

Can a Nudge Induce Garbage Disposal Behavior? Inducement in Prosocial Behavior*

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Abstract. In this study, the target behavior of prosocial behavior was defined as garbage disposal (behavior of taking out the trash), and an intervention method using an inducement was proposed and evaluated. Specifically, we conducted an intervention in which the saturation of a trash can was visualized using a colored light that could be changed to red, yellow, and green. In addition, questionnaire surveys were administered before and after the intervention to 28 undergraduate and graduate students and faculty members, asking about their attitudes and feelings toward garbage disposal behavior, and personality traits. The results of a survey on the frequency of trash disposal before and after the experiment showed that the time that the saturated trash can was left unattended was reduced by 81%. The questionnaire survey confirmed that the intervention increased the positive attitude toward trash disposal behavior, indicating that the intervention had an impact on trash disposal behavior. In addition, we were able to confirm the characteristics of individual personality traits and susceptibility to intervention.

Keywords: Prosocial behavior · Behavioral change support · Behavior of taking out the trash

1 Introduction

In recent years, various intervention methods to promote behavior change for solving social problems have been examined, and among them, research on techniques to promote prosocial behavior has attracted much attention. Prosocial behavior is the behavior of trying to help others or other groups of people or to do things for the benefit of other people or society, without expecting external rewards [1]. Volunteer activities such as beautification activities can be cited as examples.

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In this study, the elements of "intervention" for behavior change are classified into four categories: "inducement," "persuasion," "coercion," and "deception." In this experiment, we employed inducement as the approach method. Inducement is a method in which the target behavior is realized by the affected person without setting goals by himself/herself or coercion from others or society, such as institutions or requests. Compared to other intervention elements, inducement is characterized by the expectation of short-term but significant effects. Conventional studies on the promotion of prosocial behavior have not sufficiently considered what factors promote prosocial behavior from both psychological and physical perspectives. To the best of our knowledge, there are still few papers that investigate the correlation between interventions and individual personality traits. In this study, the target behavior of prosocial behavior was defined as the behavior of taking out the trash. An evaluation experiment was conducted with 28 participants to test the effectiveness of an intervention to visualize the saturation of a trash can by means of a colored light that changes color to red, yellow, and green. Questionnaires were administered before and after the intervention. In the questionnaire, personality traits and attitudes toward taking out the trash were measured in the pre-intervention questionnaire, and attitudes toward and awareness of taking out the trash were surveyed in the post-intervention questionnaire. This allows us to investigate the relationship between an individual's personality characteristics and susceptibility to intervention effects.

2 Related work

2.1 Prosocial behavior

Prosocial behavior is defined as "the behavior of trying to help others or other groups of people or to do things for the benefit of these people without the expectation of external rewards [1]. Specifically, they include volunteer activities, acts of kindness and compassion such as giving up one's seat on public transportation, and donations.

2.2 Classification of interventions

In this study, the elements of "intervention" are classified into four categories: "inducement," "persuasion," "coercion," and "deception." "Inducement" is to make an affected person voluntarily realize a certain behavior without setting a goal by himself/herself or being forced to do so by others or society, such as institutions or requests. "Persuasion" is support for behavior change toward the goal set by the affected person himself/herself, and an example is health promotion applications. It refers to more active interventions, such as a reminding function that actively encourages the target behavior or a system in which the affected person inputs data and behavior by himself/herself. In this study, we proposed a system which uses an inducement and a persuasion.

2.3 Research position

There are still few studies that propose triggers using IT or that take into account both the personality characteristics of the subjects and the physical changes caused by the experiment [3]. In addition, few studies have evaluated intervention systems that have both incentive and persuasion properties. Therefore, in this study, we propose a research method using an intervention system that has both nudge and persuasion properties, in which the weight of a trash can is indicated by colored light, and we evaluate the subjects' personality characteristics, psychology toward the intervention, and changes in their awareness of their trash disposal behavior through a questionnaire. This will allow us to assess both the effect of the experiment on the subjects as a whole and their sensitivity to the intervention given their individual personalities. The results of these IT interventions and combined evaluations are expected to provide very useful data for the widespread use of AI and IT technology-based interventions in the future.

3 System configuration and questionnaire design for the experiment

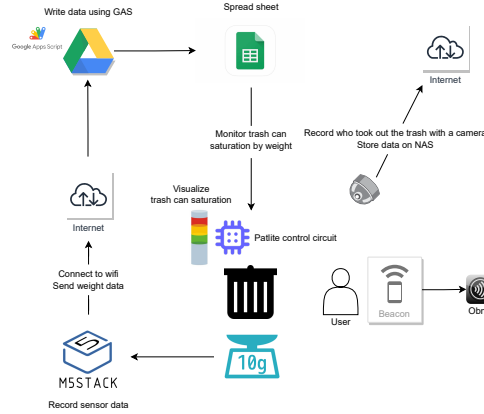


Fig. 1. System configuration diagram in this experiment

3.1 System configuration of the experiment

The system configuration of this experiment is described below. In order to construct the system for the experiment, we used a microcontroller module called M5Stack Core2³. The M5Stack can measure the weight of a trash can to the

³ <https://shop.m5stack.com/products/m5stack-core2-esp32-iot-development-kit>

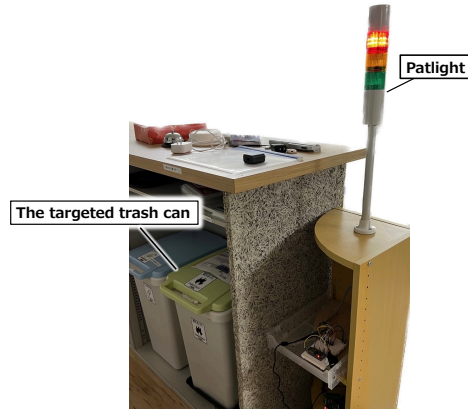


Fig. 2. View of the colored light indicating saturation of the trash can

second decimal place. A motion-detection network camera⁴ was used to record images around the trash can, and the images were stored on a Network Attached Storage (NAS⁵). For the color light, a Patlite⁶ was used, which can be changed to red, yellow, or green, and the color change of the Patlite is controlled by a circuit called ESP32⁷. The weight of the trash can was recorded by converting the data measured by M5stack into a Google spreadsheet once a minute using Google App Script⁸, an application development platform provided by Google. The weight of the trash can was about 2kg when empty, and although a range of variation was observed depending on the density of the trash, the weight was 2.3-2.7kg when the trash can was about 70% saturated, and more than 3.2kg when the trash can was almost full. Therefore, we set the color of the Patlite to green when the weight of the trash can was between 0.00-2.50kg, yellow when it was between 2.50-3.20kg, and red when it was more than 3.20kg. The M5Stack sends a signal to the Patlite once a minute. At the same time, in order to grasp the number of participants in the laboratory at a given time, participants carried a 3.7cm×3.7cm beacon called Hibeacon⁹ attached to their bags, keys, etc. A beacon is a device with unique ID information. A beacon is a terminal that transmits unique ID information at regular intervals. In this experiment, a service called Obniz¹⁰ was used as the receiver of the signals of beacons. The system configuration diagram is shown in Figure 1, and the actual situation where the Patlite turns red is shown in Figure 2. We used the trash

⁴ <https://www.forcemedia.co.jp/vivotek/fixed-dome>

⁵ <https://www.buffalo.jp/product/detail/ls520d0402g.html>

⁶ <https://www.patlite.co.jp/product/detail0000000628.html>

⁷ <https://www.espressif.com/en/products/socs/esp32>

⁸ <https://www.google.com/script/start/>

⁹ <https://www.hibeacon.jp/link01>

¹⁰ <https://obniz.com/ja/jobs>

Table 1. Evaluation items for each questionnaire

Measurements	Pre*	Post**
Attitudes toward garbage disposal behavior	✓	✓
Frequency of garbage disposal behavior or reasons for not taking out the trash		✓
Dissonance against the nudge		✓
Descriptive norm	✓	✓
Diversification of Responsibility	✓	✓
Self-esteem	✓	
Big5	✓	
Altruistic Behavior by Object	✓	
Social Value Orientation	✓	
Desire to gain praise and avoid rejection	✓	
Friendly motive	✓	
Social support reciprocity among friends	✓	
Confirmation of prosociality for garbage disposal behavior	✓	

* : Pre-questionnaire, ** : Post-questionnaire

can with a yellowish-green lid in the foreground of Figure 2, the trash can for combustible trash in this experiment.

The following subsections describe the evaluation items used in the questionnaires. The items evaluated in the pre- and post-questionnaire are shown in Table 1.

3.2 Questionnaire evaluation items

Descriptive norm Descriptive exemplars of garbage-dumping behavior were surveyed using originally developed evaluation items. The questions were the six below: "I think that everyone in the laboratory takes out the trash if it is piled up even if no one tells them to," "I think that everyone in the laboratory takes out the trash if it is piled up even if no one is watching or praising them," "I think that everyone in the laboratory takes out the trash if it is piled up even if they are a little tired," "I think that everyone in the laboratory takes out the trash if it is piled up even if they are not in a good mood," "I think that everyone in the laboratory takes out the trash if it is piled up even if they are busy and have no time," and "I think that everyone in the laboratory takes out the trash if it is piled up even when the weather is not so nice." The respondents were asked to indicate their answers on a seven-point scale, with 1 being "Not at all applicable" and 7 being "Very applicable."

Diversification of the responsibility When responsibility is shared by more than one person, the weight of that responsibility may be distributed among the individuals [4]. This dispersion of responsibility can lead to a situation in which the desired event is less likely to be accomplished. One of the predicted cases of dispersion of responsibility in garbage disposal behavior is that the subject will not take out the trash because he or she feels that "Someone else will take out

the garbage, so I don't have to do it myself." In order to measure the dispersion of responsibility in this experiment, we conducted a survey using two originally developed scales: "I think that someone else will take away the garbage in the laboratory without me" and "I do not have to worry about the garbage in the laboratory because I think that someone else will take out the garbage in the laboratory." The respondents were given a seven-point scale, with 1 being "Not at all applicable" and 7 being "Very applicable" as answers.

Confirmation of prosociality for garbage disposal behavior In order to confirm the prosociality of garbage disposal behavior, we asked, "Do you think it is beneficial for someone around you to take out the trash in the laboratory?" The answer items were set to "Not at all applicable" as 1, and "Very applicable" as 7.

Self-Esteem Scale The Rosenberg Self-Esteem Scale [5] is the most widely used scale for measuring self-esteem. In this study, the Japanese version of the RSES(RSES-J) by Mimura & Griffiths(2007) [6] was used to measure self-esteem. The answer items were rated on a 7-point scale, with 1 being "Not at all applicable" and 7 being "Very applicable."

Big Five The five factors of personality traits, "Extraversion," "Conscientiousness," "Neuroticism," "Openness," and "Agreeableness," were used as a model to evaluate the five factors of personality traits. As a model, we adopted a shortened version of the Big Five scale from Namikawa (2012) [7], which is less burdensome for respondents due to the smaller number of questions. 29 items were used to evaluate the Big Five, with 1 being "Not at all applicable" and 7 being "Very applicable" as answers.

Self-Report Altruism Scale Altruism is defined as "a way of thinking or a motivation to put the interests of others before one's own interests [8]. "We employed the Self-Report Altruism Scale of Oda(2013) [8] as the measurement item for the altruism scale. Seven questions were used as evaluation items, with "Not at all applicable" as 1 and "Very applicable" as 7 for answers. The magnitude of the numerical value was positively correlated with the strength of altruism.

Social Value-Intending Mental Act Scale Social intending is the disposition to seek mental interaction with others and to be interested in the way of life of others [9]. We adopted the items measuring social intending from Sakai's (1997) [9] Social Value-Intending Mental Act Scale as the assessment items for measuring social intending. Eight items, including questions such as "If I see someone in trouble, I willingly help them," were used for the content of the measurement, and seven-level response items were created, with 1 being "Not at all applicable" and 7 being "Very applicable."

Acquiring praise and avoiding rejection We employed evaluation items developed by Kojima (2003) [10], based on Sugawara (1986) [11], as a scale to measure both acquiring praise, which aims to gain positive evaluations from others, and avoiding rejection, which aims to avoid negative evaluations. The 18 items were evaluated as follows: "I want to show off my presence as much as possible when talking to others" as an evaluation item to measure gaining praise, and "I always pay attention so as not to be laughed at for doing something out of place" as an evaluation item to measure avoidance of rejection. The questionnaire was designed with a seven-point scale, with 1 being "Not at all applicable" and 7 being "Very applicable." The questionnaire was designed so that the order of these items was randomized.

Affiliation motive Typical elements of affinity synchrony in interpersonal relationships are affiliation motives and interpersonal alienation [12]. We used Sugiyama (2000) [12] as a scale to measure these factors as affiliation motives. A 17-item scale was used, including questions such as "I don't want to be ostracized" to measure rejection anxiety and "I like to associate with others" to measure affinity tendency, with "Not at all applicable" set at 1 and "Very applicable" at 7 as answers. The questionnaire was designed so that the order of these items was randomized.

The scale of social support reciprocity among friends "Social support" is the psychological and social support that occurs between people in society, such as friends, family members, and people at work [12]. Reciprocity in social support means that the amount of support given by the subject to the other person and the amount of support received by the subject from the other person is comparable [13]. In this experiment, we administered Asano's (2016) [14] six-item assessment to measure social support reciprocity as perceived by the subjects in the laboratory. The questions included a rating item, "I and my lab members comfort each other when we are down." A seven-point scale was used, with 1 being "Not at all applicable" and 7 being "Very applicable" as answers. The questionnaire was designed so that the order of these items was randomized.

Evaluation items for garbage disposal behavior The following were measured: attitudes toward garbage disposal behavior, frequency of taking out the trash, reasons for not doing so, and dissonance toward the intervention using the Patlite in this experiment. The attitudes toward garbage disposal behavior were measured by a 7-point scale, with 1 being "Not at all applicable" and 7 being "Very applicable." The frequency of taking out the trash after the Patlite intervention was also surveyed in five categories: "Every time," "Often," "When I am aware of it," "Sometimes," and "Never." If the respondent answered "never," the reasons were surveyed under the following categories: "I was busy," "I was going to do it later," "No one was around," "I still had room to put the trash in," "Someone around me did it," and "Others (free text box)."

4 Experiment

4.1 Validation items

In this study, the following three validation items were set to verify the effectiveness of the proposed system.

- Does the intervention by the proposed system affect the frequency of garbage disposal by users?
- Does the intervention by the proposed system affect the user’s attitude toward garbage disposal?
- Is there any correlation between the susceptibility to the intervention and the user’s individual characteristics?

4.2 Experiment summary

This experiment was conducted from 1/16/2023 to 1/28/2023. The pre-survey was distributed on 1/13/2023 and the post-survey was collected between 1/13/2023 and 1/29/2023, and the post-survey between 1/29/2023 and 2/3/2023. Twenty-eight subjects, including university students, graduate students, and faculty members, participated in the study. The subjects consisted of 27 males and 1 female, ranging in age from 21 to 37 years, with a mean age of 24.14 years (SD=3.11). We conducted an experiment to test the effect of introducing patrol lights, but we purposely did not inform the subjects which color represented what. This was done to ensure that the only variable being tested was the introduction of the Patlite and to eliminate any potential biases that could arise if the subjects were aware of the color meanings.

The experimental environment was prepared as shown in Fig. 2. A Patlite was placed next to the trash can to be tested, and the color of the Patlite turned red, yellow, or green according to the weight of the trash can. Questionnaire surveys were administered to the users once before and once after the experiment, according to the details described in chapter 3.1.

5 Results and discussion

Since all 28 responses were determined to be valid, we evaluated the results of the 28 questionnaire responses.

5.1 Does the intervention by the proposed system affect the frequency of garbage disposal by users?

Figure 3 shows a graph of the number of participants in the laboratory and the weight of the trash can from 2023/1/10, before the introduction of the Patlite on 2023/1/16, to 2023/1/28. The bar graph in blue represents the number of participants in the laboratory, and the line graph in red represents the weight of the trash can(kg). The area filled in light red at the top of the graph indicates

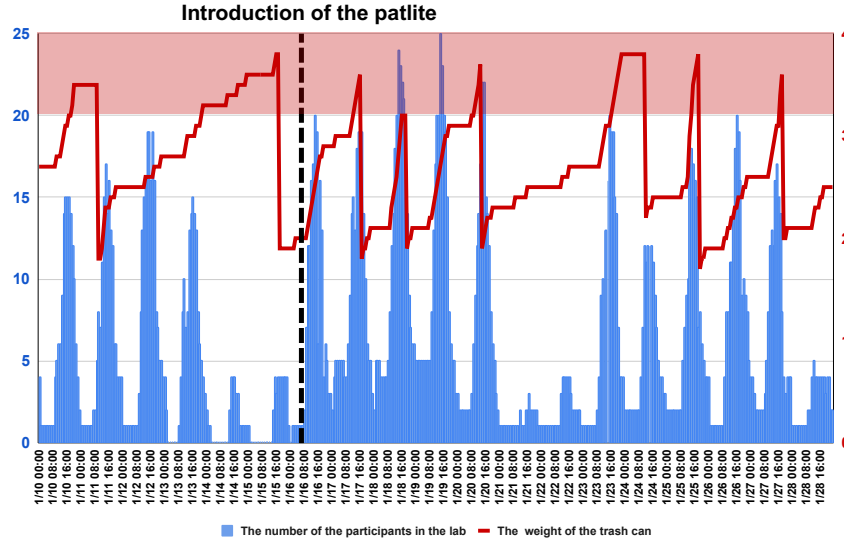


Fig. 3. The number of the participants in the lab and the weight of the trash can

that the weight of the trash can is 3.20kg or more. The timing of the introduction of the Patlite is indicated by the black dotted line. After the introduction of the Patlite, the Patlite turns red when the weight of the trash can exceeds 3.20kg. Compared to before the introduction of the Patlite, after the introduction, the time from when the weight of the trash can exceeds 3.20kg to when the trash is taken out was reduced from an average of 30 hours to 5.67 hours, a reduction of 81% on average. In the case of the trash disposal at 18:00 on 1/18/2023, the subject saw the red light of the Patlite and communicated with the other subjects, saying, "When the Patlite is on red, I feel I have to take out the trash." In the post-intervention case, some of the subjects had never taken away the trash before the experiment, and two out of the six post-intervention cases were the subjects who had not actively taken away the trash before the intervention.

5.2 Does the intervention by the proposed system affect the user's attitude toward garbage disposal?

For the common evaluation items in the pre- and post-questionnaires, namely "Attitudes toward garbage disposal behavior," "Descriptive norms," and "Diversification of responsibility," the mean values of the subjects' responses were calculated, and the results were compared between the pre- and post-questionnaires. For the Attitudes toward disposal behavior, higher values indicate less resistance to garbage disposal. For the Descriptive norms, higher values indicate a stronger normative awareness that garbage should be taken out. Both of these items increased throughout the experiment. For the item of the Diversification

of responsibility, higher values indicate stronger Diversification of responsibility for garbage disposal behavior. After the intervention, the mean value of the variance of responsibility became smaller. The amount of change in these three items before and after the experiment was evaluated for significant differences using a paired-sample t-test. Table 2 shows the mean values and pre- and post-questionnaire results for each item and the results of the t-test. The box-and-whisker plots of the questionnaire results before and after the intervention are shown in figure 4. A significant difference of $p < .001$ was confirmed with respect to the Diversification of responsibility. This indicates that the intervention increased the subjects' sense of responsibility for garbage disposal.

In the post-intervention questionnaire, "Did you check the trash can and take out the trash when the Patlite turned on?" To the question, "Sometimes," 9 out of 28 subjects responded, "Sometimes," or "I did when I noticed it." The subjects who answered "No, I didn't," gave reasons such as "I didn't notice the lights on" or "People around me did. For the dissonance rating items "I cannot sit calmly when the lights are on" and "I cannot concentrate on my research or work when the lights are on" in response to the intervention with the Patlite, the mean value of the responses was 2.5 (SD = 0.702) ("Not applicable at all" 1, "Very applicable" 7). The subjects' discomfort due to the intervention was less than 4, with the median of the choices from 1 to 7, indicating that the intervention did not cause much discomfort.

These results suggest that the intervention decreased subjects' overall resistance to trash disposal and increased their sense of responsibility for trash disposal behavior. In addition, some subjects checked the trash can and took out the trash, and communication regarding the contents of the trash disposal was observed, confirming that the guidance by the patrol lights induced the behavior of trash disposal.

Table 2. Mean results for common items in pre- and post-questionnaire questionnaires and test results for each evaluation item

	Pre-questionnaire	Post-questionnaire	Difference (post - pre)	Significant Difference
Attitudes toward garbage disposal behavior	3.268(<i>SD</i> = 0.508)	3.595(<i>SD</i> = 0.698)	0.327	n. s.
Descriptive norm	3.738(<i>SD</i> = 0.540)	3.964(<i>SD</i> = 0.454)	0.181	n. s.
Diversification of responsibility	4.196(<i>SD</i> = 1.339)	3.321(<i>SD</i> = 1.768)	-0.875	***

5.3 Is there any correlation between the susceptibility to the intervention and the user's individual characteristics?

Next, we investigated the relationship between individual personality traits and susceptibility to the intervention. Specifically, we evaluated the correlation between 12 individual personality traits and the change in attitudes toward garbage disposal after the intervention. First, the mean value of each measurement was calculated for each individual. Next, we calculated the difference between the mean value after the intervention and the mean value before the intervention for

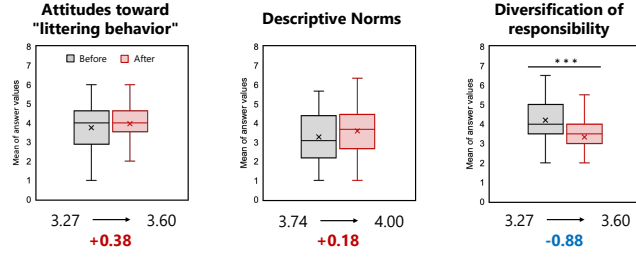


Fig. 4. Box-and-beard diagram of pre- and post-experimental questionnaire results of psychological items garbage disposal

Table 3. Correlations between individual personality traits and the impact of the intervention

	Attitudes toward garbage disposal behavior	Descriptive norm	Sense of responsibility for taking out the trash
Prosociality of taking out the trash	-.230	.189	.189
Self-Esteem Scale	.184	.140	-.230
Self-Report Altruism Scale	-.257	-.272	.341
Social value-intending	-.154	.087	.032
Acquiring praise and avoiding rejection	.032	-.099	-.041
Affiliation motive	-.109	-.038	.019
Social support reciprocity among friends	-.363	.061	-.009
Extraversion(Big5)	.178	.162	.122
Conscientiousness(Big5)	-.108	.047	-.013
Neuroticism(Big5)	-.411	-.188	-.132
Openness(Big5)	-.164	-.040	-.054
Agreeableness(Big5)	.091	.066	.170

the three items of "attitudes toward garbage disposal," "descriptive norms," and "responsibility dispersion. For "responsibility dispersion," we reversed the sign of the obtained value, and it was used as an indicator of the strength of the sense of responsibility for taking out the trash. Finally, we calculated the correlation coefficient between the mean values of the individual personality traits and the difference between the mean values of the awareness of garbage disposal before and after the intervention. The results are shown in Table 3.

Weak correlations were found for several items, with absolute values between 0.300 and 0.500. The change in the "Self-Report Altruism Scale" and "Sense of responsibility for taking out the trash" showed the largest positive correlation, with a correlation coefficient of 0.341. The correlation coefficient between the "Neuroticism" of the Big Five and "attitudes toward garbage disposal behavior" was -0.411, the largest negative correlation. We judged that a correlation relationship was observed for the items for which correlation coefficients with an absolute value of 0.35 or higher were observed in a small number of 28 subjects. The reason why there was a negative correlation between the reciprocity of "Social support reciprocity among friends" and the change in "Attitude toward littering behavior" can be considered that users with high social support reciprocity among friends often engaged in garbage disposal behavior before the

intervention and that the intervention reduced the aggressiveness of the garbage disposal behavior. In fact, a user who frequently dumped trash before the intervention said, "I felt that if the Patlite was on, I didn't have to take out the trash because someone else would do it." The negative correlation between Big5 Neuroticism and the change in attitude toward garbage disposal showed that the higher the Neuroticism, the less willingness of the users to take out the trash after the intervention. One of the users commented that he felt like he was being watched by the camera and was reluctant to go to the dump, suggesting that the intervention may reduce the aggressiveness of dumping behavior among users with high Neuroticism. In addition, users with a higher Self-Report Altruism Scale showed smaller dispersion of responsibility after the intervention. It can be considered that the users who have a strong mindset of prioritizing the interests of others over their own interests felt that they should engage in trash disposal behavior before the intervention and that the intervention led them to engage in trash disposal behavior. In fact, one of the users said that he usually thought about taking out the trash and that he took out the trash a few times after the intervention.

5.4 Future work

In the future, in addition to the intervention of inducement by the Patlite introduced in this study, we will conduct a hybrid intervention of three types: persuasion by posting a poster to promote trash disposal, and group-associative and psychological rewards by reporting trash disposal behavior by a Slack bot and recommending appreciation. We expect to increase the effectiveness of the hybrid intervention and to evaluate the combined effects of these different types of interventions in the future.

6 Conclusion

In this paper, we focused on the method of promoting prosocial behavior, and proposed a method using colored light to promote garbage disposal behavior, and evaluated the psychological effects and attitude changes of the method on the subjects through a questionnaire survey. Based on the findings of this study, we will plan to improve the hybrid intervention that integrates inducement and persuasion and verify its effectiveness in longer-term experiments.

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