Advocating Attitudinal Change Through Android Robot's Intention-Based Expressive Behaviors: Toward WHO COVID-19 Guidelines Adherence

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***Abstract*—Motivated by the fact that some human emotional expressions promote affiliating functions such as signaling, social change, and support, all of which have been established as providing social benefits, we investigated how these behaviors can be extended to Human-Robot Interaction (HRI) scenarios. We explored how to furnish an android robot with socially motivated expressions geared toward eliciting adherence to COVID-19 guidelines. We analyzed how different behaviors associated with social expressions in such situations occur in Human-Human Interaction (HHI) and designed a scenario where a robot utilizes context-inspired behaviors (polite, gentle, displeased, and angry) to enforce social compliance. We then implemented these behaviors in an android robot and subjectively evaluated how effectively it expressed them and how they were perceived in terms of their appropriateness, effectiveness, and tendency to enforce social compliance to COVID-19 guidelines. We also considered how the subjects' sense of values regarding compliance awareness would affect the robot's behavior impressions. Our evaluation results indicated that participants generally preferred polite behaviors by a robot, although participants with different levels of compliance awareness manifested different trends toward appropriateness and effectiveness for social compliance enforcement through negative expressions by the robot.**

***Index Terms*—Android robot, attitudinal behavior, COVID-19, compliance, human-robot interaction.**

I. Introduction

EMOTIONAL expressions, which are a rich communicative device during interactions, take verbal (linguistic) or non-verbal (facial expressions, gestures, gaze, posture, and social touch) forms or a combination of both [1], [2]. Emotional expressions are a means of engaging in a variety of communicative functions, such as expressing what is inside (intention), directing other people's behavior, representing what the world is like, and commitments to future courses of action [3]. The implication is that emotional expressions are both scientific and predictive, as affirmed by the theory of basic emotions [4]. Also, according to the theory of behavioral ecology [5], emotional expressions are voluntary and context-dependent tools, serving "social motives/intention" in essential ways for understanding their communicative functions. Both of these theories allude to the fact that emotional expressions are socially motivated. They also support the formation and sustenance of long-term and intimate relationships through fostering closeness and cordiality and offering consolation and eschewing antisocial behavioral tendencies [6].

Emotions can be either positive or negative [4]. For negative emotions, studies in human-human-interaction (HHI) have revealed that they have a propensity to initiate affiliating functions which are beneficial not only to expressers but also to other interlocutors. Negative emotions foster cordiality and closeness amongst interlocutors in an organization [7]. Such negative emotions as anger-inspired expressions are also an efficient means for both direct or indirect rebukes and discouraging antisocial behavioral tendencies [8]–[10].

Similarly, human-robot interaction (HRI) studies argue that an agent's negative emotion during collaborative tasks has a higher tendency to encourage progress [11]–[13]. Negative expressions have a regulatory effect on human actions and influence attention when an unclear situation emerges during tasks [11], [12]. This study also revealed that when anger is activated by an agent during a collaborative task, a human subject is more motivated to rectify a situation that impedes progress. Similarly, an agent's negative feedback can fuel energy-saving behaviors in humans [13].

Both HHI and HRI studies concede that negative emotions have symmetric and asymmetric consequences that are context dependent; they also provide social functions that might be deemed either beneficial or harmful, depending on the context. For example, scolding a person for refusing to act in an antisocial manner towards others would have symmetrical consequences where none of the parties is beneficiated, while expressing displeasure or anger towards one who violates a social norm could have asymmetrical consequences if the violator adheres to that reprimand.

As the world continues to battle the COVID-19 pandemic, we are hopeful that more vaccinations will be made available worldwide as well as other measures that will defeat the virus. The World Health Organization (WHO) has issued guidelines

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that mandate face masks and social-distancing observations in public places to reduce its spread [14], [15]. However, ensuring compliance remains a great challenge, particularly since most of countries have no penalties for those who violate such rules [16]. HHI studies concluded that people struggle to observe such social rules, especially when no direct penalties are incurred from such violations. In such situations, enforcing compliance must require some form of reprimand from individuals. However, the effectiveness of such reprimands can be influenced by an individual's sense of values, personality, and societal norms [17].

In this study, we investigate the perceived impressions on the use of agents who enforce WHO guidelines during the COVID-19 pandemic while considering the different strands of perspectives among people and the need to adhere to guidelines for their own safety and that of others. We investigate how adequately an agent's harmonized expressive behaviors (polite, gentle, displeased, and angry) can be effectively utilized to elicit adherence to WHO guidelines on social distancing and masks. We equipped a robot with context-inspired expressions as reprimands in situations where these guidelines are being ignored or broken. We subjectively evaluated the perceived extent to which these agent behaviors were deemed socially appropriate, effective, and tending to enforce the desired attitudinal changes from both individual and third person perspectives.

We also consider the person's sense of values regarding compliance awareness, i.e., how deeply one feels compliance with the social rules recommended by the WHO geared towards reducing the spread of the virus. We consider that people with lower compliance awareness (LCA) would react differently to an agent's attitudinal behavior in comparison to people with higher compliance awareness (HCA). Furthermore, we also investigated the degree to which our subjects perceived the agent to be in-group (i.e., a member of their own group) and how such a perspective was related to compliance awareness.

The remaining sections of this letter are organized as follows. Section II overviews related studies. In Section III, we present an overview of the experimental design, hypotheses, and procedures adopted for this study. In Section IV, we subjectively experiment and analyze our results and discuss them in Section V. Finally, Section VI offers conclusions and suggestions for further studies.

II. Related Work

In human-robot interaction (HRI), several studies have been devoted to furnishing social agents (robotic and non-robotic) with expressive behaviors (positive and negative) by focusing on facial expressions, head movements, utterance content, and body gestures, all of which are aimed to give these agents more social acceptance [11], [18]–[19]. Other studies have explored body gestures (including hand gestures and upper body motions) in agent emotional or attitudinal expressions [20]–[23].

Efforts have been geared toward understanding how humans and agents interact and collaborate in various scenarios and concluded that emotional expressions can be leveraged to improve HRI [24]–[26]. The outcomes from these studies have improved the perception of agents as teammates and companions in settings where their positive affects align with those of human subjects. Studies have also revealed how these agents influence human effectiveness by encouraging humans during cooperative tasks [26], [27]. Although these studies focused on situations of synergy between robot and human's affect, another study considered the impact of robot's expressive language for discouraging or encouraging during a competitive game with humans [28]. These studies investigated the implications of an agent's expressive behaviors in both cooperative and competitive HRI situations.

The successful use in agents has also been reported in enforcing compliance and persuasion, for instance, providing encouragement and instructions during sporting activities and therapy sessions [29], [30], promoting energy-saving culture [31], influencing the decision-making ability [32], [33], and encouraging honest behavior [34], [35]. It has been also reported that the appearance of the robot also affects the impressions on its authority on compliance [36]. For social robots that provide healthcare support, the effect of agent's perceived level of politeness is investigated in speech and gestures on user's intention to comply [37]. Findings from the study revealed that these factors negatively affect the user's perceived benefit to comply and the intention to comply.

However, most of these studies have not considered the possible effects of individual's sense of values on the interaction's subject. Studies in psychology allude to the fact that knowing a person's values provides a clue about what she is capable of in a given situation or across situations. For instance, the role of personality and a sense of values on persuasion for online shoppers and persuasive messaging for political purposes have been explored in HHI [38].

In the present study, we evaluate how the expressive behaviors of an agent can be utilized to elicit desired social changes of attitudes in interlocutors who violated WHO guidelines during the COVID-19 pandemic. We also evaluate the perceived social appropriateness, effectiveness, and propensity to enforce changes on interlocutors using these behaviors while simultaneously weighing variations in the perspectives (values) regarding compliance to such guidelines.

III. Experiment Design

A. Scenario Design

During the world's COVID-19 pandemic, many people do not feel comfortable obeying WHO guidelines about the use of face masks and social distancing, perhaps owing to the inconveniences associated with such rules and the fact that no direct penalties have been enacted for non-observance. Some people are skeptical about the severity of the pandemic and have low compliance awareness concerning the need to uphold these rules. Faced with these challenges, eliciting social compliance becomes complicated, since violators may react differently to appeals to conscientious actions or verbal shaming. Of course, some respond to voluntary appeals or reprimands. Others accept polite reprimands, and still others might be influenced by repeated admonitions in the form of displeasure or intense expressions of angers. We then sought to determine to what extent an agent's context-inspired behaviors (polite, gentle, displeased, and angry) are considered socially appropriate, effective, and have a higher tendency of effecting desired social changes in

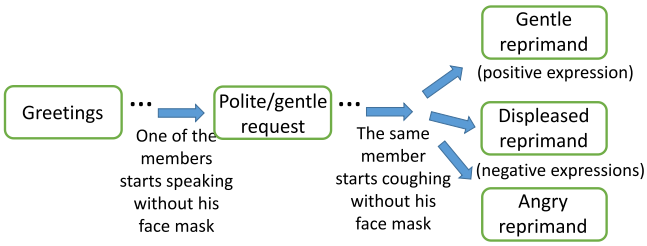

Fig. 1. Interaction scenario flow to evaluate effects of different attitudinal behaviors by an agent.

TABLE I
AGENT'S UTTERANCE SCRIPT

Scene	Script	Expression
A	Hello, guys, it is a pleasure having you all. Recently it been getting a bit colder; I feel winter has come.	
B	John you don't have to take off your facemask when speaking. I can imagine wearing a mask seems uncomfortable to you. However, this is for the safety of everyone.	Polite
C	Oh John! Are you alright? But you can't be coughing without a facemask. We all need to stay safe during this COVID-19 period. So, would you kindly put on your facemask?	Polite/ Gentle
D	John, I have been stressing on the need to always have your facemask on. And now you are coughing without a facemask. This is quite inappropriate. We should always put on our face facemask especially when we have others around.	Displeased Angry

those who have a different sense of values regarding compliance awareness on WHO guidelines.

Therefore, we designed a video-based user study of a scenario in which a robot agent and two visitors engage in a multi-party interaction at our research institute. Prior to this interaction, these visitors were reminded to adhere to the WHO guidelines during their interactions with the agent. However, during the interaction, the agent observes that one of the participants removed his mask while speaking and politely requested him to put it back on. Subsequently during the interaction, the same participant is seen coughing without a mask. This situation results in three optional reprimands from the agent: polite/gentle, displeased, and angry (Fig. 1).

The scripts utilized by the agent during the interaction are shown in Table I. The same script (scene D) is utilized by the agent for both the displeased and angry reprimands.

We recorded four scenes that captured the described scenario. Based on this scenario and our established objective, we developed the following hypotheses (H1 and H2) that center on an individual's sense of values regarding compliance awareness on WHO's COVID-19 guidelines and relationship to the behavioral preferences of reprimands toward others (third-party violators) and oneself (individual violator). We provide an initial estimate as to how these relationships might occur.

H1: From a third person perspective, subjects with lower levels of compliance awareness (LCA) will show lower preference for behaviors with negative expression (displeased and angry) of the agent, as appropriate or effective for enforcing desired social changes in persons who violate WHO guidelines during the COVID-19 pandemic. Subjects with higher levels of

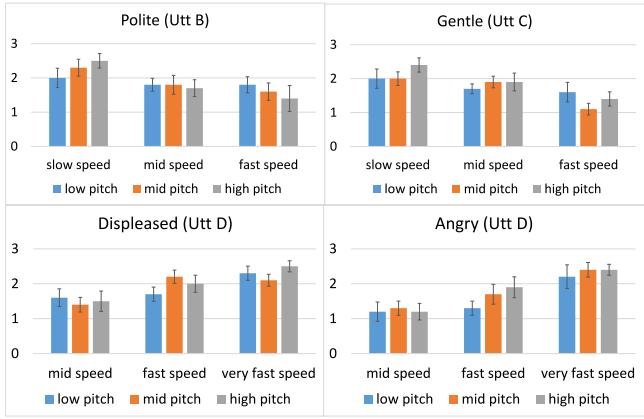

Fig. 2. Subjective average scores of emotion/attitude expressions for different combinations of voice pitch and speed for utterance sets B, C, and D.

compliance awareness (HCA) will show higher preference for behaviors with negative expressions as more appropriate and effective for enforcing desired social changes toward third-party violators.

H2: From an individual perspective, subjects with LCA will show higher acceptance to behaviors with negative expressions as a form of reprimand when they violate COVID-19 guidelines. Those with HCA will show higher acceptance to polite reprimands when they are violating WHO guidelines.

B. Pre-Evaluation of Agent's Voice

To appropriately design the expressions for the robot agent and considering that the speech synthesizer (Hoya VoiceText) used for it does not support explicit control for emotional expressions, we stressed the establishment of the best combination of robot utterance factors (voice pitch and speed) that effectively conveys the desired attitudes (polite, gentle, displeased, and anger) for this study. We carried out a within-subject evaluation of the synthesized utterances based on different pitch and speed combinations for three sets of utterances in Table I (scenes B, C, and D).

Since the default voice pitch is set to 110% (mid pitch), we set 100% and 120% for synthesizing the low and high pitch. For the voice speed settings, the default was 100% (mid speed), and so we set 90% for a slow speed, 110% for a fast speed, and 120% for a very fast speed. Based on our preliminary experiments, for speed, we used a set of {slow, mid, fast} for the target polite/gentle expressions, and a set of {mid, fast, very fast} for the target angry/displeased expressions, since a very fast speed was obviously less polite/gentle, and a slow speed was clearly less angry/displeased.

For the evaluation, each set of utterances was graded in terms of four emotion/attitude scales (polite, gentle, displeased, and anger) on 4-point scales (from 0 for unperceived to 3 for strongly perceived). Ten subjects (all of which were either native or fluent English speakers) participated in this preliminary evaluation. Fig. 2 shows some of the results for the perceived emotion/attitude expressions.

The results in Fig. 2 reveal that high-pitch and slow-speed utterances (pitch 120%; speed 90%) were perceived as more polite

TABLE II
POSITIONS AND TYPES OF THE GENERATED GESTURES (STROKE/BEAT POSITIONS IN BOLD)

Scene	Gesture positions and types
Greetings	(**Hello**, guys, it is a pleasure having you all.) [*gesture 1*] Recently …
Polite request	(**John** you don't have to take off your facemask when speaking.) [*gesture 2*] I can …
Gentle reprimand	(**Oh John**!) [*gesture 3*] (Are **you alright**?) [*gesture 1*] But ... So, (**would you kindly** put on your facemask?) [*gesture 2*]
Displeased reprimand	(**John**,) [*gesture 2*] I have been stressing … This is (quite **inappropriate**) [*gesture 1*] We should …
Angry reprimand	(**John**, I have been stressing on the need to **always** have your facemask on. And now you are **coughing** without a facemask.) [*gesture 4*] (This is quite **inappropriate**.) [*gesture 5*] (You should **always** put on our face facemask especially) [*gesture 5*] (when we have **others around)** [*gesture 1*]

and gentle, and very fast speed (speed 120%) utterances were evaluated as more effective for conveying displeased and angry expressions. Based on these findings, we adopted an utterance with the highest polite/gentle scores (pitch 120%; speed 90%) for expressing polite/gentle behaviors in the main experiments of Section IV. For the displeased and anger utterances, although high scores were attributed to both high- and low-pitch utterances, we adopted the low ones (pitch 100%; speed 120%) for the main experiment, since the desired anger expression in this study is geared toward eliciting attitudinal changes rather than emotional ones. High-pitch utterances sounded more emotional.

C. Generation of Agent's Behaviors

To design humanlike context-inspired behaviors for our agent, we conducted a preliminary analysis in which acted audio visual data were collected to determine relevant expressive gestures for the agent in our specific scenario. We collected the performed data of 20 female native English speakers (United States). (We restricted our analysis to female speakers for this study, since we use a female android robot in our main experiments.) Their ages ranged from 18 to 47 ($M = 30.9$, $SD = 1.5$). They video-recorded themselves while naturally saying the utterances based on the script and the emotions in Table I. We sorted and analyzed the collected data from these participants to establish predominant hand gesture types and emphasized the word/stroke positions of the gestures. Based on the analysis, we used the expressive behaviors of four of the speakers who had the highest consistency of gesture type and stroke position for designing the agent's expressions.

Five predominant gesture types were identified and named as follows: {gesture 1: both arms spread with palms turned upward; gesture 2: pointing with open palm turned upward; gesture 3: meet palms at the chest height; gesture 4: pointing with the index finger extended; gesture 5: both arms spread with palms turned vertically}. Table II shows the positions of the gesture types to be generated.

A female android robot, ERICA [39], was adopted for this study. Her audio-visual expressions during the interactions were generated based on the analysis results in this study as well as previous studies on gesture generation in polite and anger expressions [20] [21]. The generated motions in the android were

Fig. 3. Snapshots of gestures generated by ERICA for different behaviors.

recorded as four video clips (one for each scene in Fig. 1) for the main experiments described in the following section. Note that since ERICA is unable to express clear facial expressions for anger, her hand gestures play a larger role in attitude/emotion expression.

ERICA's motions were created using a motion-editor interface, where the actuator values were hand-tuned to achieve behaviors that mirrored the speaker's gestures. Base motions were first created for the five individual gesture types and synchronized with the focused words (shown in bold in Table II). After a gesture stroke, the hands are hold along the sentence (shown within brackets in Table II), and turned back to the rest position, to create the motion data of a whole utterance. Fig. 3 shows snapshots of the gestures generated in ERICA during gentle (gesture 3), displeased (gesture 1), and angry (gesture 4) reprimand. (See also the attached video.)

IV. SUBJECTIVE EXPERIMENTS

A. Experiment Procedure

Utilizing Amazon Mechanical Turk (AMT) services, we recruited 97 participants resident in the United States: 69 males and 28 females, whose ages ranged from 20 to 62, $M = 35.0$, $SD = 9.2$. We carried out video-based evaluations of the recorded scenarios.

Prior to watching the videos, participants answered relevant questions that evaluated their sense of values regarding compliance awareness on WHO guidelines concerning this pandemic. The ten questions are shown in Table III (The answers are in 5-point scale: 1: strongly disagree, 5: strongly agree).

Subsequently, the participants received a description of the scenario in each video clip prior to watching it. They watched four videos. The first was called Intro and contained scenes A (greetings) and B (polite caution). The second was called Behavior 1 for scene C that was expressed with a gentle behavior. The third and fourth, Behaviors 2 and 3, were expressed for scene D with displeased and angry behaviors.

After watching each video clip, the participants evaluated their perceived impressions on the agent's behaviors in terms of the emotion/attitude conveyed by its expression (Q1-Q4), its naturalness (Q5), its social appropriateness, effectiveness, and tendency to enforce the desired social change (Q6-Q10) based on the context in the viewed clip, as shown in Table IV. Q1-Q5 were answered after watching each clip, and Q6-Q10 were answered after watching all the clips. The participants were allowed to re-watch them.

TABLE III
QUESTIONNAIRE FOR PARTICIPANTS' SENSE OF VALUES REGARDING COMPLIANCE AWARENESS ON WHO COVID-19 GUIDELINES

	Questions
1	Is it always necessary to wear a mask in public during this pandemic?
2	Is it important to maintain social distance in public places during this pandemic?
3	Is it acceptable to ask someone who takes off her mask while talking in a public place to put it back on?
4	Is it acceptable to enact laws that penalize individuals who fail to comply with the WHO guidelines concerning the use of face masks in public places and social distancing?
5	Is it acceptable to force others to wear a mask?
6	Are there health risks associated with wearing a mask?
7	Do you agree that everyone, including those without symptoms, should wear a mask to reduce community spread of the virus when they leave their home?
8	I wouldn't be happy using public transportation unless passengers are required to wear masks.
9	For my own safety and that of others, I will be wearing a mask when I'm outside my home.
10	I won't use public transportation unless social distancing is being maintained.

TABLE IV
QUESTIONNAIRE ON PARTICIPANTS' IMPRESSIONS FOR AGENT'S BEHAVIOR EVALUATION

	Questions
Q1	What is your perception of the degree of politeness conveyed by this clip? (4-point scale: 0: not specifically polite 3: extremely polite).
Q2	What is your perception of the degree of gentleness conveyed by this clip? (4-point scale: 0: not specifically gentle 3: Extremely gentle).
Q3	What is your perception of the degree of displeasure conveyed by this clip? (4-point scale: 0: not specifically displeased 3: extremely displeased).
Q4	What is your perception of the degree of anger conveyed by this clip? (4-point scale: 0: not specifically angry 3: extremely angry).
Q5	What is your perception of the degree of naturalness of the agent's expression? (5-point scale: 1: not natural 5: Very natural).
Q6	Among the behaviors expressed by the agent in the videos (Behaviors 1, 2, and 3), which do you feel is most appropriate in enforcing social compliance (the need to wear a mask) in the described scenario?
Q7	Among the behaviors expressed by the agent in the videos (Behaviors 1, 2, and 3), which do you feel is the most effective to change John's behavior, considering that he was repeatedly requested to wear his mask?
Q8	If you were in John's position, would you obey the agent's request in Behavior 1? (yes/no/maybe)
Q9	If you were in John's position, would you obey the agent's request in Behavior 2? (yes/no/maybe)
Q10	If you were in John's position, would you obey the agent's request in Behavior 3? (yes/no/maybe)

Finally, this experiment was reviewed and approved by the ethical committee of our research institute (ethical review number 20-605). All the recruited subjects gave their formal consent in accordance with the proscribed procedure of the ethical committee.

B. Experiment Results

For analyzing the obtained results, we split the participants into two groups, based on the mean scores on the ten questions related to their sense of values regarding compliance awareness on the WHO guidelines during this pandemic. The resulting groups were comprised of 32 subjects from the lower levels of the compliance awareness (LCA) group ($M = 2.9$, $SD = 0.9$) and 65 participants from the higher levels of the compliance awareness (HCA) group ($M = 4.7$, $SD = 0.3$). The subsequent analyses regarding the subjective impressions are based on this categorization.

TABLE V
TWO-WAY ANOVA RESULTS (F-VALUES AND SIGNIFICANCE LEVELS) FOR EACH SUBJECTIVE IMPRESSION ITEM

Evaluation item	Compliance awareness F(1,95)	Behavior type F(3,95)	Interaction F(3,95)
Polite	17.5, $p < .01$	152.1, $p < .01$	6.9, $p < .01$
Gentle	8.4, $p < .01$	138.9, $p < .01$	4.3, $p < .01$
Displeased	0.01, $p = 0.9$	82.2, $p < .01$	2.1, $p = 0.1$
Angry	4.1, $p < .05$	140.4, $p < .01$	3.1, $p < .05$
Naturalness	5.9, $p < .05$	2.3, $p = .1$	0.7, $p = .57$

A two-way ANOVA was conducted on the influence of two independent variables (compliance awareness and behavior type) on the impressions of the attitudes expressed by the robot: polite, gentle, displeased, and angry. The compliance awareness consisted of two items (LCA, HCA), and the behavior type consisted of four items (Intro, Behavior 1, Behavior 2, and Behavior 3). Table V shows the ANOVA results for each subjective impression item. Among the attitudes expressed by the robot, all the effects were statistically significant, except for the compliance awareness groups in displeased. Interaction effects were significant in polite, gentle, and angry. Multiple comparisons through Ryan's method were also conducted. Significance levels will be specified case-by-case below in the subsequent analysis results.

Regarding the perceived attitudes conveyed by the robot's different behaviors, despite small differences, analysis revealed that both groups had similar trends (Fig. 4). Overall, the robot's behaviors in Intro and Behavior 1 received higher polite and gentle impression scores (around 2 to 3), and the negative behaviors in Behaviors 2 and 3 received higher displeased and angry scores (around 2 to 2.5), in both the compliance awareness groups ($p < 0.01$). This validates our expectation that the positive and negative expressions created in the robot would be correctly perceived by the participants.

However, contrary to our expectations, no significant differences were found between Behaviors 2 and 3. Both received high scores of displeasure and anger. Perhaps other modalities are required, such as voice quality and facial expressions, to better distinguish their impressions. Nonetheless we re-enforce that both were clearly perceived as negative expressions.

Regarding the differences between LCA and HCA, the HCA participants attributed higher scores to polite and gentle ($p < .01$) and slightly lower scores to angry ($p < .05$) in Intro and Behavior 1. Regarding the subjective naturalness of the robot's expressions, slightly lower scores were attributed by LCA participants, regardless of the behavior type ($p < .05$).

The above results suggest that the LCA participants tended to have slightly worse impressions of the robot than the HCA participants.

Fig. 5 shows the distributions of the subject's choices on the behavior judged as the most appropriate or effective in enforcing compliance on third-party. As for social compliance

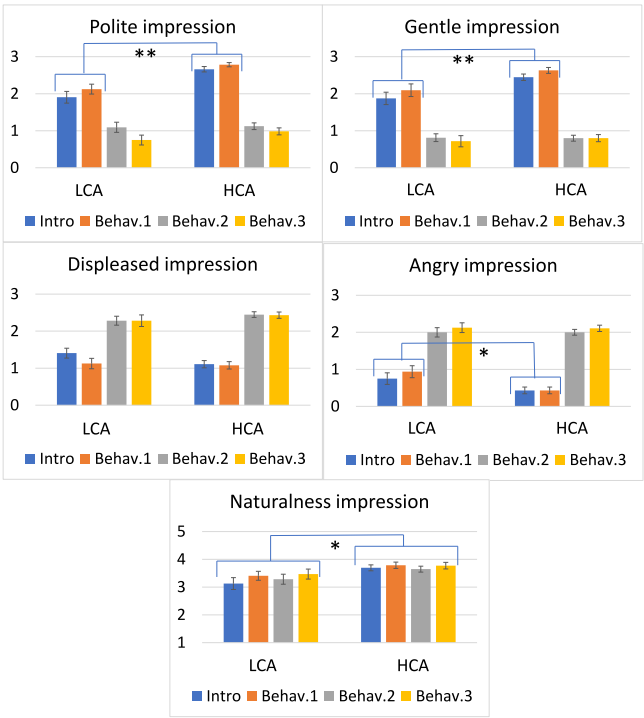

Fig. 4. Subjective average scores on emotion/attitude and naturalness of robot's behavior types (Q1 ∼ Q5) and by lower and higher compliance awareness groups (LCA, HCA).

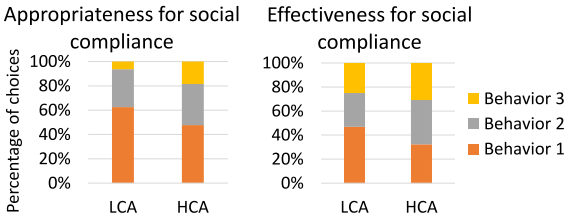

Fig. 5. Subjective preferences on appropriateness and effectiveness of robot's behaviors in enforcing compliance on third-party (Q6 ∼ Q7) by lower and higher compliance awareness groups (LCA, HCA).

(left panel, Fig. 5), our results indicate in both the LCA and HCA groups a preference for Behavior 1 (polite/gentle expression) as more appropriate for enforcing social compliance. However, the percentage of preference for Behavior 3 (the most negative expression) increased regarding their opinions on the effectiveness for social compliance in this scenario (right panel, Fig. 5).

Regarding hypothesis H1, the obtained results for the LCA group were in agreement for both the appropriateness and effectiveness of behaviors. However, for the HCA group, the results obtained with respect to appropriateness for social compliance were contrary to H1, and those for the effectiveness for social change were in agreement. Note that those in the HCA group believe that a gentle behavior is more appropriate for social compliance, although for making people change their behaviors, they believe that a strong attitude is more effective.

Fig. 6 shows the distributions of the subject's choices ("yes", "no" or "maybe") for the tendency to obey the robot for the different behavior types. It can be observed that about 60% of

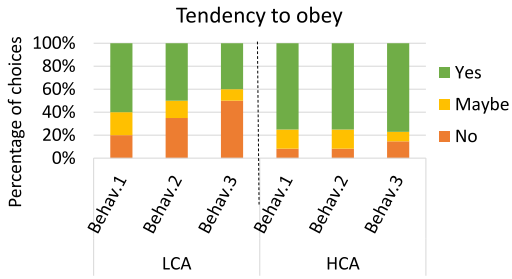

Fig. 6. Subjective preferences on tendency to obey robot when expressing different behaviors (Q8 ∼ Q10) by lower and higher compliance awareness groups (LCA, HCA).

the subjects in the LCA group would obey the robot's request in Behavior 1 (gentle), but 50% would not in Behavior 3 (angry) (with significance levels of $p < .05$, by chi-square tests). On the other hand, almost 80% of the subjects in the HCA group answered they would obey the agent in all three behavior types ($p < .01$, by chi-square tests). This suggests that these subjects would also accept the agent's negative expressions, since they are aware of the importance of wearing masks in that situation.

With respect to hypothesis H2, the LCA group results are contrary to hypothesis H2, which states that the subjects in this group would show a higher tendency to obey the robot through negative expressions. For the HCA group, the results agree with the hypothesis, but they would also obey through negative expressions.

Overall, only 2 of 97 participants (in the LCA group) answered they would not obey the agent in any of the behaviors, suggesting its potential effectiveness for changing a person's mask-wearing behavior, if the robot can express appropriate behavior toward that person.

C. Compliance Awareness and Robot's Social Acceptance

In the above subjective experiments, we investigated the effects of the participant's compliance awareness on the robot's behavior impressions. However, after the experiments, a question was raised regarding the possibility that how the participants viewed the robot (i.e., its social acceptance) could also influence its behavior impressions.

To investigate this issue, we conducted an additional experiment with 50 American participants (44 male, 6 female) utilizing AMT services whose ages ranged from 21 to 62, M = 35.1, SD = 7.7. The same experiment described in Section IV (A) was conducted with additional questions regarding the robot's likeability and its social competence (Q11 and Q12 in Table VI) for each of the behaviors. Since the results for the other questions showed similar trends to those reported in Section IV (B), we limit our analysis results to questions Q11 and Q12 in this section.

Fig. 7 shows scatter plots of the subjective scores of the robot's likeability and social competence versus the subjects' compliance awareness levels. The robot's likeability and the subjects' compliance awareness are highly correlated (correlation of 0.70), indicating that people with lower compliance awareness would not like having a robot ask them to comply. A high correlation of 0.68 was also observed between the robot's

TABLE VI
QUESTIONNAIRE ON PARTICIPANTS' IMPRESSIONS FOR AGENT'S BEHAVIOR EVALUATION

	Questions
Q11	Based on the scenario described in this experiment and the agent's expressed behavior in this video, to what extent do you have likeability for the robot as a member of your community? (5-point scale: 1: low likeability; 5: high likeability)
Q12	Based on the described scenario in this experiment and the agent's expressed behavior in this video, to what extent do you feel the robot is socially competent? (5-point scale: 1: not competent; 5: highly competent).

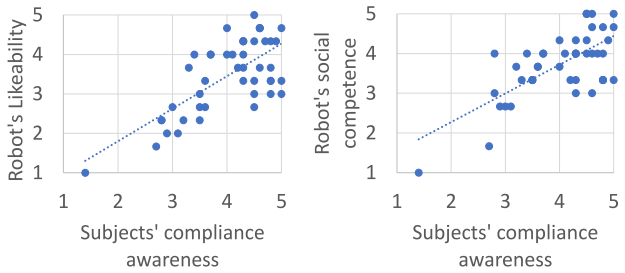

Fig. 7. Distributions of robot's likeability and social competence scores by subject's compliance awareness levels.

social competence and the subjects' compliance awareness. However, only two of the participants scored the robot as being incompetent. This suggests that subjects with lower compliance awareness tend to dislike the robot's behaviors, even though they tend to consider it competent in advocating attitudinal changes regarding the COVID-19 guidelines.

V. DISCUSSION

Our subjective analysis results revealed that not everyone holds the same sense of values with regards to upholding the non-pharmaceutical guidelines recommended by WHO for reducing the spread of the COVID-19 virus. Based on the expectation of such variation among subjects, we argued that an individual's sense of values regarding compliance awareness affects how the behavior of the robot is appraised by such a person as socially appropriate, effective, having a tendency of causing desired social change, and having a tendency for obedience.

Our analysis results showed that the LCA participants feel that Behavior 1 (gentle) of the robot is more appropriate and effective in enforcing reprimands. They also feel that the robot can best enforce persuasion through gentle appeals and are more likely to obey it through such behavior. This result is shared by our hypothesis. This observed trend might be attributable to the fact that since this group does not feel any need to uphold WHO's non-pharmaceutical guidelines, they may also not recognize the need to express Behaviors 2 and 3 (displeased and angry) toward behaviors that contravene the new norm of the pandemic. It is also logical that only polite appeals to the conscience of such people will be persuasive.

On the contrary, our analysis result revealed that the HCA group has a higher preference for Behavior 1 (gentle) as a more appropriate behavior for enforcing social compliance, while Behaviors 2 and 3 (displeased and angry) were judged as effective for enforcing social compliance. This group also showed a higher tendency to obey the robot through all behavior types. This finding partly disagrees with our hypothesis. However, perhaps these observations can be ascribed to the possibility that this group is comprised of courteous individuals, and as such, their preference of Behavior 1 (gentle) is more appropriate. Further studies must scrutinize these results.

Regarding the agent type, we used a female android robot since it has a humanlike appearance. Other robot types must be investigated, such as male-type robots, small-sized robots, or animated CG agents. These are also topics for future investigation.

VI. CONCLUSION

As the COVID-19 pandemic continues to ravage the entire globe, we investigated how adequately a robot's harmonized expressive behaviors (polite, gentle, displeased, and angry) can be effectively utilized to elicit adherence to WHO guidelines on social distancing and wearing masks. We subjectively evaluated the perception of three attitudinal behaviors (polite/gentle, displeased, and angry) of a robot as reprimand functionalities for admonishment in situations where these guidelines were being continuously ignored, while bearing in mind that not everyone shares the same perspectives (sense of values regarding compliance awareness) on the need to uphold them.

Our subjective evaluation results first indicated that the robot's behaviors with both positive and negative expressions were correctly perceived by all subjects. From a third person perspective, subjects with lower levels of compliance awareness (LCA) for the need to adhere to WHO guidelines showed greater preference for polite/gentle reprimands to violations of these guidelines as both appropriate and effective behaviors. On the other hand, those with higher levels of compliance awareness (HCA) had higher preference for polite/gentle behaviors in terms of appropriateness toward third-party violators, but they also appraised the negative expressions (displeased and angry behaviors) as more effective in enforcing compliance for such people.

From an individual perspective, our subjective evaluation revealed that almost all the participants would obey a robot's reprimand. Most of the subjects in the HCA group would obey the robot's behavior with both positive and negative expressions, while those in the LCA group would tend to obey its reprimands, partly to positive or negative expressions. Further analysis must clarify which individuals in the LCA group would adhere to positive or negative expressions.

Our current findings are relevant to the HRI field because they offer insight about the need for furnishing robots with behaviors that are not only situation dependent but also cognizant of an interlocutor's sense of values on the interaction's subject.

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