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# Short-term responses to nudge-based messages for preventing the spread of COVID-19 infection: Intention, behavior, and life satisfaction

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## Abstract:

To control and slow down the spread of COVID-19, policymakers and practitioners are employing messages with elements and wording based on nudges to encourage people's voluntary behaviors of contact avoidance and infection prevention. However, although existing studies have found that nudge-based messages strengthen their intention to take the behaviors, it is not known whether the messages really promote their actual performance. In the end of April 2020, we conducted a survey experiment on a nationwide sample of Japan through the internet, where we randomly provided to them one of five different nudge-based messages and a message without nudges, and subsequently ascertained their intention to take the contact avoidance and infection prevention behaviors. In the beginning of the following month, May, we further conducted a follow-up survey to determine their actual behavioral changes. The empirical analysis with 5,225 respondents found that only the "Altruistic Message" emphasizing that their behavioral adherence would protect the lives of people close to them reinforced their intentions and also could promote some actual behaviors. However, the similar behavioral changes were not observed for the messages which contained an altruistic element but emphasized it in a loss-frame, or described it as protecting both of their own and others' lives. The message emphasizing only their own benefit were found to have the adverse effect of impeding their intention and behavior. Further analysis revealed that even the gain-framed "Altruistic Message" with the promotional consequences had side effects of deteriorating the quality of sleep and diet and life satisfaction. When employing nudge-based messages as a countermeasure for COVID-19, the policymakers and practitioners need to carefully scrutinize the elements and wording of the messages while considering their potential adverse effects and side effects.

**Keywords:** Infectious diseases, nudge, behavioral economics, altruism, physical distance

**JEL codes:** C93, D01, D91, I12,

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The outbreak of COVID-19 is posing a major health threat all over the world. Until effective therapeutic drugs and vaccines are developed, it is crucial to slow down the further spread of novel coronavirus infections. Practicing social distancing, frequent and proper hand washing, disinfecting hands, reducing contact with other people, and wearing a mask have been reported to be effective in preventing the spread of infection (WHO, 2020). As such, there has been rising demand for information about what types of intervention can be performed to encourage individuals to take such preventive actions.

Urban lockdowns have been enforced in most countries, restricting individuals from going out and operating businesses. Governments' aim with such measures was to reduce the chance of contact with others. Meanwhile, some countries, including Japan, have been unable to enforce compulsory interventions such as the lockdowns under their current laws. Instead, the countries have implemented non-compulsory interventions (e.g., requests/guidance), urging people to voluntarily take preventive actions. Moreover, the number of the countries that have now lifted the previously implemented lockdowns is increasing. Also in such countries, non-compulsory interventions are expected to encourage voluntary preventive behaviors while simultaneously resuming economic activity. Therefore, there is currently a particular need for insight into which non-compulsory intervention effectively promotes voluntary infection prevention behaviors in individuals.

“Nudge” is an intervention that makes use of behavioral economics and is generally known as a method to guide people’s behavior toward a socially desirable direction while maintaining their

freedom of choice (Thaler & Sunstein, 2009). It has been reported that nudge-based interventions can promote positive behaviors in medical and health fields (Patel et al., 2018; Vallgårda, 2012).

In this COVID-19 pandemic, policymakers and medical practitioners have developed a message that contains elements of nudges and used such a nudge-based message to encourage people to take the behaviors of contact avoidance and infection prevention. In particular, we often found altruistic messages emphasizing that taking such the behaviors will save the lives of others (British Broadcasting Corporation News, 2020; New Zealand Police, 2020).

Concurrently, an increasing number of studies have experimentally evaluated the impacts of nudge-based messages on people's intentions and actual behaviors to prevent the spread of COVID-19 infection. For example, Jordan et al. (2020) found that the message that emphasizes the public interest ("don't spread it") was more effective in strengthening intention to take measures to prevent COVID-19 than the message that emphasizes an individual's interest ("don't get it"). Lunn et al. (2020) found that the message emphasizing the possibility that you could cause the exponential spread of infection to others was more effective in fostering intention to take preventive actions than the message that instructs people to maintain social distance of two meters. Utych and Fowler (2020) found that people residing in an outbreak region were likely to recognize the risks of COVID-19, when they received the message emphasizing how COVID-19 poses a danger both to the elderly and young people. In addition, Barai et al. (2020) reported that their nudge-based messages did not have no additional stimulatory effect among people who were already taking sufficient preventive actions. Furthermore, Falco and Zaccagni (2020) found that the message emphasizing how taking preventive actions benefits "you and your family"

increased intention to engage in such actions, although they had no observable effect on their actual behaviors.

Existing studies suggest that altruistic messages making people consider the benefits and risks to others strengthen intention to take preventive behaviors. However, little is currently known about which message promotes their actual performance of the behaviors.

This study conducted the following online experiment for residents throughout Japan to clarify the effect of nudge-based messages on their intention to take actions to prevent the spread of COVID-19 infection, actual behavior, and life satisfaction. In the experiment, after first presenting a nudge-based message and asking the subjects about their intention to avoid contact with others and to take preventive actions, we conducted a follow-up survey around one week later to determine whether the actual action had been performed. By using these answers, we will assess the influence of nudge-based messages on actual behavior as well as intention.

Additionally, the experiment and its follow-up survey captured subjects' degree of satisfaction in various daily situations, including overall lifestyle contentment, how leisure time is spent, family relationships, etc. The answers will enable us to verify the effectiveness of nudge-based messages on life satisfaction and clarify possible side effects.

Recent studies in behavioral economics suggest that it is important to develop nudge-based interventions which contribute to the achievement of social goals while not worsening individuals' welfare (Allcott & Kessler, 2019). The behavioral changes expected in this study are beneficial to our society in terms of preventing the spread of infection and at the same time to

individuals in terms of preventing their own infection. However, the changes also include the potential to limit or alter their lifestyles, which could lead to their disutility and may appear in forms of reduced income, unemployment, and poor health in the long term. Since this study has followed respondents only for a short period of time, we will use multiple measures of life satisfaction as proxies of individuals' welfare and empirically consider the potential for nudge-based messages to deteriorate it.

This study utilized five nudge-based messages: (1: Altruistic Message): By avoiding contact with others and taking action to prevent infection, you can protect the lives of people close to you; (2: Loss-framed Altruistic Message): If you do not take such measures, you will expose people close to you to danger; (3: Selfish message): By taking such measures, you can protect your own life; (4: Altruistic and Selfish Message): By taking such measures, you can protect the lives of yourself and people close to you; and (5: Simple Message): Stay home.

Our nudge-based messages have three main characteristics. First, we compared the message which emphasizes the interests of others (1) with that which emphasizes self-interest (3). Previous behavioral economics studies have found that many people act not only in their own interest but also in the interests of others, such as charitable giving (Andreoni ,1990) and other cooperative behaviors (Fehr & Gachter, 2000). Some studies have shown that messages emphasizing social interests enhance people's willingness to receive influenza vaccines (Betsch et al.. 2017) and to take actions to prevent the spread of COVID-19 (Jordan et al., 2020).

The message (4) emphasizes both sets of interest. We first expect that emphasizing both will further strengthen the people's intention and promote their actual behavior. However, in people attempting to behave for the interests of others, promoting both sets of interest may simultaneously "crowd out" their altruistic motivation and thus impeding their actions (Gneezy & Rustichini, 2000).

Second, we compared the message (1), which emphasizes the interests of others by framing in terms of "gain" and the message (2), which emphasizes by framing in terms of "loss." The prospect theory of Tversky and Kahneman (1981) states that people's choices can depend on whether they are framed in terms of "gain" or "loss," even if their substance is essentially the same. In health and medical fields, the "gain" frame has been found to be effective for the behaviors aimed at preventing the onset of diseases, including the use of sunscreen (Detweiler et al., 1999) and quitting smoking (Toll et al., 2007). Meanwhile, for promoting disease-discovery behaviors including undergoing a mammography (Schneider et al., 2001), "loss" frames have been shown to be more effective (Rothman et al., 2006).

Third, we compared the message (5) simply urging a specific action. It is generally known that simple expressions are easier to understand (Sunstein 2014). The way to simplify actionable instructions has long been the subject of debate in public health (Zarcadoolas, 2011). Our simple message "stay home" was also used through social media and online campaigns worldwide.

## Experimental Design

### Overview of Experiment

This study consisted of two parts; the first was an experiment for intervention that displayed nudge-based messages, while the second was the follow up. We commissioned MyVoiceComm Co., Ltd., which is a company engaged in conducting online surveys, to conduct our experiment and subsequent survey. Respondents were extracted from their monitors, who reside throughout Japan, such that the respondents' gender and age (20–69 years) ratios would be equal. The first experiment was conducted over a 3-day period from April 28–30, 2020, and 6,050 samples and their response data were collected. The follow-up survey was conducted during a 5-day period from May 8–12, 2020, and 5,664 samples and response data were collected. We used for the study analysis 5,225 respondents who participated in both and provide valid answers.

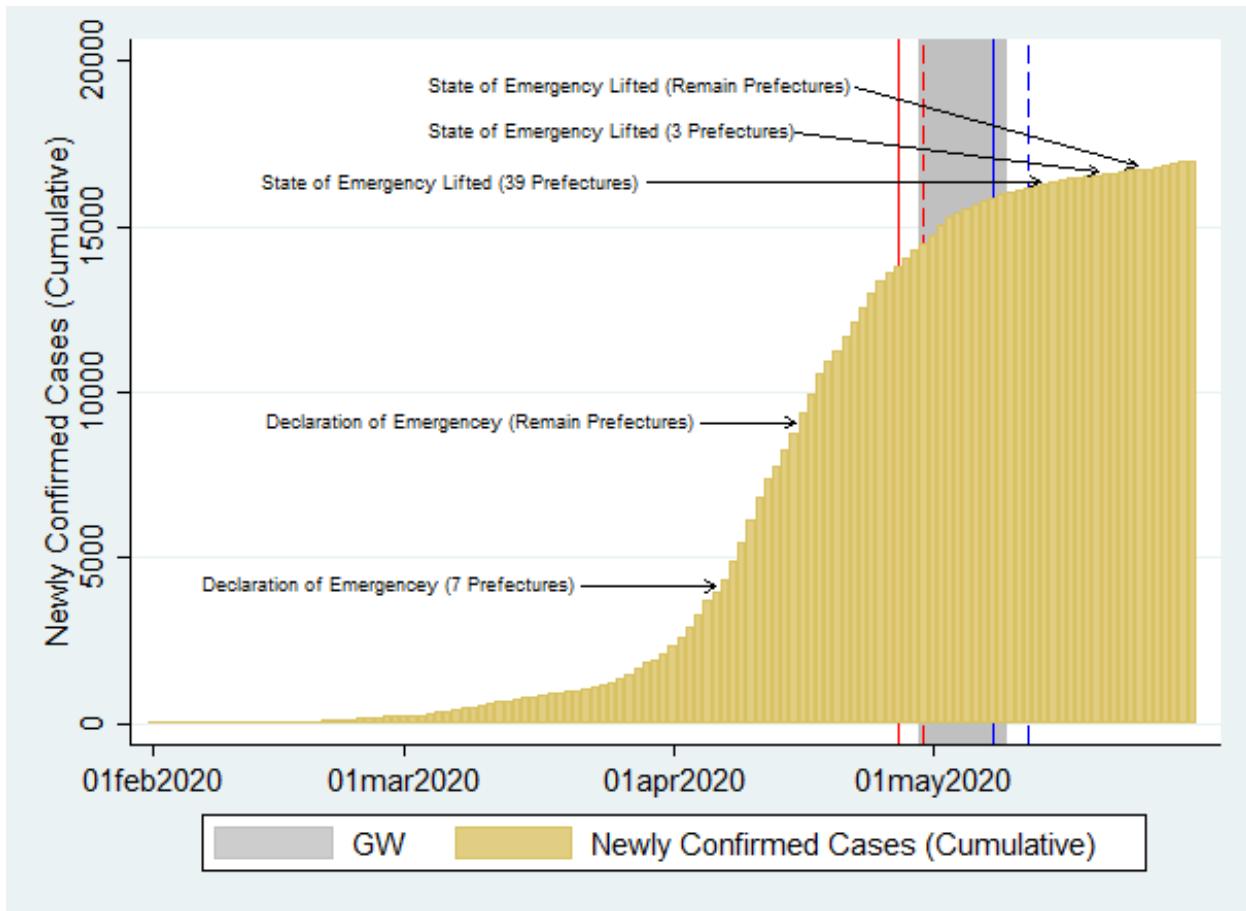
The first experiment captured respondents' personal attributes, including gender, age, and address, as well as frequency of contact avoidance and infection prevention behaviors for the week prior to the experiment and their level of life satisfaction. Next, we randomly assigned the respondents to one of the control group and five nudge-based message groups, and displayed a different message to each group. Then, we asked their intention to take the contact avoidance and infection prevention behaviors during the following week. Finally, we asked them questions about their socio-economic attributes, which are not affected by random assignment, including educational background, family structure, and household income.

The follow-up survey again presented questions concerning frequency of contact avoidance and infection prevention behaviors during the past one week and the degree of life satisfaction.

We conducted this experiment and survey from the end of April to the beginning of May, 2020, when the level of awareness regarding the spread of COVID-19 infection reached its peak in Japan (Figure 1). Furthermore, this period (referred to as “Golden Week” in Japan) contains several holidays in close succession, and every year many people travel to tourist spots throughout Japan. In the midst of the pandemic, it was extremely important to control people’s movements as much as possible during the holiday week, promote avoidance of close contact, and take thorough actions to prevent the further spread of infection.

We started this study after obtaining ethics committee approval from Graduate School of Economics, Osaka University.

**Figure 1 Timeline of the Experiment and the COVID-19 Related Policy in Japan**



*Notes:* A red solid (dash) line shows the start (end) point of the first experiment. A blue solid (dash) line shows the start (end) point of the follow-up survey. Grey shade (April 29-May 6) shows “Golden Week” (GW) which contains several holidays in close succession. Japanese government declared the state of emergency in 7 prefectures (Tokyo, Saitama, Chiba, Kanagawa, Osaka, Hyogo, Fukuoka) on April 7 and the other prefectures on April 16. Japanese government lifted the state of emergency in 39 prefectures on May 14 and 3 prefectures (Kyoto, Osaka, Hyogo) on May 21 and the other prefectures (Tokyo, Saitama, Chiba, Kanagawa, Hokkaido) on May 25.

## **Nudge-based Messages**

During the intervention, we first provided general information about COVID-19 (declaration of emergency, mortality rate, transmission routes, etc.) to all the groups (see the actual screen in Figure A1 of the Appendix). After that, we displayed a different message to each group. In the control group, we introduced three effective measures to prevent infection, as follows:

***“To prevent infection,***

- Reducing contact with others***
- Avoiding the “3 Cs” of closed spaces, crowded spaces, and close contact***
- Practicing proper hand washing and wearing a mask***

***are effective.”***

In the intervention groups, one of the five nudge-based messages was randomly displayed in addition to the introduction. The specific messages were as follows (see the actual screens in Figures A2-A7 of the Appendix):

(1: Altruistic Message)

***By refraining from going out, avoiding the “3 Cs,” washing your hands, and wearing a mask,***

***you can protect the lives of people close to you.***

(2: Loss-framed Altruistic Message)

*By going out, not avoiding the “3 Cs,” and not washing your hands or wearing a mask,  
you will put the lives of people close to you at risk.*

(3: Selfish Message)

*By refraining from going out, avoiding the “3 Cs,” washing your hands, and wearing a  
mask,  
you can protect your own life.*

(4: Altruistic and Selfish Message)

*By refraining from going out, avoiding the “3 Cs,” washing your hands, and wearing a  
mask,  
you can protect the lives of yourself and people close to you.*

(5: Simple Message)

*Stay home.*

*You can protect the lives of people close to you.*

We confirmed that socio-economic attributes were well-balanced across the groups (see Table A1 of the Appendix).

## Outcome Measures

This study used three types of indicator as outcome variables (Table 1). The first was contact behaviors with others by going out. For the following ten types of behaviors, in the first experiment, we measured the frequency of respondents' actual behavior during the previous one week before the intervention ("0: never" to "7: almost every day") and the strength of their intention to avoid such behavior after the intervention ("0: no intention of stopping" to "7: will definitely stop"), while the follow-up survey captured the frequency of their actual behaviors after the intervention on the same scale as the first.

The second indicator was other infection prevention behaviors. For the following 15 types of behaviors, in the first experiment, we assessed the frequency of respondents' actual behavior before the intervention ("0: never" to "7: almost every day") and the strength of their intention to take such behavior after the intervention ("0: no intention of doing" to "7: will definitely do"), while the subsequent survey captured the frequency of their actual behaviors after the intervention on the same scale as the first. We created the first and second indicators, which were based on the study of Jordan et al. (2020) and Muto et al. (2020) and fine-tuned, reflecting Japan's situations.

The third indicator was life satisfaction. We used a 5-point scale (responses ranging from "1: dissatisfied" to "5: satisfied") calibrated to seven categories of items, including general lifestyle, residential area, leisure time, current household finance status, family relationship, friendships, and work.

**Table 1 Outcome Measures**

		Frequency prior to the intervention			
Panel A. Contact behaviors with others by going out		("0: never" to "7: almost every day")			
		Mean	S.D.	0	7
1	Go to a tavern or bar	0.113	0.662	96.37%	0.15%
2	Go to a restaurant	0.288	0.956	88.18%	0.36%
3	Go to a cafe	0.181	0.812	93.21%	0.34%
4	Go to a supermarket or grocery store	2.541	1.881	16.99%	4.26%
5	Go to a gym	0.117	0.697	96.61%	0.19%
6	Go to work	2.285	2.651	51.08%	10.33%
7	Travel on public transportation such as trains and buses	0.859	1.808	76.18%	2.53%
8	Travel by plane	0.099	0.640	96.99%	0.27%
9	Participate in small gatherings and events (excluding online ones)	0.203	0.853	92.50%	0.40%
10	Participate in large gatherings and events (excluding online ones)	0.109	0.664	96.71%	0.25%

		Frequency prior to the intervention			
Panel B. Infection prevention behaviors		("0: never" to "7: almost every day")			
		Mean	S.D.	0	7

1	When you need to cough or sneeze, place a mask or handkerchief over your mouth (“cough etiquette”)	5.329	2.442	11.15%	57.75%
2	Practice gargling and frequent hand washing and disinfection of hands and fingers with alcohol	6.074	1.702	2.42%	68.47%
3	Try to avoid touching your face	4.101	2.418	14.29%	25.77%
4	Always wear a mask when talking	5.109	2.322	8.94%	46.81%
5	Avoid shaking hands	5.612	2.400	11.76%	67.67%
6	Talk with others via phone or video call whenever possible	4.116	2.805	23.43%	36.29%
7	Designate one person to do the shopping or go out in a small group and during times when stores are not crowded	5.095	2.204	6.76%	43.16%
8	Use cashless payment methods (credit cards, electronic money, etc.) instead of cash	4.558	2.564	14.79%	36.99%
9	Use take-out or home delivery services instead of going to restaurants	3.841	2.983	30.83%	36.16%
10	Use delivery or mail-order services for larger purchases	3.712	2.884	28.92%	31.63%
11	Always wear a mask when going out	5.905	2.040	5.46%	69.97%
12	Avoid going out if you feel unwell	5.023	2.684	17.26%	55.17%
13	Try to stay home as much as possible even if you are not ill	5.805	1.930	4.78%	61.14%
14	Get plenty of rest and sleep	5.613	1.842	2.63%	52.03%
15	Eat nutritious foods	4.802	2.038	5.69%	31.97%

		Degree prior to the intervention			
		(1: dissatisfied" to "5: satisfied)			
Panel C. Life satisfaction		Mean	S.D.	1	5
1	General lifestyle	2.974	1.131	12.90%	9.02%
2	Residential area	3.191	1.046	7.99%	10.37%
3	Leisure time	3.028	1.107	11.36%	9.25%
4	Current household finance status	2.762	1.160	17.81%	7.76%
5	Family relationship	3.374	1.095	7.06%	17.11%
6	Friendship	3.267	1.006	6.47%	11.93%
7	Work	2.877	1.075	13.61%	7.46%

*Notes:* We used the data of 5,225 respondents and calculate the descriptive statistics.

Table 1 also shows the level of each indicator prior to the intervention. We found that approximately 90% of respondents had not visited a bar, restaurant, cafe, or gym during one week prior to the intervention, and many had already taken some actions to avoid close contact. This study's situation is similar to that of Barai et al. (2020).

## Results

### Intention

Using only the data of the first experiment, we examined respondents' intention to take contact avoidance and infection prevention behaviors immediately after seeing nudge-based messages. We used for analysis an ordinary least-squares regression.<sup>1</sup>

Panel A in Figure 2 shows estimated parameters of receiving a nudge-based message, with 10 types of intention to avoid contact with others by going out as dependent variables. We found significant and promotional effects only for the Altruistic Message (although at a 10 percent level), which could strengthen respondents' intention to refrain from visiting supermarkets or grocery stores (4) and going to their office (6) during the following week. In contrast, we found no effect to increase their intention to avoid close contact for the other nudge messages, among which the Simple Message rather weakened their intention to refrain from going to gym (5).

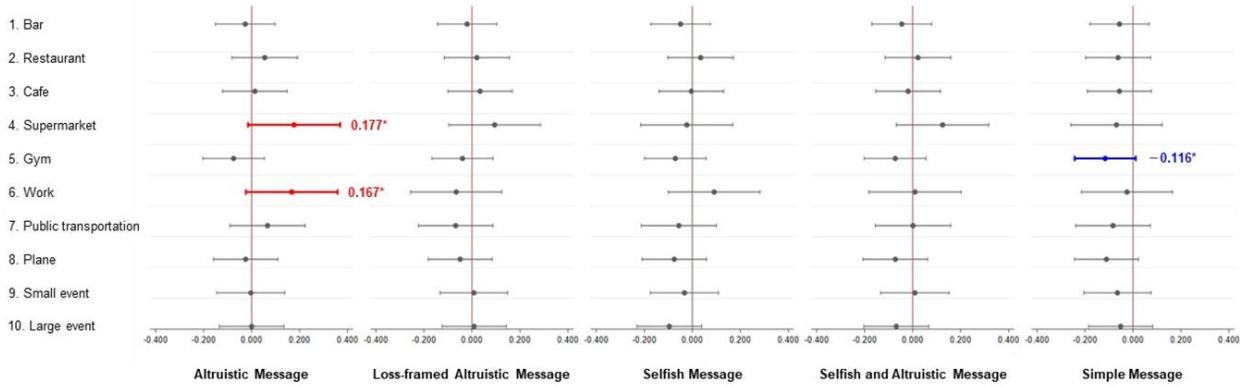
Panel B in Figure 2 shows estimated parameters of receiving a nudge-based message, with intention to take 15 types of infection prevention behavior as dependent variables. We also here found significant and promotional effects for the Altruistic Message, which

strengthened their intention to “3: try to avoid touching your face,” “5: avoid shaking hands,” and “6: talk with others via phone or video call whenever possible.”

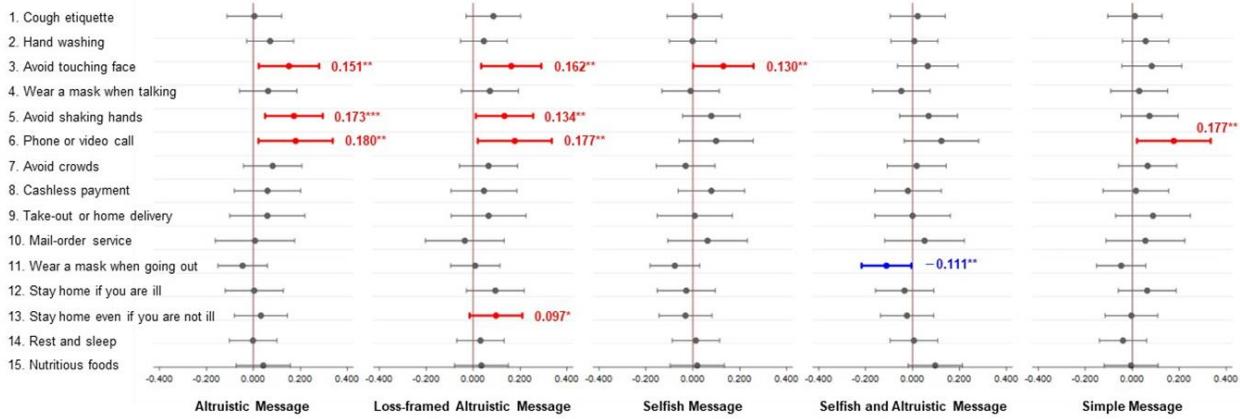
Additionally, the Loss-framed Altruistic Message were also found to have significant and positive effects on some intention to engage in infection prevention behaviors. The Selfish Message and the Simple Message had a positive effect on only one type of behavior, while the Selfish and Altruistic Message showed an opposite effect.

## Figure 2 Effects of Nudged-Based Messages on Intention

Panel A. Intention to Avoid Contact with Others by Going Out (“0: no intention of stopping” to “7: will definitely stop”)



Panel B. Intention to Take Infection Prevention Behavior (“0: no intention of doing” to “7: will definitely do”)



Notes: Significantly different from zero at the \*10% level, \*\*5% level, and \*\*\*1% level. A red line shows a promoting effect, while a blue line shows its opposite effect.

In sum, we found that the Altruistic Message, which is followed by the Loss-framed Altruistic Message, is effective for strengthening people's intention to take contact avoidance and infection prevention behaviors.

## **Behavior**

Using the data of both the first experiment and its follow-up survey, we investigated how respondents' behaviors of contact avoidance and infection prevention changed before and after seeing nudge-based messaging. We used for analysis a fixed-effect model estimation.

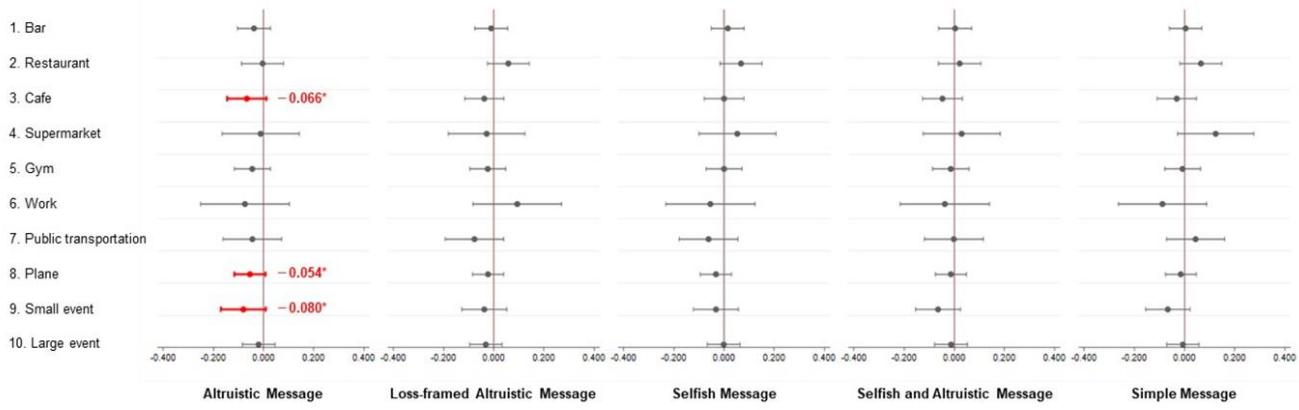
Panel A in Figure 3 shows estimated parameters of receiving a nudge-based message, by using 10 types of contact behaviors by going out as dependent variables. As with the case where we used respondents' intention as the outcomes, we found expected effects only for the Altruistic Message (although still at a 10 percent level), which could reduce people's frequency of visiting cafes (3), taking planes (8), and participating in small events (9). By contrast, no effect was observed for the other nudge-based messages to promote any contact avoidance behavior.

Panel B in Figure 3 shows estimated parameters of receiving a nudge-based message, by using 15 types of infection prevention behaviors as dependent variables. Surprisingly, any nudge-based message did not show an expected promotional effect, while they showed more or less opposite effects. In particular, the Selfish Message had negative effects on 7 types of the behaviors. Specifically, when receiving the message, the frequency of cough etiquette (1), hand washing and disinfection of hands and fingers with

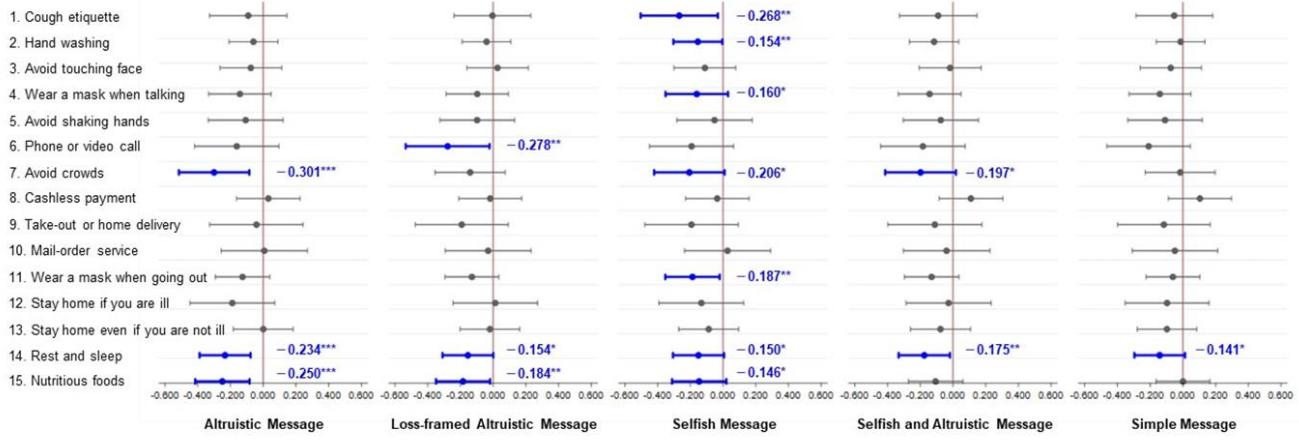
alcohol (2), wearing a mask when talking (4), designating one person to do the shopping or going out in a small group and during times when stores are not crowded (7), wearing a mask when going out (11), getting plenty of rest and sleep (14), and eating nutritious foods (15) are more likely to decrease compared to when receiving the message without any nudge in the control group.

### Figure 3 Effects of Nudge-Based Messages on Behavior

Panel A. Frequency of Taking Contact Behavior with Others by Going Out (“0: never” to “7: almost every day”)



Panel B. Frequency of Taking Infection Prevention Behavior (“0: never” to “7: almost every day”)



Notes: Significantly different from zero at the \*10% level, \*\*5% level, and \*\*\*1% level. A red line shows a promoting effect, while a blue line shows its opposite effect.

Even the Altruistic Message, which promoted some contact avoidance behaviors, had some opposite effects, decreasing the frequency of avoiding crowds when shopping (7), getting plenty of rest and sleep (14), and eating nutritious foods (15). However, it is possible that since people who received that message reduced the frequency of going out, they may have moved together as a group for their few opportunities to go out. In addition, since their frequency of shopping decreased, the quality of food and sleep may have deteriorated.

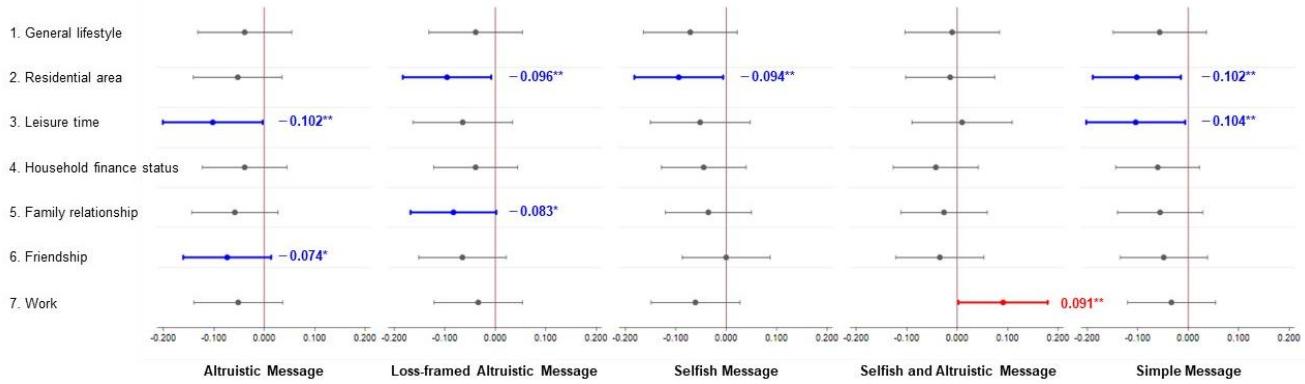
In sum, our results indicate the possibility that the Altruistic Message promotes actual some contact avoidance behaviors; however, the message has inevitable side effects at the same time. The other four messages either have no effect on actual behavior or, if they do, they have only negative effects, although some of the messages (in particular, the Loss-framed Altruistic Message) show expected promotional effects on intention.

### **Life Satisfaction**

We considered how respondents' degree of life satisfaction changed during the 1-week period after receiving the nudge-based messages, by using a fixed-effect model estimation. We found from Figure 4 that the Altruistic Message, Loss-framed Altruistic Message, Selfish Message, and Simple Message diminished some types of life satisfaction. Specifically, in comparison to the control group, the intervention group receiving the Altruistic Message showed a decrease in life satisfaction regarding leisure time (3) and friendships (6). This is also a kind of side effect, which we introduced in subsection of *Behavior*. However, we found the decrease in life satisfaction relating to

residential area, etc., for the Loss-framed Altruistic Message, Selfish Message, and Simple Message, which did not show any promotional effect on actual behavior.

**Figure 4 Effects of Nudged-Based Messages on Life Satisfaction (“1: dissatisfied” to “5: satisfied”)**



*Notes:* Significantly different from zero at the \*10% level, \*\*5% level, and \*\*\*1% level. A red line shows a promoting effect, while a blue line shows its opposite effect.

All results in the three subsections were confirmed using the other estimation methods, including an ordinal logit model.

## Discussion and Conclusions

We found from analyses that the patterns of the effects of nudge-based messages on respondents' intention to engage in contact avoidance and infection prevention actions, actual behaviors, and life satisfaction can be classified into three categories. The first category includes messages that can promote both their intention and actual behaviors, but also reduce quality of sleep and diet and life satisfaction. The second category includes messages that have a promotional effect on intention but no effect on actual

behavior and furthermore, reduce quality of life and satisfaction. The third category includes messages that not only have no promotional effect on intention but actually increase the frequency of contact behaviors and other risky behaviors as well as reduce quality of life and satisfaction.

The first type is the Altruistic Message, which was found to strengthen intention to avoid contact by going out and take measures to prevent infection as well as actually could reduce people's frequency of going to cafes, taking planes, and participating in small events. In contrast, this type of message had side effects, including a deterioration in quality of sleep and diet, and life satisfaction. The second type is the Loss-framed Altruistic Message and the third is the Selfish Message. No noteworthy and unifying trends were observed in conjunction with the use of the Altruistic and Selfish message and Simple message.

The intention reinforcing effects of the Altruistic message are consistent with those observed in Jordan et al. (2020). However, while Jordan et al. (2020) reported observing no difference between the effects of the Altruistic message and Altruistic and Selfish message, our results for the Altruistic and Selfish Message show no effect on respondents' intentions. This might be explained by motivational crowding out, where referring to one's own gain blocks a rise in altruistic motivation (Gneezy & Rustichini, 2000). Additionally, this study's respondents exposed to the Selfish message were likely to engage in behaviors with a high risk of infection, while the Altruistic and Selfish

message did not have the effect of promoting such actions. Emphasizing the interests of others over one's own interests might curb the appearance of the risky behaviors.

We found that only the Altruistic Message could have promotional effects on both people's intention and actual performance of contact avoidance and infection prevention behaviors, while the intention-behavior gap was found for the Loss-framed Altruistic Message. This is consistent with the results of previous studies, which demonstrated that a gain-framed message promotes disease prevention behaviors more than a loss-framed one (Detweiler et al., 1999; Toll et al., 2007).

Therefore, it is worth considering the employment of gain-framed altruistic messages to promote the actual behaviors as a countermeasure against the COVID-19 pandemic. Some public and medical institutions have already employed the altruistic messages (British Broadcasting Corporation News, 2020; New Zealand Police, 2020), and our findings will support the adequacy of such the efforts. However, the effects of our altruistic message on the behaviors could be weak, while their effects of reducing quality of sleep and diet and life satisfaction has been robustly found. Considering these side effects, policymakers should carefully consider whether the magnitude of the promotional effects are sufficient.

Why did some nudge-based messages not have the effect of transforming actual behaviors, even though they had the effect of strengthening intentions? One possibility is that before our intervention, the respondents had already taken contact avoidance and

infection prevention actions at the maximum level they could and there may have been no room for any further implementation. In addition, why does life satisfaction diminish even though behavioral changes have not occurred in many respects? One possibility is that receiving a nudge message may have made people acutely aware of the inconvenience to their current lifestyles as well as the need to prevent infection.

Future research should develop a nudge-based intervention that can promote both contact avoidance and infection prevention behaviors sufficiently forcefully while suppressing side effects of reducing quality of life and satisfaction. Also, this study only tracked respondents' behavior for approximately one week immediately after displaying the nudge-based messages, and thus the nudges' effects were short-term. Their long-term effects should also be investigated in future research.

### **Notes**

1. Our OLS estimations controlled the effects of age, gender, schooling year, married status, annual household income, and information on response time, in addition to actual behavior during the previous one week before the intervention.

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## Appendix

### Appendix A. Appendix Figures and Tables

#### Figure A1 Screen of General Information about COVID-19

COVID-19 is rampaging rapidly in Japan.

On April 7, the Japanese government declared a state of emergency in seven prefectures regarding the COVID-19. On April 16, the government also declared a state of emergency in 40 other prefectures, expanding the coverage area throughout Japan.

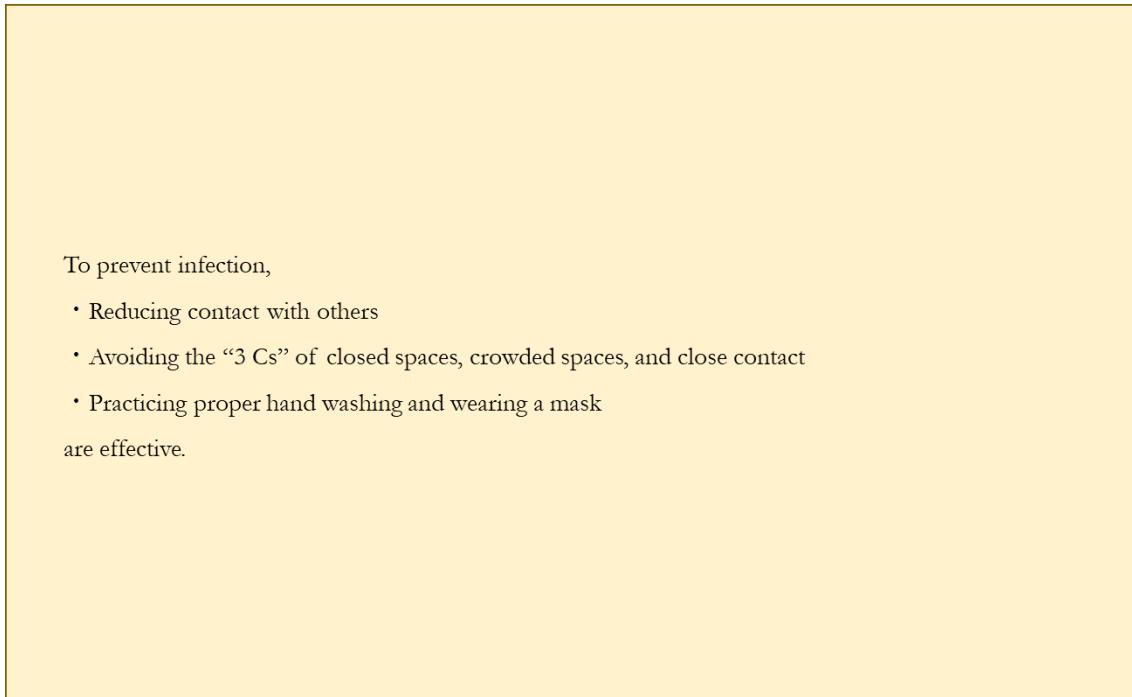
The spread of the disease has led to a collapse in medical care and the loss of many lives.

While the fatality rate for influenza is around 0.1%, the fatality rate for COVID-19 is known to be as high as 2.3%.

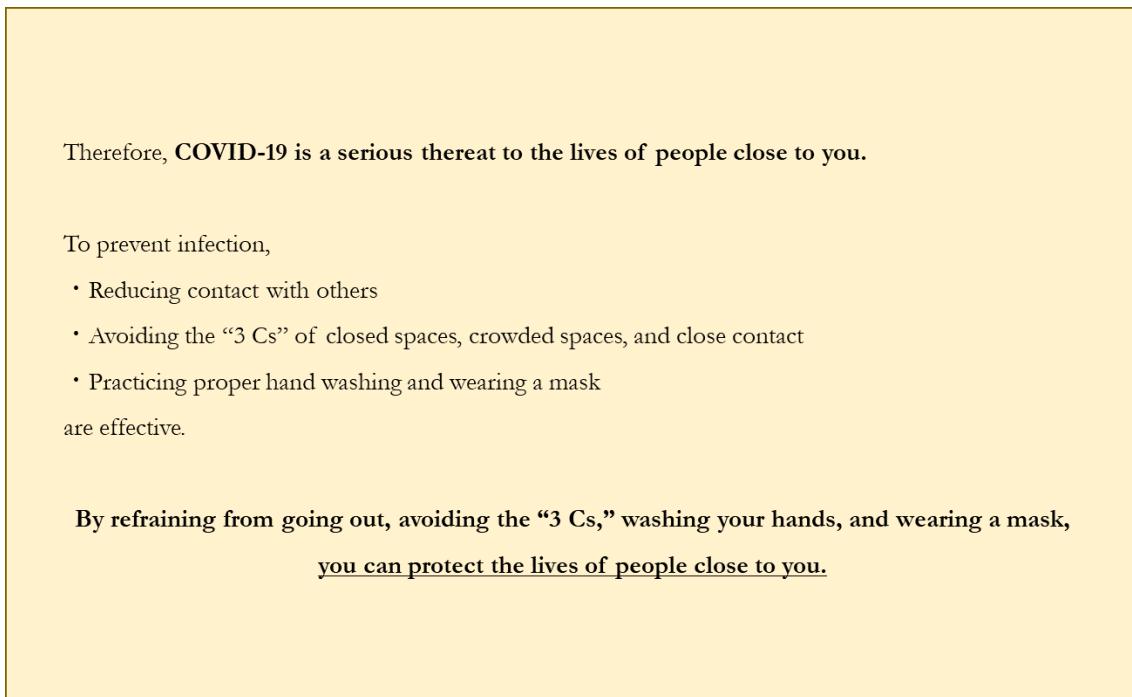
Although the main route of infection is through droplet and contact transmission, under certain conditions, such as talking with many people at close range in a closed space, there is a risk of spreading the disease even if there are no symptoms such as coughing or sneezing.

There is also a risk of spreading the infection in asymptomatic people.

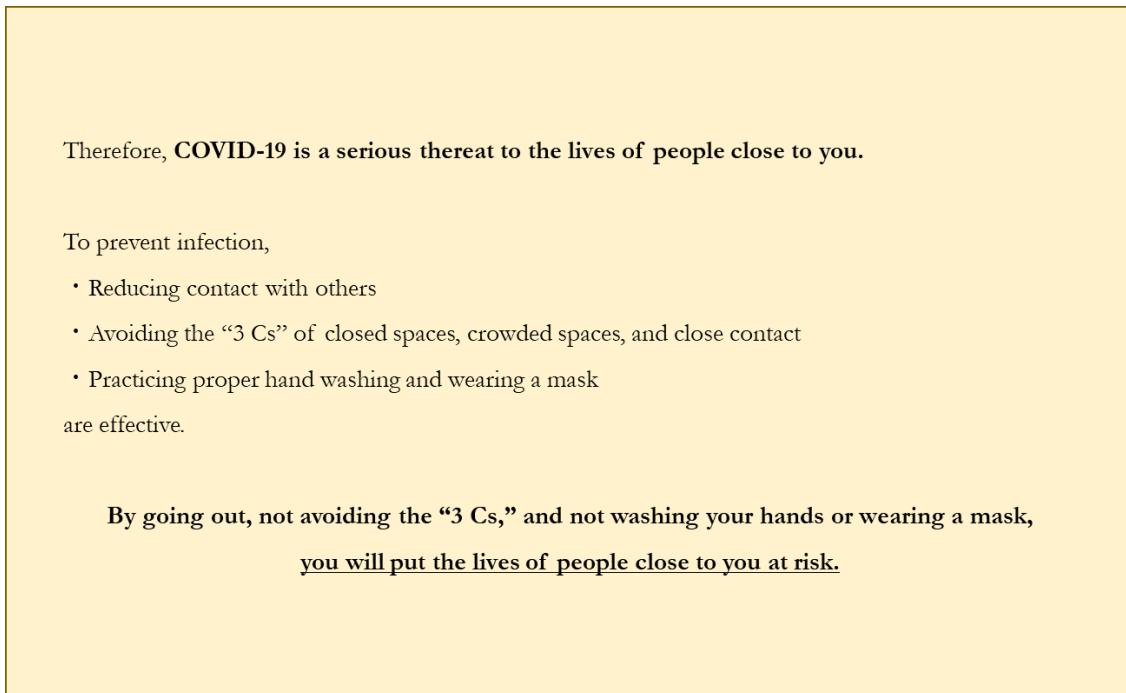
**Figure A2 Screen of Control Group**



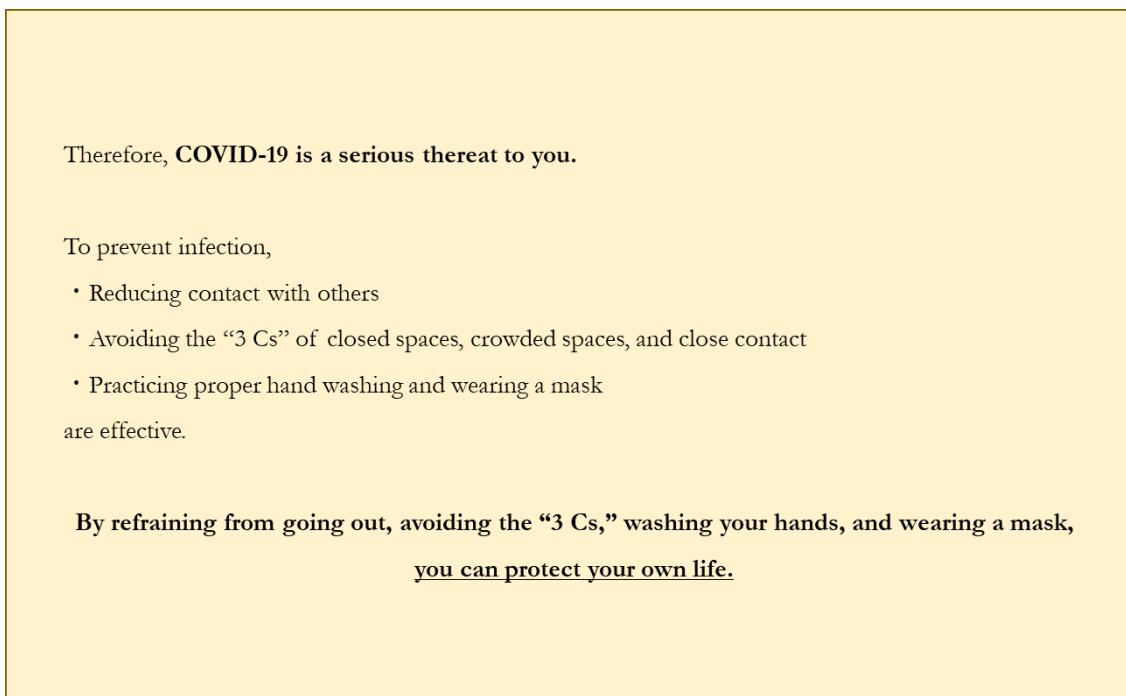
**Figure A3 Screen of “Altruistic Message” Group**



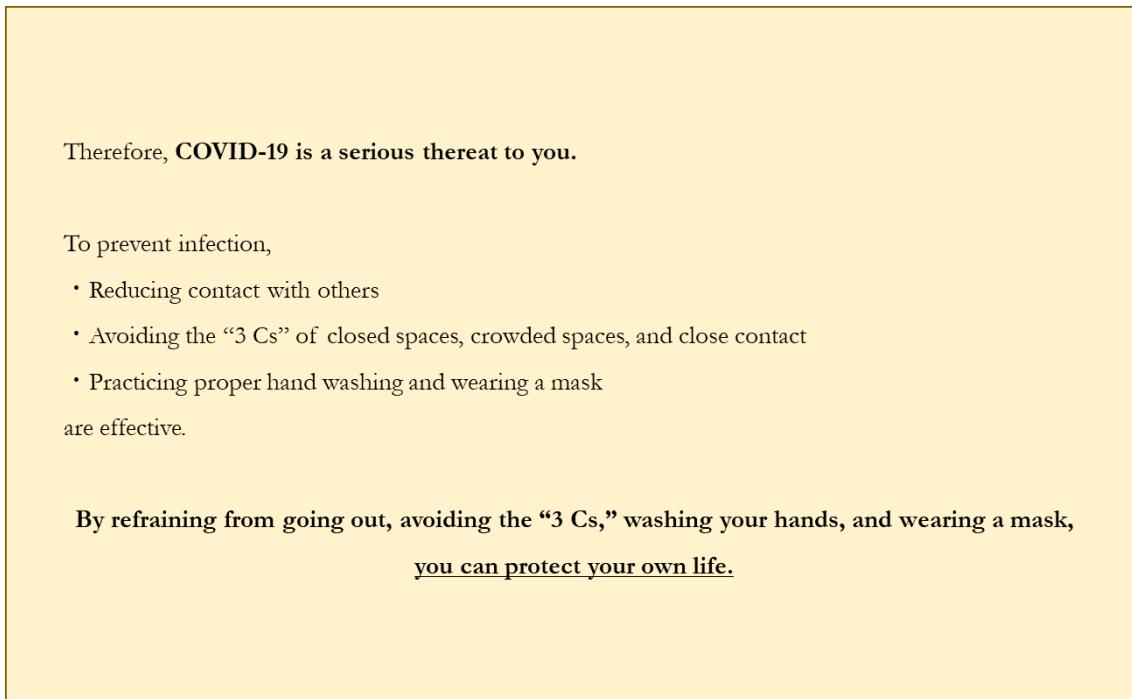
**Figure A4 Screen of “Loss-framed Altruistic Message” Group**



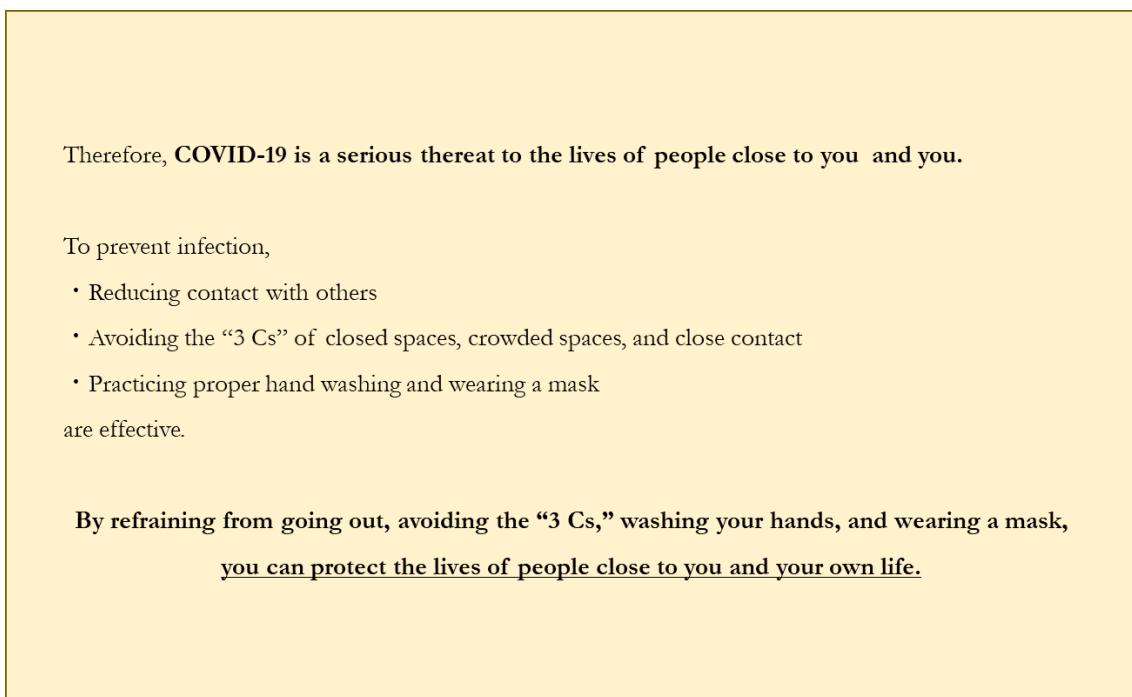
**Figure A5 Screen of “Selfish Message” Group**



**Figure A6 Screen of “Altruistic and Selfish Message” Group**



**Figure A7 Screen of “Simple Message” Group**



**Table A1 Balance Test**

	Control	Altruistic	Loss-framed	Selfish	Selfish and Altruistic	Simple
			Altruistic		Altruistic	
<i>Name of attributes</i>		<i>Mean (and standard deviation) of attributes</i>				
Age	45.662 (13.801)	45.423 (13.832)	45.445 (13.857)	45.070 (13.935)	45.826 (13.942)	45.507 (13.839)
Female	0.508 (0.500)	0.495 (0.500)	0.495 (0.500)	0.504 (0.500)	0.509 (0.500)	0.496 (0.500)
Schooling year	14.561 (2.147)	14.576 (2.105)	14.614 (2.032)	14.627 (2.073)	14.626 (2.110)	14.676 (2.086)
Married status	0.564 (0.496)	0.581 (0.494)	0.582 (0.494)	0.537 (0.499)	0.563 (0.496)	0.541 (0.499)
Annual household income	603.318 (350.553)	618.485 (379.780)	597.576 (358.093)	616.628 (379.717)	626.316 (344.483)	614.127 (367.780)
No income information	0.201 (0.401)	0.178 (0.383)	0.187 (0.390)	0.188 (0.391)	0.193 (0.395)	0.188 (0.391)
Number of observations	874	871	887	869	855	899

Notes: Some respondents did not answer annual household income. We imputed the average amount of the income for such respondents while considering that they did not answer it by using the variable of no income information.