

# An Experimental Study on Promotion of Pro-Environmental Behavior Focusing on “Vanity” for Interactive Agent

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**Abstract.** Although one of the solutions for environmental issues is to promote our pro-environmental behaviors (PEB) which is one of prosocial behaviors, it has not been done enough. This study focuses on “Vanity” for interactive agents as motivation for PEB. The purpose of this study is to confirm three hypotheses as follows; (1) One have “Vanity” for an interactive agent who is an observer. (2) Pro-social behavior is promoted by “Vanity” for interactive agents. (3) (1) can be also realized even when the prosocial behavior is PEB that are not supposed to be shared as one of our norms. In order to confirm these hypotheses, a comparison experiment employing an interactive agent and non-interactive agent was conducted. In the experiment, participants were asked to communicate with one agent for five minutes. After the communication, they were asked to wash dishes and to donate some money by the agent. Then, they were also asked to communicate with another agent, and they were asked to wash dishes and to donate by the agent as well. The amount of water use and the amount of donation were evaluated as indicators of PEB and prosocial behavior, respectively. Furthermore, the “Vanity” for the agent was measured by a questionnaire. As the result, there was a significant difference in the degree of “Vanity” ( $p < .001$ ), however there was no significant difference in the amount of water use and donation amount. The interactivity of the agent affected participants’ subjective feelings.

**Keywords:** Interactive agent · Vanity · Pro-environmental behavior · Subject experiment.

## 1 Introduction

Energy consumption has been increasing since the Industrial Revolution[1], and it has caused serious global warming issue. Since carbon dioxide, a greenhouse

gas, is generated with the consumption of energy, energy saving is necessary to solve the global warming issue. It is therefore necessary for individuals to perform pro-environmental behavior (PEB). Since PEB has a social dilemma structure, strong motivation is necessary to take action. In this study, the authors focused on “Vanity” as a motivation for PEB. “Vanity” is defined as “the desire to show oneself better to the other” in this study. This means that the presence of observer motivates them to behave prosocial activity to improve their reputation. Izuma et al. studied on their prosocial behaviors dealing with donation[2]. They compared donation rate in two cases with and without an observer, and revealed that the donation rate got higher in the case with observer. This can be interpreted that they change their behavior worrying about their reputation. In other words, they have vanity and tend to show themselves better when being observed. It has been known that the target of the vanity should not always human being according to conventional studies. Powel et al. conducted an experiment where they found that the amount of donations with eye figure on a donation box in supermarket increased 48% comparing with that without eye figure[3]. The dictator’s game conducted by Haley & Fessler indicated that they provided more dividend under the condition where eye figure was displayed on the screen than that without eye figure[4]. Although above studies suggest that vanity has a possibility to motivate them to do prosocial behaviors which may make them lose over, there have been few study to deal with PEB as one of the prosocial behaviors. In this study therefore the authors have focused on an interactive agent as an observer to tickle their vanity and promote their PEBs. The interactive agent is expected to have strong influence for making them to have vanity and to improve prosocial behaviors comparing with non-interactive agent because they have higher personification. The purpose of this study is therefore to confirm the following hypotheses related to the relationship between an interactive agent as an observer and prosocial behaviors such as PEB.

- Hypothesis 1. They tend to have more vanity for an interactive agent than that for non-interactive agent.
- Hypothesis 2. The vanity for an interactive agent promotes prosocial behaviors which value is shared as norms.
- Hypothesis 3. Hypothesis 2 can be held even when the prosocial behavior is PEB which is not known to be shared as norms.

## 2 Design guidelines of interactive agents to promote PEB

Based on the conventional studies mentioned above, the following three factors are supposed to be essential to stir vanity and defined as the design guideline for the interactive agent.

1. The user feels that the agent does evaluate his/her behavior.
2. The user feels that the agent has sense of value for certain activities (PEB / protective activity in this study).
3. The user feels the agent favorable.

### 3 Experimental method

#### 3.1 Outline of experiment

In this study, a comparison experiment was conducted with two experimental conditions of an interactive agent and non-interactive agent, and their vanity for the agents and prosocial behaviors were measured to find whether three hypotheses mentioned in Chapter 1 were held or not. Concretely, in order to verify the hypothesis 1, questionnaires were given after contacting with both agents to investigate how much vanity they had. In order to verify the hypothesis 2, how much amount of donation they made, which was an index of prosocial behavior, was investigated when communicating with both agents and compared the results. And in order to verify hypothesis 3, how much amount of water they saved to do a task, which was an index of PEB, was measured when communicating with both agents and compared the results as well.

#### 3.2 Interactive and non-interactive agents

In this study, a chick type CG character “Piyota” was employed as the agent. Piyota has been developed as a non-human-type interactive agent, and it can dynamically form emotional expressions [5][6]. Fig.1 shows the appearance of two types of agents employed in this experiment. In the experiment, one was assigned as an interactive agent while another was as non-interactive agent. And two kinds of agent’s speech voice with higher pitch and lower pitch were generated using a prototype of deep neural network-based parametric text-to-speech developed by R&D group of Hitachi, Ltd.. Their colors and voices were set to be different for the interactive agent and non-interactive agent in order for the participants to distinguish them. The assignment of their colors and voices were randomly set to each participant in order to counterbalance their influence. The fundamental design of the both agents were the same. Both of the agents talked to the participants that they thought PEB was important in order to realize the design guideline 2. And they talked about their private information to disclose themselves for the participants to feel them favorable in order to realize the design guideline 3. They also talked a short story which showed they sometimes observed and evaluated others’ behaviors in order to realize the design guideline 1. The difference of the agents was interactivity, for example, the non-interactive agent didn’t ask questions or do interactive behaviors such as they showed pleasure when they were stroked while the interactive agent did them. Table 1 shows the contents of their dialogues.

**Table 1.** Dialogue with interactive and non-interactive agents

| Element of remark  | Interactive agent  | Non-interactive agent   |
|--------------------|--|---|
| Self disclosure    | <ul style="list-style-type: none"> <li>· Tell that the agent's birthday gifts were always hand-me-down</li> <li>· Tell that the agent's birthday present hat is still a favorite</li> <li>· Tell that many brothers gathered together on a cold day</li> </ul>   | <ul style="list-style-type: none"> <li>· Tell that the agent's birthday and Christmas were simultaneous cerebrated (the agent wanted to celebrate them separately)</li> <li>· Tell that the agent has big socks, and there is a big present in the socks when the agent gets up in the Christmas's morning</li> </ul>   |
| Find values in PEB | <ul style="list-style-type: none"> <li>· Explain that saving water can save power</li> <li>· Explain that detergent use leads to river pollution</li> </ul>  | <ul style="list-style-type: none"> <li>· Explain that saving water can save power</li> <li>· Explain that detergent use leads to river pollution</li> </ul>   |
| Evaluate others    | <ul style="list-style-type: none"> <li>· Tell that the agent did not want to see the water meter want up with the agent's friend leaving the shower running</li> <li>· Tell that friends do not sort garbage</li> <li>· Tell that the agent broke off a relationship with the agent's friend because they acted badly for the environment</li> </ul>   | <ul style="list-style-type: none"> <li>· Tell that the agent's friend was brushing her teeth with water flowing and did not want to see water wasted</li> <li>· Tell that the agent's friends set air conditioning to 18 degrees</li> <li>· Tell that the agent broke off a relationship with the agent's friends because they acted badly for the environment</li> </ul> |
| Interaction        | <ul style="list-style-type: none"> <li>· Ask for his/her name and call his/her by name</li> <li>· Ask and remember participant's birthday</li> <li>· Ask about transportation and respond according to the answer</li> <li>· Ask whether he/she does PEB and respond according to the answer</li> <li>· Express pleasure when being stroked</li> <li>· Ask whether he/she usually does housework and praise how to wash</li> </ul> |   |



**Fig. 1.** Appearances of agent.

### 3.3 Experimental period and participants

The experiment was conducted from December 9th to 20th, 2019. The participants were 33 university undergraduate students or graduate school students who had no communication anomaly.

### 3.4 Experimental Environment

The experiment was conducted in an experimental room which top view is shown in Fig.2. One of the agents was displayed on the monitor which was placed in front of the participants and the monitor size was 1.37m width and 0.87m height.

### 3.5 Procedure

Fig.3 shows the experimental procedure. The interaction of the interactive agent was realized in Wizard of Oz method. One of experimenters was hidden behind the partition, monitored their utterances and behaviors by a camera installed at the top of the monitor, and operated the agent speech and behaviors as reactions to them. In order to measure the degree of PEB activity, the participants were asked to wash dishes as an experimental task and amount of water use when washing was measured as an index of PEB. Since it is supposed that the amount of used water got decreased because of learning effect, a practice task for washing was done before the experiment. In the practice task, they were asked to decorate a cake and then wash the used chopping board, a cup, a spoon and a knife using a sponge, dishwashing detergent and water. After the practice task, they took a five-minute break and then conducted experimental condition 1, which was one of the interactive agent condition or the non-interactive condition. When starting the condition 1, they were given one 500 JPY coin, four 100 JPY coins and ten 10 JPY coins as their reward. And they were instructed to use the money when they donated in the later experiment. After that, the agent appeared and talked for five minutes as shown in Fig.4. They were asked to wash the dishes as well as the practice task and then they were to donate some money. The amount of donated money was measured as an index of their prosocial behaviors. They moved to

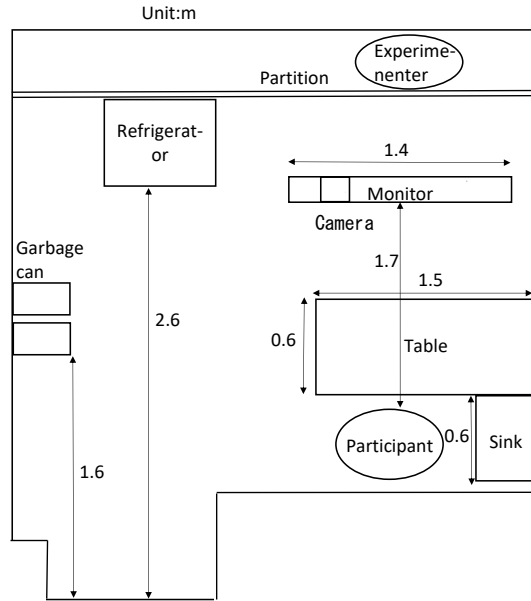


Fig. 2. A layout of an experiment room.

the waiting room after the donation and answered the questionnaire. Then the condition 2 started where another agent appeared as well as the condition 1. When starting the condition 2, the same amount of coins was given as well as the condition 1. The agent of condition 1 and 2 was one of the interactive agent or the non-interactive agent and they were randomly assigned to each participant in order to counterbalance the order to eliminate the ordering effect.

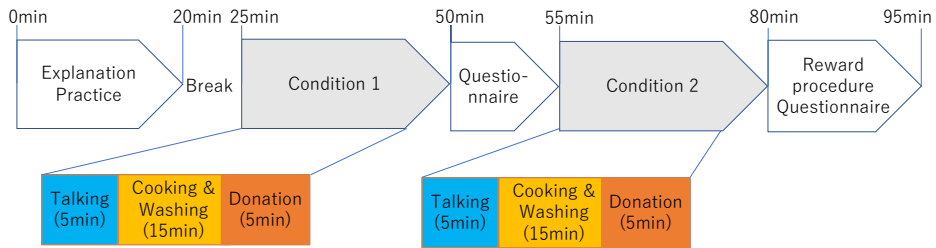
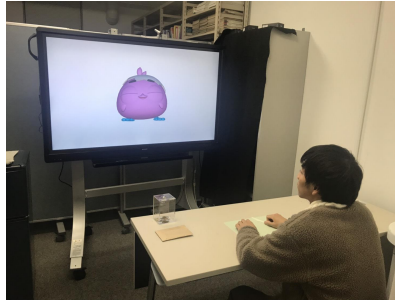


Fig. 3. Experimental procedure.



**Fig. 4.** A Scene of experiment.

### 3.6 Measurement items

– Questionnaire

The following subjective feelings were asked in seven grade Likert scale from 0 to 6.

1. How they felt they had interacted with the agent (interaction).
2. How they thought the agent regarded ecological activity valuable (understanding of sense of value for ecological activity).
3. How they thought the agent regarded protection of endangered species valuable (understanding of sense of value for species protection).
4. How they felt the agent had evaluated your behavior (evaluated feeling).
5. How they like the agent (favor).
6. How they wanted to show themselves better than usual (vanity).
7. How they felt the agent had its own will (will).

– Amount of donation

Each agent asked donation for species protection to the participant. The amount of the donation was measured under each condition as an index of prosocial behavior because its value has been widely shared among people.

– Amount of water use

The agent talked to them that saving water was important for the environment and then they were asked to wash dishes and the amount of the water use when washing was measured as an index of PEB.

– Feeling to be observed by experimenter

Because it may be possible that their behaviors based on the vanity was not for the agent but for the experimenter, the feeling how they had been observed by the experimenter was asked by seven grade Likert scale from 0 to 6 as well.

## 4 Experimental Results and discussion

### 4.1 Subjective feelings for agents

The results were analyzed by two-tailed paired t-test between the interactive agent condition and non-interactive agent condition, and then the interaction

of order and appearance of agents were confirmed by two-way ANOVA. The analysis results are shown below;

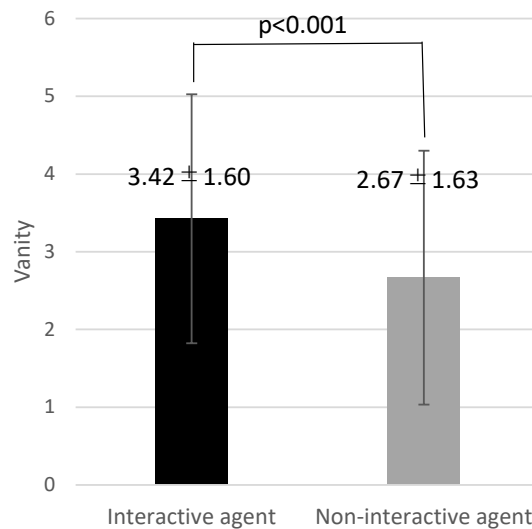
- Feeling of interaction  
The average score under the interactive agent condition was 4.24 (S.D.=1.35) while that under non-interactive agent condition was 2.54 (S.D.=1.77), and there was a significant difference ( $p<.001$ ). No interaction of orders and appearances of the agents were found by the result of ANOVA.
- Feeling of having will  
The average in the interactive agent condition was 4.00 (S.D.=1.64), and the average in the non-interactive agent condition was 3.12 (S.D.=1.75). A significant difference appeared ( $p<.001$ ). An interaction in regard to the order was observed ( $p<.05$ ). Specifically, when the agent in the Condition 2 was the non-interactive agent, the average value in regard to the non-interactive agent was significantly lower than that when the agent in the Condition 1 was the non-interactive agent. When contacting the non-interactive agent after contacting the interactive agent, a feeling that communication was one-sided could be emphasized, and they felt that the non-interactive agent have less will.
- Feeling to be evaluated  
The average score under the interactive agent condition was 4.18 (S.D.=1.33) while that under non-interactive agent was 2.67 (S.D.=1.67), and there was a significant difference ( $p<.001$ ). No interaction of orders and appearances of the agents were found by the result of ANOVA.
- Favor  
The average score under the interactive condition was 4.45 (S.D.=1.44) while that under non-interactive agent condition was 3.52 (S.D.=1.48), and there was a significant difference ( $p<.001$ ). No interaction of orders and appearances of the agents were found by the result of ANOVA.
- Understanding of sense of value for ecological activity  
The average score under the interactive agent condition was 4.94 (S.D.=1.09) while that under non-interactive agent was 4.76 (S.D.=1.09), and there was no significant difference. It was supposed that ceiling effect appeared because the scores under both conditions were high. An interaction of orders of the agent was found by the result of ANOVA. In case that they contacted with the interactive agent first, the average score under the non-interactive agent was lower. It was supposed when they listened to the non-interactive agent they only felt weak enthusiasm comparing with the interactive agent.
- Understanding of sense of value for species protection  
The average score under the interactive agent condition was 4.42 (S.D.=1.12) while that under non-interactive agent was 4.06 (S.D.=1.41), and there was no significant difference. From the results of understanding of sense of values, their understandings were not depending on the interactiveness of the agents but the contents which they talked. Interaction of appearance of agents was found, where the score of non-interactive agent was lower when its color was pink. It was supposed that the voice pitch of another agent, yellow, was lower



so that they felt its persuasion stronger. Because the average scores of both understandings were more than 4, it was supposed that they understood what they should do to show themselves better.

– Vanity

The result of vanity is shown in Fig.5. The average score under the interactive agent condition was 3.42 (S.D.=1.60) while that under non-interactive agent was 2.67 (S.D.=1.63), and there was a significant difference ( $p<0.001$ ). No interaction of orders and appearances of the agents were found by the result of ANOVA. It was found that the hypothesis 1 was held from these results.



**Fig. 5.** Average scores of vanity under interactive agent condition and non-interactive agent condition.

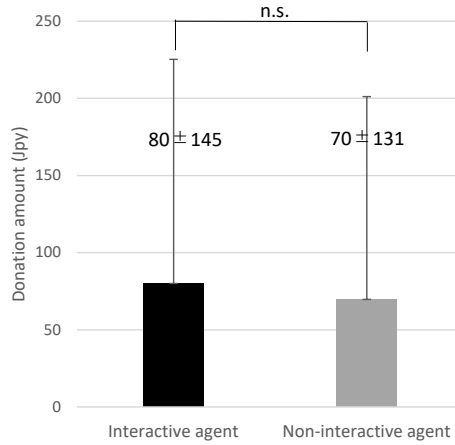
– Feeling to be observed by experimenter

The average score was 3.94 (S.D.=1.74) and there was no significant correlation between these scores and vanity, amount of donation or amount of water use. It was supposed that the feeling to be observed by experimenter didn't affect the experimental results.

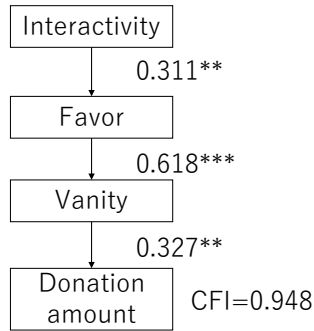
#### 4.2 Amount of donation

The average amount of donation is shown in Fig.6. There was no significant difference between the interactive agent condition and the non-interactive agent condition. No interaction of order and appearance was found by the results of ANOVA. Fig.7 shows the result of Structural Equation Modeling (SEM) from interactiveness to amount of donation. It was found that interactiveness affected

favor, favor affected vanity and vanity affected amount of donation. The model however included 500JPY donations which were outliers. When they were excluded, the path coefficient between vanity and donation would be lower.



**Fig. 6.** Average amount of donation under interactive agent condition and non-interactive condition.



**Fig. 7.** Result of Structural Equation Modeling for donation.

### 4.3 Discussion about donation amount

There was no significant difference of donation between the conditions even though vanity improved prosocial behavior as the result of SEM. It was because 23 participants out of 33 made the same amount of donations under both the conditions. In the experiment, they made donations twice. It was supposed that they remembered amount of their first donation and tended to give the same amount for their second donation. It was suggested that the experimental design

where the degree of prosocial behavior was measured by the amount of donation should be redesigned.

#### 4.4 Amount of water use

The average amount of water use is shown in Fig.8. There was no significant difference between the interactive agent condition and the non-interactive agent condition. No interaction of order and appearance was found by the results of ANOVA. Fig.9 shows the result of SEM from interactiveness to amount of water use. There was no significant path from vanity and amount of water use.

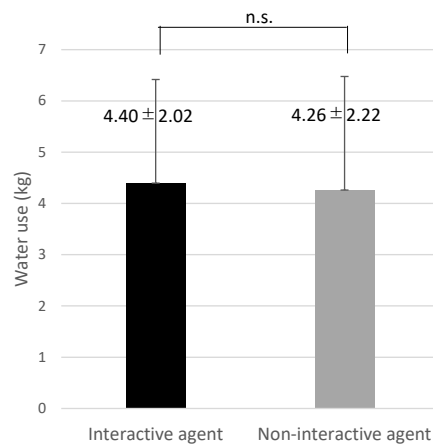


Fig. 8. Average amount of water use.

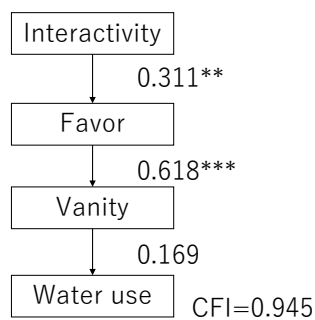


Fig. 9. Result of Structural Equation Modeling for water use.

#### 4.5 Discussion of Water use

There was weak but significant correlation found between amount of water use and feeling of interaction (Correlation Coefficient(C.C) = 0.36,  $p < .01$ ), and weak but significant correlations were also found between amount of water use and favor (C.C. = 0.31,  $p < .01$ ) and feeling of having will (C.C. = 0.29,  $p < .01$ ). As the feature of the dish washing task, it was supposed that the more they behaved politely the more they consumed water when they washed dishes. Because the feeling of interaction, favor and feeling of having will might make the behaviors of some participants polite, the amount of water use increased under the interactive agent condition. It was also suggested that the experimental design where the degree of PEB was measured by the amount of water use should be redesigned as well as donation.

### 5 Conclusion

In this study, a comparison experiment between an interactive agent and a non-interactive agent was conducted to verify whether vanity for agents worked to promote PEB. As the result, it was found that they had vanity for interactive agents, however it wasn't confirmed that vanity promoted prosocial behaviors such as donation and PEB. As a future work, the experimental design to measure the degree of prosocial behavior and PEB will be redesigned and another experiment will be conducted to confirm the other hypotheses.

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