama Foundation for Science & Technology and Culture (R2-A1-55) and ISHIZUE 2024 of Kyoto University.

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