

Effect on The Mental Stance of An Agent's Encouraging Behavior in A Virtual Exercise Game

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Abstract—Most of people think an agent is very different from human. The mental stance provides a critical barrier for an agent to cross before it can be accepted as a social partner. In this study, we focused on the situation in which an agent encouraged performing a task. We experimentally investigated how to influence the mental stance of human participants during task performance by the encouraging behavior of the agent. We implemented two agents: an “encouraging agent” that provided motivational behavior to the participants and a “time-report agent” that reported the passage of time to the end of the game. We conducted an experiment to evaluate whether the behavior model estimation had the potential to induce and maintain the intentional stance in a variety of situations. As a result, the agent could motivate the participants and induce the participants’ affective assiduities for the agent as that when they interact with humans.

Keywords—Multi-modal interaction; human-agent interaction; intentional stance.

I. INTRODUCTION

Agents that perform collaborative tasks have been developed over a long period. It is expected that agents will soon be developed that can replace humans in a variety of roles, particularly short-term interactions such as front desks, shopping counters, and information offices, where the quality of the interaction between humans is “mechanical.” Agents are usually regarded as multimodal interfaces that provide useful information, rather than as social partners that can establish relationships with humans [1]. To establish such social relationships, people’s mental state with respect to humans or agents is an important factor. The difference provides a critical barrier for an agent to cross before it can be accepted as a social partner.

The mental states that people infer when considering an agent can be defined as physical stance, design stance, and intentional stance [2]. In the physical stance, we pay attention to physical features such as the power of the motor and the specification of the display. In the design stance, we expect that the agent will follow predefined rules. In the intentional stance, we assume that the agent has subjective thoughts and intentions. When humans interact with each other, they usually take the intentional stance, and they and their communication partner respect each other. When humans interact with a machine, they usually take the design stance. In this case, they usually interact with the machine from a self-centered perspective because they do not consider that the machine has

its own intentions. To establish social relationships between a human and an artificial agent, the agent has to induce the intentional stance in its human partner.

To induce such interactions, many previous researchers have attempted to approximate the behavior model of an agent to a generalized model of human behavior. For example, Heider and Simmel [3] demonstrated that observers attribute elaborate motivations, intentions, and goals to even simple geometric shapes based solely on the purposeful pattern of their movements. In the same way, when an agent exhibits appropriate behavior, people who interact with the agent take the intentional stance. However, in the course of a long-term interaction, we expect that the behavior of the other entity will be personalized as the interaction proceeds. This approach is therefore not considered suitable for developing an agent that can be regarded as a communicative social partner. There are also differences in people’s mental states when engaging with humans and with agents [4]. These differences provide a critical barrier for an agent to cross before it can be accepted as a social partner. It is important to ensure that the mental state of people interacting with the agent is the same as that when they interact with humans.

Goal-oriented behavior is one of the important factors in the induction of the intentional stance [5]. In an earlier study, we confirmed that goal-oriented behavior was helpful in inducing intentional stance during an interaction task [6]. In that study, the apparent goal-oriented behavior of an agent was established via trial-and-error. However, based on interaction analysis we consider it more important to establish the behavior model of an agent than to show goal-oriented behavior. In addition, if only the goal-oriented behavior related to the immediate task is used to induce the intentional stance, it becomes difficult to induce in long-term relationships, wherein many different types of interaction are involved.

This study aims to investigate the method to influence the mental stance of human participants during task performance by making them estimate the behavior model when the behavior of the agent is not directly related to the task itself. If such a model of behavior can influence the mental stance of the human participant, a more effective method for inducing the intentional stance can be developed by combining this model estimation approach with the goal-oriented behavior approach. In long-term interactions, the agent can induce the intentional stance using goal-oriented behavior in performing a particular task and can maintain that stance using the model estimation

approach when the user switches to performing different tasks.

The paper is organized as follows. Section 2 briefly introduces previous work on the intentional stance. Section 3 outlines the proposed behavior model estimation approach. Section 4 describes an evaluation experiment conducted to investigate the effect on the mental stance toward the agent and presents the results. Section 5 discusses the achievements and the limitations of our approach. Section 6 concludes and discusses future work.

II. RELATED WORK

If an agent resembles a human or an animal in appearance, people tend to spontaneously think that the agent has intentions. Friedman et al. [7] reported that 42% members of discussion forums about AIBO which was an animal robot sold by Sony, a robotic pet, spoke of AIBO having intentions or that AIBO engaged in intentional behavior. On the other hand, [8] reported that an appropriate match between a robot's social cue and its task will improve people's acceptance of and cooperation with the robot. This means that we cannot induce the intentional stance by the appearances alone.

Roubroeks [4] reported the occurrence of psychological reactance when artificial social agents are used to persuade people. In that study, participants read advice on how to conserve energy when using a washing machine. The advice was either provided as text-only, as text accompanied by a still picture of a robotic agent, or as text accompanied by a short film clip of the same robotic agent. The results of the experiment indicated that the text-only advice was more accepted than either advice with the still picture of the robotic agent or the advice with the short film clip of the robotic agent. Social agency theory proposes that more social cues lead to more social interaction, but the result was the exact opposite. This is caused by differences in people's mental state with respect to humans or agents.

From these researches, it is important that the mental stance of people when they interact with the agents is the same as that when they interact with humans. In our study, we tried to influence the mental stance when the behavior of the agent is not directly related to the task itself. Chen et al. [9] reported that the perceived intent of the robot significantly influenced people's responses when a robotic nurse autonomously touched and wiped each participant's forearm. They used the explicit behavior which is directly related to the task to convey intent of the robot. In our study, we focused on the motivational behavior as agent's behavior which was not directly related to the task. Deci and Ryan [10] provided "self-determination theory" which was a model to motivate people. This model is applied in many situations (e.g., [11]). Readdy et al. [12] reported that rewarded behaviors were not meaningfully connected to successful performance. The rewarded behavior was a kind of the motivational behavior. We thus considered the motivational behavior was not directly related to the task. To spontaneously make participants estimate the agent's behavior model, our proposed agent provided the motivational behavior when the motivation of the participants were weakening.

III. AN ENCOURAGING AGENT REFLECTING THE USER'S STATE

In a previous study [6], we were able to induce the intentional stance by presenting a goal-oriented, trial-and-error

process using multimodal behavior. However, the effect of the method was low when participants were doing something which was not directly related to the task. This suggested that participants think the agent is only capable of producing appropriate behavior directly related to performing the immediate task. If participants just focus on the task performance, it is hard to establish social relationships between a human and an agent.

In this study, we tried to extend the method to induce the intentional stance. For the purpose, we investigated whether the agent's behavior could improve and maintain the participant's active commitment to a task. The improvement is not directly related to objectives of the task but important mental state to performing the task. If the agent could do that, we think participants represented a kind of affective attitudes towards the agent.

The agent provided encouraging utterances in the task when the agent judged that the participant's commitment was weakening. The agent's behavior was caused by participant's behavior history and estimated current inner state. We expected the participant to try to estimate the agent's behavior model because they could easily find the agent had some rules to interact with them but the behavior was not directly related to performing the task. The estimation of the behavior model is first step to maintain the intentional stance in general situations. In this section, we briefly explain the architecture of the "encouraging agent."

A. Task description

In this study, we used a first-person throwing game using virtual balls in an immersive virtual space as the interactive task. This game was designed for encouraging exercise. The explicit objective of the participants was to win the game, while the implicit objective was to improve the commitment to the exercise. The encouraging behavior of the agent was related to the participants' implicit motivation, but did not directly contribute to winning the game, as in some situations, the winning strategy was for the participant to exit the game (when the participant had a large point score or when the remaining time was short). The encouraging behavior was used to investigate the effect of the participant's understanding that the agent's behavior is related to the implicit objective.

In the game task, the players (including the agent) shared the basic rules and had the implicit and explicit objectives as a common ground. This helped both partners estimate the behavior model of the other. In the first-person throwing game, the players could not verbally share information because the states of the game and of the players changed too quickly. The agent therefore did not need to use detailed verbal communication in the experiment. Use of a game task also allows good data to be obtained because participants become immersed in the game [13].

We set the following conditions on the exercise game task:

- Multiple players joined the game, and most players were humans.
- Some objectives could be achieved without interacting with other players.
- Other objectives could be achieved only when players interacted.

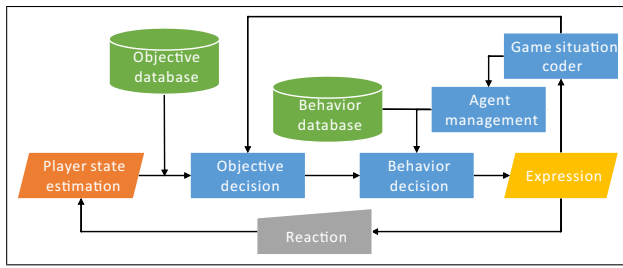


Figure 1. The outline of the system architecture.

- The only explicit reward was the game score. Other rewards were implicit, and the player could not identify them.
- The game session was short (about 10 min) to ensure that the player concentrated on performing the task.
- The game characters were controlled by the players' body motions. This allowed the player to intuitively control the game character.
- All players had the same abilities and followed the same rules.

More detailed rules were defined depending on the target state of the players, such as how strongly motivated they appeared, how long they played the game, and how deeply immersed they seemed. We expected that the rules would allow us to investigate the effect of the agents' behavior on the human players' mental stance.

B. Outline of the architecture

The outline of the system architecture, as shown in Figure 1, was based on a Belief-Desire-Intention (BDI) model. Each component is briefly described below.

Player state estimation:

This component estimated the user's state in relation to task commitment based on the parameters obtained from the exercise game and the predefined rules. The details of the parameters are given below.

Game situation coder:

This component categorized different situations in the game based on the parameters of the game and the predefined rules. The game parameters are described below.

Objective database:

The database contained all the possible objectives.

Objective decision:

This component chose an objective from the objective database, based on the outputs of the player state estimation component and the game situation coder component.

Agent management:

This component calculated the state of the agent, based on the same parameters as those of the player.

Behavior decision:

This component chose a concrete behavior based on the received values.

Expression:

This component produces the selected behavior.

The game parameters

Game score distribution:

The game was scored by the points accrued by each player (including the agent) in line with the game rules. The distribution compared the scores of the players.

Remaining time:

This showed the time remaining until the game was over.

Rate of accruing game score:

Each player had this parameter. This parameter increased as the player accrued points and it decreased with time.

The player parameters

Hate value:

Each player had more than one parameter for each other player. This parameter measured how strongly one player wanted to target the other player. This parameter increased when the other player hit the ball and it decreased with time.

Movement distance:

This parameter showed how far the player had moved over the last 30 seconds.

Frequency of accruing game score:

This parameter showed how frequently the player accrued points.

Some of the parameters decreased with time, reflecting the observation of Wohl et al. [14] that the memory of past events decreases with time.

The encouraging agent exhibited behavior designed to motivate a player when the agent judged that the player's commitment to the game was falling. This was done under the following conditions:

- When the player's movement distance parameter fell below 75% of their movement distance at the start of the game. Initially, the player's commitment is high, but he/she does not yet know what behavior is appropriate when playing the game. We used this initial player state as the benchmark for the behavioral activity.
- When the player's frequency of accruing the game score parameter was less than that of the other players, including the agent, by two or more. A player's motivation drops when his/her ability to win the game is poor [15]. When the player was in this state, the agent assumed that commitment was low.

IV. EXPERIMENT

To investigate the effects on mental stance when the agent encourages the participant's commitment to the exercise task, we conducted an experiment using two agents: an "encouraging agent" that provided motivational behavior to the participants and a "time-report agent" that reported the passage of time to the end of the game. We assumed that if we could influence the mental stance of the participants using this approach, the behavior model estimation has the potential to induce and maintain the intentional stance in a variety of

situations.

To evaluate this, we analyzed the number of target actions made toward the agent in the course of the experiment. The target action meant that the participant tried to hit the ball to another player, including the agent. We assumed that, when the participants have an intentional stance toward the agent, they unconsciously balance the target frequency, in a manner similar to that when they want to balance the game score of each participant in human-human interactions. The target actions were counted automatically based on the behavioral data. In addition, we asked the participants to complete a questionnaire after the experiment. We compared the experimental results between a group wherein participants interacted with the “encouraging agent” and a group wherein participants interacted with the “time-report agent.”

A. Task

Two humans and an agent participated in the game task. The task was a virtual first-person throwing game. Each was player assigned a different color. The player could change their own ball to the color of another player’s ball by moving a game object (a moving teddy bear) to a place corresponding to each color. The players won a point when their ball hit another player with the corresponding color. When the ball with the player’s own color hit another player, the player received a point. If the player hit a non-colored ball at another player, that player stopped for 5 seconds and dropped their teddy bear at that place. Other players could pick up the dropped teddy bear. The player who was carrying the teddy bear could not shoot a ball. The virtual ball was automatically refreshed after 5 seconds.

B. Experimental setting

The experimental setting is shown in Figure 2. We used an Immersive Collaborative Interaction Environment (ICIE) [16] and Unity3D [17] to construct the virtual environment and the two agents. ICIE uses a cylindrical immersive display that is composed of eight portrait orientation liquid-crystal-displays (LCD) with a 65-inch screen size, arranged in an octagonal shape. In this environment, participants could look around in the virtual space with a low cognitive load, as in the real world. A participant’s virtual avatar could be controlled by their body motions using motion sensors placed on their dominant arm, both feet, and waist. These sensors captured throwing motions, stepping motions, and body orientation. The participant could intuitively control the virtual avatar using body motions with low physical constraints.

The speed of movement of the avatar was controlled by the participant’s stepping motion. The minimum speed was slower than the speed of the teddy bears and of the game playing characters, while the maximum speed was faster. Participants could achieve the maximum speed by adopting a brisk walking pace and could throw the virtual ball with a throwing motion. The speed of the ball was not dependent on the throwing motion. The direction of movement and throwing trajectory were determined by body orientation. To determine the participant’s inner state, physical exertion was estimated from the stepping motion. This information was sent to the game system in real time.

The rules controlling the movement of the teddy bears were simple and consistent. The teddy bear did not consider

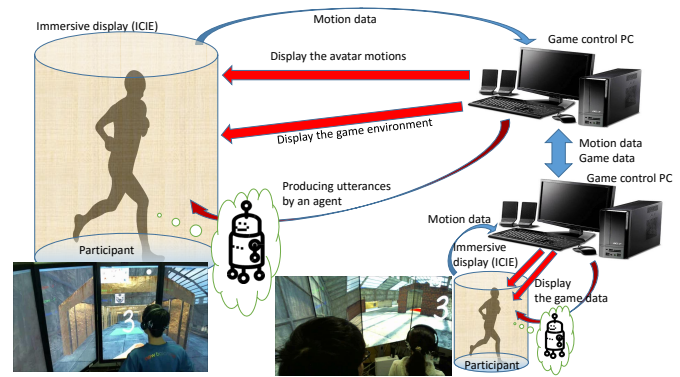


Figure 2. The experimental environment.

the participant’s inner state or the game conditions (e.g., if the score was high or if the previous strategy was the same as the current strategy). The rules depended on the positional relationships in the game and on whether the players had a teddy bear.

C. Procedure

Two participants who were acquainted with each other joined the game task. The interactive agent who joined the game was randomly selected to display encouraging or remaining-time-report behavior. The frequency of intervention was the same for both agents. The frequency of intervention by the encouraging agent was calculated from a preliminary experiment. Neither of the agents could change their interaction strategy in the game.

First, the participants were instructed on the experimental procedures and the motion sensors were attached. After confirming the data from the sensors, the experimenter started the video cameras and the game. The participant first performed a practice session and then performed three game sessions. Each game session lasted 10 minutes, with 2-minutes rest intervals between sessions. At the conclusion of the experiment, the participant completed a questionnaire.

Ten pairs of participants (20 students, 16 males and 4 females) participated in the experiment. All participants were students aged from 19 to 32 years (average 21.7 years). Ten participants (8 males and 2 females) played the game with the encouraging agent (E-group) and the rest played the game with the time-report agent (T-group).

D. Result of interaction behavior analysis

The purpose of this analysis is to investigate whether judgments about an agent’s behavior that is not directly related to task performance influenced interaction behavior. We calculated the ratio between the number of target actions directed toward the agent and the number of target actions directed toward the other participant. We expected that the proportion would be around 0.5 when a participant took the intentional stance, as the players tried to balance the game score. In contrast, a participant who took the design stance would either ignore the agent, assuming that the agent was not a good player, or target only the agent, assuming that this would be an easy way to improve their game score.

We compared the results from the E-group with those

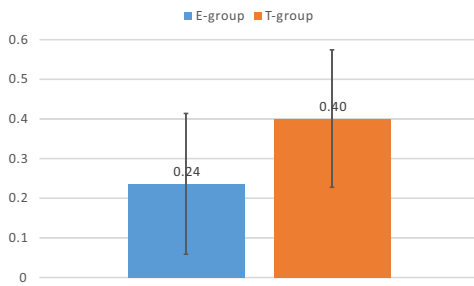


Figure 3. The ratio between the number of target actions directed toward the agent and the number of target actions directed toward the other participant.

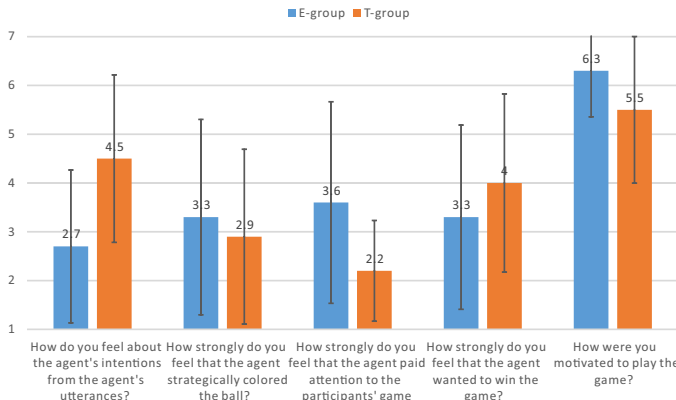


Figure 4. Results of questionnaires.

from the T-group in the second and third sessions, and then calculated the distances from 0.5. The results are shown in Figure 3. A Mann-Whitney U test showed that the distance in the E-group was significantly less than that in the T-group ($p = 0.027$). The average in the E-group was 0.23. This means that a small difference arose once or twice in each session. The results suggest that the participants took care to balance the game score. These results suggest that the approach was successful in inducing the intentional stance.

E. Result of questionnaire analysis

The purpose of this analysis is to investigate how agent behavior not directly related to task performance influenced the subjective impressions of the participants. The participants rated the behavior of the agent on a seven-point scale, presented as ticks on a black line without numbers. We post-coded these scores from 1 to 7. The results are shown in Figure 4. We performed Mann-Whitney U tests on the questionnaire data. This shows the final impressions of participants toward the agents in the experiment.

- **How do you feel about the agent's intentions from the agent's utterances?**

This was used to confirm the subjective impression of the encouraging or time-report utterances of each agent. The utterances of the remaining-time-report agent were scored significantly higher than those of the encouraging agent ($p = 0.028$). This was an unexpected result. From observation of the video data, we identified situations wherein the agent's encouraging

behavior was inappropriate in the game context, for example, encouraging a strategy immediately after the same strategy had been performed. In these cases, the participants could not understand the intentions of the agent. In contrast, the time-report utterances were always appropriate to the game context, and the participants always understood the intention behind them. This may be one of the reasons for this unexpected result.

- **How strongly do you feel that the agent strategically colored the ball?**

This was to confirm whether the utterances that induced the intentional stance caused the participants to judge the meaning of the agent's other behavior. The Mann-Whitney U test showed that there was no significant difference between the groups ($p = 0.53$), suggesting that encouraging utterances did not influence the participants' judgments on the meaning of the agent's behavior.

- **How strongly do you feel that the agent paid attention to the participants' game scores?**

This was to explore whether the participants were aware of the implicit inner state of the agent. The Mann-Whitney U test showed no significant difference between the groups ($p = 0.16$). Within the E-group, there were large individual differences in awareness of the agent's inner state. If this approach is to be applied to general situations, we need to find ways to reduce the individual variation through the presentation method.

- **How strongly do you feel that the agent wanted to win the game?**

Both agents had as an objective that "the agent wants to win." The objective was very general but it was not presented explicitly. This question was used to explore whether the participants registered these objectives. Again, the Mann-Whitney U test showed there was no significant difference between the groups ($p = 0.34$). Nor were there differences in the averages or variances. This suggests that the participants did not pay attention to objectives that were not presented explicitly. This result was a little disappointing. We expected that the participants who had the intentional stance would read objectives and intentions that were not directly related to the information presented.

- **How were you motivated to play the game?**

This question was asked to confirm whether the agent could motivate the participant to play the game. There was a marginally significant difference between the groups ($p = 0.081$). The participants in the E-group were more motivated than the participants in the T-group. We suspect that there is a ceiling effect because the virtual exercise game in an immersive environment is itself motivating enough.

V. DISCUSSION

In our previous study [6], we were able to induce the intentional stance by presenting goal-oriented behavior, but it proved challenging to induce the intentional stance in situations wherein the relevance to task performance was low. This study aims to induce the intentional stance in more

general situations than those in the previous study. For the purpose, we made the participants estimate an agent's behavior model when performing the task. In the evaluation experiment, when the participants interacted with an agent that presented encouraging behavior (the E-group), participants focused on the balance of the game score. They appropriately read the meaning of the agent's behavior, and their mental stance was influenced by the agent's interactive behavior.

A particularly important finding from our analysis was that the encouraging agent's behavior, while not directly related to task performance, affected the behavior of the participants in performing the task. The participants were obviously aware of the meaning of the agent's behavior (i.e., the agent encouraged the participant's commitment). Although the meaning was not usually related to the balance of the game score which was directly related to the task performance, the participants took care to balance the game score. This suggests that the agent's behavior model induced affective effects. Humans naturally show this kind of consideration even in competitive situations. We think that this type of consideration is a first step to establishing a social relationship between humans and artificial agents.

On the other hand, the proposed method did not affect the participants' judgment of those parts of the agent's behavior that were not related to the explicit behavior. We were disappointed with this result because we expected that the participants would be able to judge the agent's behavior more broadly. In future studies, we will investigate an interaction model that allows the participant to judge a range of behaviors in long-term interactions. We think that our previous studies ([6], [18]) provides the foundations for such an interactive model.

VI. CONCLUSIONS

In this study, we investigated how to influence the mental stance of human participants during task performance when the behavior of the agent is not directly related to the task itself. For this purpose, we tried to make the participants estimate the agent's behavior model in human-agent interaction. We adopted "encouraging behavior" as an estimated model of the agent because the causal relationship between the agent's behavior and its intention was clear and presumable. We implemented two agents: an "encouraging agent" that provided motivational behavior to the participants and a "time-report agent" that reported the passage of time to the end of the game. We conducted an experiment to evaluate whether the behavior model estimation had the potential to induce and maintain the intentional stance in a variety of situations. As a result, the agent could motivate the participants and they took care to balance the game score. This is a kind of affective assiduities. In future work, we will investigate an interaction model that allows the participant to judge a range of behaviors in long-term interactions.

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REFERENCES

- [1] B. Shneiderman and P. Maes, "Direct manipulation vs. interface agents," *interactions*, vol. 4, no. 6, 1997, pp. 42–61.
- [2] D. C. Dennett, *The intentional stance*. MIT press, 1989.
- [3] F. Heider and M. Simmel, "An experimental study of apparent behavior," *The American Journal of Psychology*, 1944, pp. 243–259.
- [4] M. Roubroeks, J. Ham, and C. Midden, "When artificial social agents try to persuade people: The role of social agency on the occurrence of psychological reactance," *International Journal of Social Robotics*, vol. 3, no. 2, 2011, pp. 155–165.
- [5] W. H. Dittrich and S. E. Lea, "Visual perception of intentional motion," *Perception - London -*, vol. 23, 1994, pp. 253–253.
- [6] Y. Ohmoto, J. Furutani, and T. Nishida, "Induction of intentional stance in human-agent interaction by presenting agent behavior of goal-oriented process using multi-modal information," in *COGNITIVE 2015: The Seventh International Conference on Advanced Cognitive Technologies and Applications*. IARIA, 2015, pp. 90–95.
- [7] B. Friedman, P. H. Kahn Jr, and J. Hagman, "Hardware companions?: What online aibo discussion forums reveal about the human-robotic relationship," in *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM, 2003, pp. 273–280.
- [8] J. Goetz, S. Kiesler, and A. Powers, "Matching robot appearance and behavior to tasks to improve human-robot cooperation," in *Robot and Human Interactive Communication, 2003. Proceedings. ROMAN 2003. The 12th IEEE International Workshop on*. IEEE, 2003, pp. 55–60.
- [9] T. L. Chen, C.-H. A. King, A. L. Thomaz, and C. C. Kemp, "An investigation of responses to robot-initiated touch in a nursing context," *International Journal of Social Robotics*, vol. 6, no. 1, 2014, pp. 141–161.
- [10] E. L. Deci and R. M. Ryan, *Intrinsic motivation and self-determination in human behavior*. Springer Science & Business Media, 1985.
- [11] A. St George, A. Bauman, A. Johnston, G. Farrell, T. Chey, and J. George, "Effect of a lifestyle intervention in patients with abnormal liver enzymes and metabolic risk factors," *Journal of gastroenterology and hepatology*, vol. 24, no. 3, 2009, pp. 399–407.
- [12] T. Readdy, J. Raabe, and J. S. Harding, "Student-athletes' perceptions of an extrinsic reward program: A mixed-methods exploration of self-determination theory in the context of college football," *Journal of Applied Sport Psychology*, vol. 26, no. 2, 2014, pp. 157–171.
- [13] K. Collins, K. Kanev, and B. Kapralos, "Using games as a method of evaluation of usability and user experience in human-computer interaction design," in *Proceedings of the 13th International Conference on Humans and Computers*. University of Aizu Press, 2010, pp. 5–10.
- [14] M. J. Wohl and A. L. McGrath, "The perception of time heals all wounds: Temporal distance affects willingness to forgive following an interpersonal transgression," *Personality and Social Psychology Bulletin*, 2007.
- [15] C. S. Dweck, "Motivational processes affecting learning," *American psychologist*, vol. 41, no. 10, 1986, p. 1040.
- [16] Y. Ohmoto and et al., "Design of immersive environment for social interaction based on socio-spatial information and the applications," *J. Inf. Sci. Eng.*, vol. 29, no. 4, 2013, pp. 663–679.
- [17] "Unity," <http://unity3d.com/> (2016/02/01).
- [18] Y. Ohmoto, S. Horii, and T. Nishida, "The effects of extended estimation on affective attitudes in an interactional series of tasks," in *CENTRIC 2015: The Eighth International Conference on Advances in Human-oriented and Personalized Mechanisms, Technologies, and Services*. IARIA, 2015, pp. 62–67.