

Evoking Affection for a Communication Partner by a Robotic Communication Medium

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Abstract: This paper explores an feedback effect of physical interaction with robotic media on an individual's feelings toward a communication partner in robot-mediated tele-communication. The paper hypothesized that talking while hugging a robotic medium increases affective feelings or attraction toward a conversation partner. Our experiment, using Hugvie, a human-shaped medium, for talking in a hugging state, found that hugging robotic media subconsciously evokes an attraction or affective feeling toward a stranger communication partner. The results suggest that a robot-mediated communication involving physical interactions can support starting the development of a close relationship in a novel way different from existing computer-mediated communication.

1 Introduction

Unlike telephones, robotic communication media (tele-operated robots) can be avatars of communication partners and provide a new communication manner in which we can feel that the robot is the person to whom we are talking as if we are having a face-to-face conversation with a real person. The most important trait of robotic media is that a user can virtually have physical interactions with another person (Figure 1). For example, by touching or hugging the medium, users can virtually touch or hug communication partners.

Robotic communication media bring a new style of computer-mediated communication (CMC) and can support people's communication in a new way. Recent studies have shown that CMC increases people's self-disclosure due to its visual anonymity compared with face-to-face (FtF) communication [1] and facilitates creating people's close relationships (and furthermore romantic relationships) [2]. The high level of self-disclosure in robot-mediated communication may facilitate virtual-physical interactions through robotic media even if a communication partner is a stranger or new acquaintance. It is, therefore, expected that a robotic medium can accelerate the development of a close relationship since it provides not only verbal interactions but virtually physical interactions including touch interactions which play important role in creating bonds between people [3]. In other words, a robotic medium can be a potent tool to support starting close relationships. To reveal the potential of robotic media, this paper studies an effect of virtual-physical interaction in creating people's romantic relationships, focusing on hug interaction since holdability is a distinctive feature for robotic media with a physical body.

Many studies have focused on remote touch behavior to convey affective feelings using robotic com-

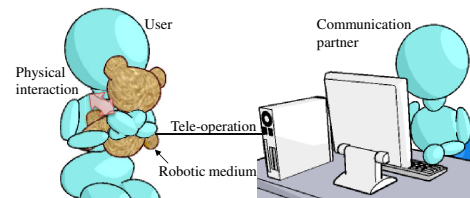


Figure 1: Tele-communication by robotic medium

munication devices [4, 5, 6]. By focusing on hugging behavior, researchers developed robotic communication devices to remotely hug communication partners [7, 8, 9]. Most focused on the development of devices to allow a person to feel a hug or a touch from another person at a remote place and the effects of being hugged or touched by the remote person [3]. None, however, studied the effect of user's hugging or touching the remote person through the robotic devices on the user's own feelings (i.e., the feedback effect of the hugging or touching behavior). This paper focuses on a behavioral (hugging behavior) feedback on a feeling in a robot mediated tele-communication.

Many psychological studies have addressed the feelings caused by behaviors. It means that a person's behavior or posture produces his feelings rather than his feeling produces his behavior or posture. Kellerman et al. [10] revealed that people exchanging gazes with a stranger of the opposite sex report increased feelings of romantic love toward their partners. In their study, subjects were instructed to gaze into each other's eyes without intending to create romantic feelings. But the gazing behavior did evoke feelings of romantic love. Other studies reported that a person's physical posture affected his feelings and behaviors. These studies suggest that subject postures influence their perceptions of the emotions of others [11] and their evaluations of their mental states [12, 13].

Although in the above studies the feedback mechanism for the feeling is still controversial, a similar effect possibly occurs in human-robotic media interaction. According to Kellerman et al. [10], if the interaction with a robotic medium (e.g., hugging it) signals affection, it may lead to romantic feelings toward a partner since the medium can be an avatar of the partner. Our paper examines the evocation of affection by hugging a communication medium called Hugvie [14] (Figure 2), which is a huggable-pillow type of communication medium for talking in a hugging state. We hypothesize that affective feelings in users who hug Hugvie will increase toward persons to whom they are talking through it. According to the fact that CMC increases people’s self-disclosure [1], it may be easier to hug a robotic medium even if the communication partner is a stranger or new acquaintance. In the viewpoint of supporting a creation of close relationship, this paper examines the evocation of affection toward strangers by hugging Hugvie.

2 Hugvie: a holdable communication medium

Recent studies have tried to realize an immersive telepresence in tele-communication by applying tele-operated robots that can transmit not only visual and vocal information but also the physical information of speakers to remote places (e.g., [15, 16]). A study with Telenoid [17], a tele-operated robot, reported that its holdability contributed to the conveyance of the individuals’ presence. Hugvie [14] (Figure 2) is a simply designed humanoid medium that specifically focuses on holdability.

Its body is mainly a cushion that resembles a simplified human to convey a sense of human existence. While hugging it, users speak to people in remote locations through cellphones inserted into a pocket in its head. The sense of hugging one’s partner and the partner’s voice heard from somewhere close to the ear creates a perception of the partner’s presence. Furthermore, the sense of touching the partner and being touched by the partner intensifies mutual affinity since the interpersonal tactile stimulation plays important role in strengthening romantic relationships [3]. It is most effective for interaction between people with close relationships, such as parents and children and lovers.

3 Effect of hugging on affective feelings

3.1 Study 1

To evaluate the effect of hugging on affective feelings, we compared subject feelings in conversations using two different communication media: Hugvie and a wireless headset. We expect subjects who are talking with partners (e.g., opposite sex persons if the subjects are heterosexual persons) while hugging Hugvie

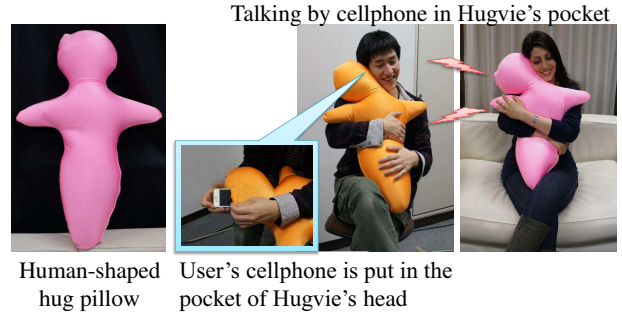


Figure 2: Human presence transfer medium: Hugvie™

(hug condition) to increase their feelings of affection or attraction toward their partner more than subjects using headsets in the headset condition. We prepared another condition in which the subjects held Hugvie without hugging it (hand condition) to clarify the hugging effect differing from the touching effect. This is because touching (without hugging) can also increase feelings of affection by behavioral feedback effect since touching signals love toward a partner [18]. The talking manners in the three conditions are shown in Figure 3. The subjects sat in recliners with face upward and with closing eyes to relax. The subjects in hug condition enveloped Hugvie’s body in their arms with it close to their body and put their ear against the pocket of Hugvie’s head. In hand condition the subjects held Hugvie in almost same manner but with holding Hugvie’s head using their arm.

In a study of the developmental stages of romantic love of Japanese young adults, Matsui [19] reported that in the initial stage the romantic feelings of males increased more than those of females. In addition, it has been shown that there is a tendency for females to respond more positively to touch than males [20]. According to these studies, we first investigated male subjects in our study. We asked Japanese young male adults (assumed to be heterosexual) to talk with a Japanese female conversation partner (she was a confederate and they did not know each other) through the medium and to answer questionnaires about their feelings toward her. We also observed their responsive behaviors toward the partner (for example, frequently looking at her after the conversation) to evaluate the effect at the subconscious level.

3.1.1 Method

In the headset condition, a single-earpiece wireless headset (Princeton Technology, PTM-BEM6) was used. A wireless speaker (Motorola, EQ5) was put in the pocket of Hugvie instead of a cellphone. Subjects listened to their partner’s voice through these devices. To control how they heard the voice among the conditions, the subjects placed their ears against the wireless speaker in the hug and hand conditions (Figure 3). They sat in recliners to relax. The subject voices were captured by a microphone at their feet. The subjects

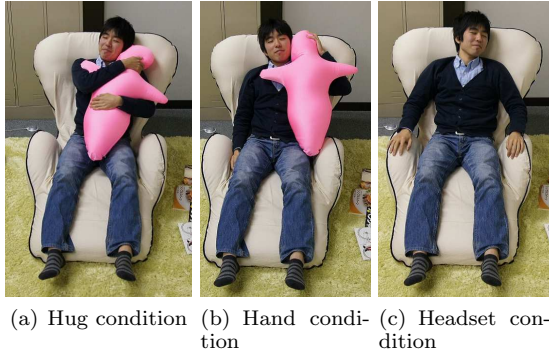


Figure 3: Three conversation conditions

were instructed to close their eyes during their conversations to relax. This allowed us to control their visual perceptions among the conditions.

Each male subject participated in one condition. Before the experiment, the subject received an explanation of the experiment and signed the consent form. They were told that they were recorded by a video camera during the experiment. A female confederate as a conversation partner participated throughout the experiment. The subjects talked with her in the next room through the communication medium. She did not know which conditions each subject belonged to. She used a normal headset to talk with the subjects and could not see them.

The following is our experimental procedure:

1. The subject talks with an experimenter in the next room for three minutes to get accustomed to using the medium on a recliner. The subject is alone in the experimental room.
2. After a five-minute interval, the subject talks with the female confederate for about ten minutes through the medium on the recliner.
3. The subject completes questionnaire about his feelings.
4. The subject waits for subsequent instructions while sitting near the recliner.
5. The experimenter brings the female confederate into the experimental room and tells her to pretend to complete a questionnaire and leaves the room. After five minutes, the experimenter enters the room and removes her from it. From the subject's location, the female cannot be seen but the experimenter's voice can be heard (Figure 4).
6. The experimenter interviews the subject.

The subjects were told that the experiment was evaluating a new communication device and that their female conversation partner is also a participant. To control the conversation content, the subjects were

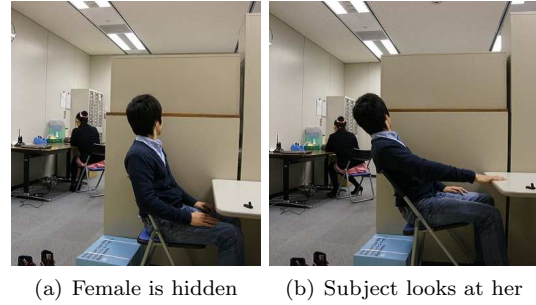


Figure 4: (a) female is hidden while subject is waiting; (b) he leans back to see her.

instructed to talk about prepared topics. The female confederate talked about the same topics and responded similarly to every subject. She took the initiative in the conversation (for example, she introduced her hometown first to prompt the subject to address the same topic). We prepared four topics: hometown, junior and senior high school, hobbies, and travel abroad. The subject behaviors were recorded by a hidden video camera.

3.1.2 Measurements

To estimate the subject feelings toward the female conversation partner, we measured the following scales with the questionnaire and the subject behaviors.

Multiple mood scale [21] Terasaki et al. [21] developed a measurement to evaluate mental states about eight feelings: depression, anxiety, hostility, fatigue, energy, well-being, social-affection, concentration, and surprise. Each type consists of five items (a total of 40 items). We used this scale for each item on a five-point scale (1: do not feel, 5: strongly feel). We expect that social-affection will increase if the subjects feel affection towards the partner.

Interpersonal attraction to female Toyota [22] reported the traits of female who are liked by male university students. 23 traits (e.g., kind and cheerful) were extracted and used in questionnaires to ask whether their partner has these traits. Each trait has a five-point scale (1: do not think, 5: strongly think). We expect that the total score will increase if the subjects attracted to their partners.

Behavioral signs of attraction Since we expected that the subjects would want to see their female conversation partner after the conversation if they are attracted to her, we checked whether they looked at her when only the two of them were in the experimental room. For this situation, the experimenter brought the female confederate into the room where she pretended to fill out a questionnaire at a desk hidden from the subjects. They might realize that the female is their conversation partner because they

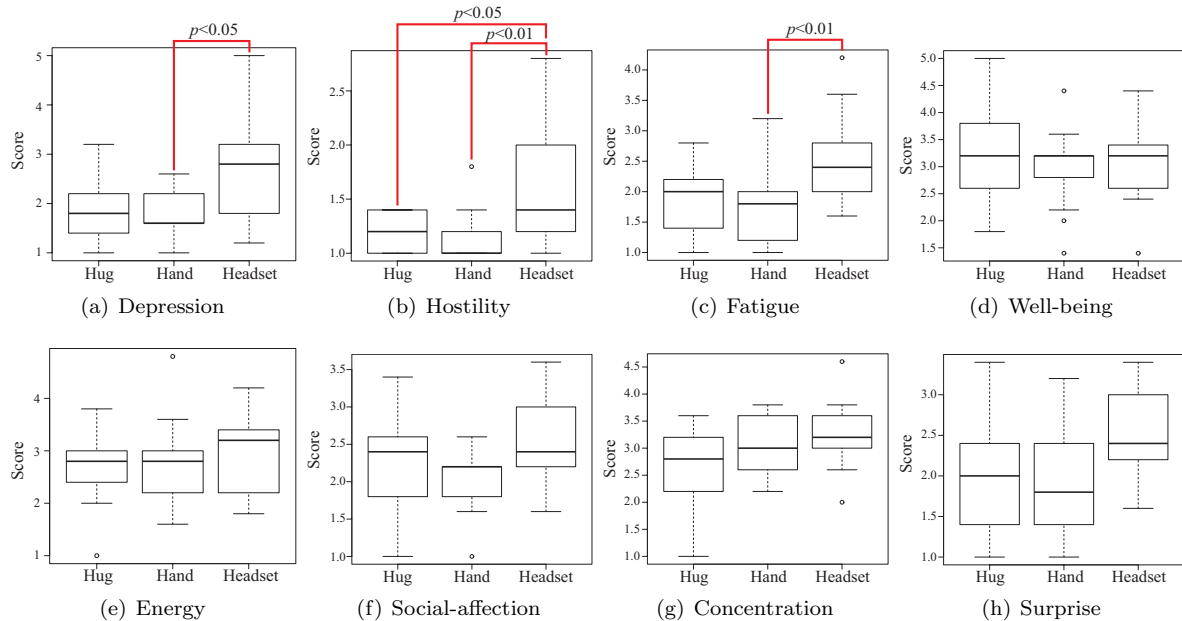


Figure 5: Result of multiple mood scale in box plot ¹

can hear that the experimenter is telling the person to fill out a questionnaire. As shown in Figure 4, the subject cannot see the person brought into the room by the experimenter. He needs to intentionally lean back to see the person; she can't accidentally enter his field of view. We checked whether the subjects leaned back and looked at her.

Physiological response To evaluate the effect at the physiological level, we measured the subject's pulse rate during the conversation (NISSEI Pulse Rate Monitor neo HR-40 was used). The subjects put the pulse rate monitor on their hand before the experiment. We confirmed that it did not disturb the subject's hugging or holding Hugvie.

3.1.3 Results

We employed 39 male Japanese university students from 18 to 26 years of age ($M = 21.6, SD = 2.1$) (13 in each condition) as well as a 22-year-old female Japanese university student. All subjects provided written informed consent in accordance with the ethics approval². An analysis of variance revealed no significant effect in the multiple mood scale. A multiple comparison test³ revealed significant differences among the three conditions (Figure 5). The depression, hostility, and fatigue scores in the headset condition were significantly higher than the hug

and/or hand conditions. For the interpersonal attraction, we compared the total scores among the conditions³, but we found no significant differences (Figure 6).

We counted the number of subjects who looked at the female confederate who pretended to fill out the questionnaire. We omitted from our analysis subjects who did not notice that the person whom the experimenter brought was the conversation partner. We also omitted subjects who looked at the person before the experimenter left the room. The results are shown in Table 1. There was a large difference among the headset and the other conditions; however, a multiple comparison test for the proportion data (Pearson's chi-square test with Bonferroni correction) revealed no significant differences among the conditions, probably because the amount of data was insufficient. We then combined the hug and hand condition results (Hugvie condition) to evaluate the effect of touching Hugvie. A Pearson's chi-square test revealed that the count in the Hugvie condition was significantly larger than the headset conditions ($\chi^2 = 3.86, p < 0.05$). We applied the same analysis for the mood and attraction scales⁴. No significant difference was found for the attraction scale between the Hugvie and headset conditions. For the mood scale, the depression, hostility, fatigue, social-affection, and surprise scores in the headset condition were significantly higher than those in the Hugvie condition ($p < 0.05$).

There is a strong tendency that the subject's pulse

¹The bottom and top of the box indicate the lower and upper quartiles, respectively, and the bold line indicates the median. The whiskers indicate the maximum and minimum values (except outliers). This is the same for the other graphs.

²This experiment was approved by the ethical committee of Advanced Telecommunications Research Institute International (No.12-506-4).

³We used a t-test with Bonferroni correction if normality was assumed by a Shapiro-Wilk test; otherwise we used a Wilcoxon signed rank sum test with Bonferroni correction.

⁴We used a t-test if the normality was assumed by a Shapiro-Wilk test; otherwise we used a Wilcoxon signed rank sum test.

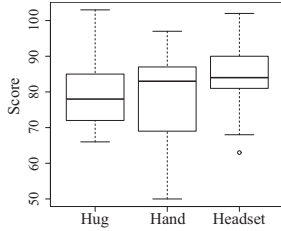


Figure 6: Interpersonal attraction result

Table 1: Behavioral sign of attraction result

Condition	Number who looked (ratio)	Number who noticed
Hug	5 (45.5%)	11
Hand	4 (40%)	10
Headset	0 (0%)	6
Hugvie (Hug+Hand)	9 (42.9%)	21

rate raises when the conversation with the female confederate begins, however, we did not find a notable difference in the pulse rate change among the conditions.

3.1.4 Discussion

Focusing on the effect of using Hugvie (regardless of holding or hugging), more subjects who used it looked at their female conversation partner. The lower depression, hostility, and fatigue scores in the Hugvie condition indicated that talking with Hugvie was more comfortable than with the headset. These results suggest that the subjects using Hugvie subconsciously increased their attraction toward their female conversation partner. We consider it is due to the feedback effect of the touching behavior on romantic attraction in the robot-mediated tele-communication. However, the social-affection score is also lower in the Hugvie condition, perhaps because the subjects were shyer in the conversation in the Hugvie condition and the social-affection scores from the self-reports were lower.

The comparison between three conditions did not clarify the effect of hugging behavior differing from holding behavior, although it indicated that talking with Hugvie increased subconscious attraction toward the partner. Ten-minute conversations that resembled self-introductions may be insufficient to evoke affective feelings. Furthermore, the hugging posture seemed to be not active or passionate (Figure 3(a)) but passive and casual in the experiment (it seems that the subject just supports Hugvie which leans over on him). In our next study, we compare the hug and hand conditions by changing the hugging posture and the conversation content.



(a) Hug condition (b) Hand condition

Figure 7: Subject's posture in study 2

3.2 Study 2

To clarify the effect of hugging, our second study compared the hug and hand conditions. The subjects were instructed to grab Hugvie in their arms for an active hugging posture in the hug condition. Figure 7 shows the hugging and holding postures in the hug and hand conditions, respectively. The subjects in the hand condition just hold Hugvie with both hands. We prepared conversation contents in which male subjects and their female conversation partners simulated a conversation between lovers while they pretended to be lovers. We expected that the subjects would easily adapt to the role of lover if hugging evokes feelings of love. To estimate the effect of hugging, therefore, we evaluated how much the subjects identified with the role by questionnaires and observing their behavior.

3.2.1 Method

The experimental apparatus is almost the same as the one used in our first study. We used a single-earpiece wireless headset in both conditions to control how the voices were heard. Furthermore, to control their visual perceptions between the conditions, the subjects were instructed to close their eyes during their conversations. The only difference between the two conditions was how Hugvie was held. Each male subject participated in one condition. Before the experiment, the subject received an explanation of the experiment and signed the consent form. They were told that they were recorded by a video camera during the experiment. A female confederate as a conversation partner participated throughout the experiment. She did not know which conditions each subject belonged to. The female confederate and the male subjects did not know each other. The subjects were told that the experiment was evaluating a new communication device and their partner is also a participant, as in study 1.

To simulate a convincing conversation, they talked about their plans for a date at Universal Studio Japan (USJ), a popular amusement park. We predefined topics that the subjects and the female confederate should discuss and follow. For example, they needed to talk about when and where to meet, which rides to try, and make a request of their partner. The female

confederate talked about the same stories based on the topic and responded similarly to every subject. Subject behaviors were recorded by a hidden camera.

The following is the experimental procedure:

1. The subjects read an instruction document that describes USJ and a conversation simulation story (five minutes).
2. The subjects and the female confederate introduce themselves by only their voices using normal headsets.
3. The subjects have a conversation with a male experimenter to get used to using Hugvie.
4. The subjects read the simulation story again to remember it (five minutes).
5. Before the conversation, the subjects complete questionnaires about their feelings.
6. The subjects talk with the female confederate for about ten minutes through Hugvie.
7. After the conversation, the subjects complete questionnaires about their feelings and are interviewed by the experimenter.

3.2.2 Measurements

Feelings in developmental stage of romantic love We measured the subjects' romantic love by defining it as a boyfriend/girlfriend relationship. Lee [23] identified six basic love styles: Eros, Ludus, Storge, Pragma, Mania, and Agape. Matsui [19] investigated young adults' love based on Lee's theory and showed that the styles of Mania, Eros, and Agape increase in the developmental stage of romantic love. We used a Japanese scale developed by Toyota [24] to measure the feelings related to these styles and measured feelings of Mania, Eros, and Agape before and after conversations to evaluate how the feelings of love changed. Each style consisted of three items; each has a six-point scale. The definition of the love styles [23] are: "Mania" is obsessive love that experiences great emotional highs and lows, very possessive, and often jealous. "Eros" is passionately physical and emotional love based on aesthetic enjoyment, stereotype of romantic love. "Agape" is selfless, altruistic love.

Impression of conversation To measure their impressions of their conversations, we asked the following questions:

- Q1 Did you feel closer to her than compared with a normal cellphone conversation?
- Q2 Did you feel nervous during your conversation?
- Q3 Do you want to talk with her more?
- Q4 Did you feel like her boyfriend?
- Q5 Are you actually attracted to her?

Q6 Did it seem that your heart was beating faster in your conversation with her?

Q7 Did you enjoy your conversation with her?

Q8 Could you express your affection to her?

Each item has six-point scale (1: not at all, 6: yes indeed).

Behavioral response The female confederate was instructed to ask "do you like me?" at the end of the simulated conversations. If the subject identifies himself as her boyfriend, he is expected to answer, "yes, I like you" ("Hai, suki-desu" in Japanese) without hesitation. We measured the response time from saying "like" ("suki" in Japanese) after she asked.

3.2.3 Results

We employed 24 male Japanese university students from 18 to 26 years old ($M = 20.9, SD = 1.7$) (12 in each condition) and a 25-year-old Japanese actress from an acting company. All subjects provided written informed consent in accordance with the ethics approval⁵. The subjects who noticed the place of the camera recording them were removed from our analysis since we inferred that they would have difficulty just being themselves.

We calculated the increments in the scores of three love styles after the conversations⁶ (Figure 8), but we found no significant differences among the conditions⁷. For their impressions of the conversations, only Q3 showed a significant difference ($W = 30.5, p < 0.05$). The subjects of the hand condition wanted to talk more with their conversation partner compared with the hug condition (Figure 9(a)). For the response time, nine subjects were omitted from the analysis (one due to an error in experimental setup, four due to not saying "like", and two due to saying too many words before "like"). Seven and eight subjects were used in the hug and hand conditions, respectively. The response time in the hug condition was significantly shorter ($t(7.53) = -2.42, p < 0.05$) than in the hand condition (Figure 9(b)).

3.2.4 Discussion

If hugging behavior evokes feelings of love and attraction toward partners, the subjects will more easily accept their roles as lovers. The increment averages in the feelings of Mania, Eros, and Agape were all positive; feelings of romantic love increased after the conversations, suggesting that the subjects embraced their roles as lovers. However, we found no significant differences in the increments among conditions.

⁵This experiment was approved by the ethical committee of Advanced Telecommunications Research Institute International (No.12-506-4).

⁶Four pieces of data in Eros were omitted due to an error in the experimental setup.

⁷We used a t-test if normality was assumed by a Shapiro-Wilk test; otherwise we used a Wilcoxon signed rank sum test in study 2.

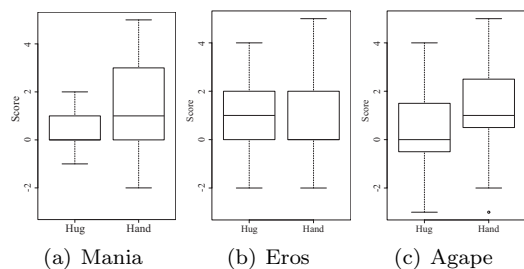


Figure 8: Increments of affective feelings of three styles

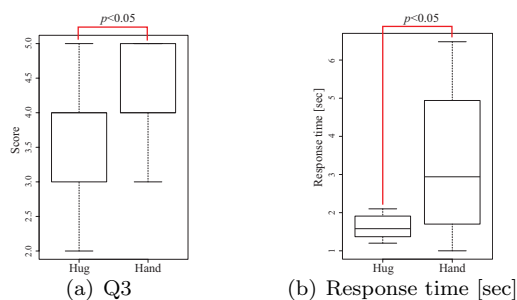


Figure 9: Impression and response time results

From the viewpoint of the response time to say “like,” in the hug condition, the subjects more readily became boyfriends. The average time in the hug condition was 1.6 seconds, which means they almost immediately said “like.” Conversely, in the hand condition, they took an average of 3.3 seconds, which means they slightly hesitated, suggesting a gap between their feelings as boyfriends and themselves. In other words, no hesitation might mean that the subjects really increased their attraction toward the female conversation partner. Perhaps not just touching but also hugging more strongly evokes feelings of love and attraction in the subconscious level.

The subjects in the hand condition wanted to talk more with their partners compared with the hug condition. We infer that the subjects were shyer in the hug condition, and their Q3 scores were lower as well as the social-affection result in study 1.

4 General discussion

In both studies, we found that the behavioral responses interpreted as attraction toward the female appeared differently among the conditions but the subjects’ self-feeling and impression reports did not; the attraction seemed subconsciously increased. In the early developmental stage of romantic love, such feelings might subconsciously rise, and individuals are aware of self-romantic feelings after observing the self-behaviors evoked by the attraction. Our result might be obtained in the early stage of close relationship. Another possibility that might explain the inconsistency

between the behavioral and questionnaire results is that the subjects did not honestly report their romantic feelings to the experimenter because they were too shy despite being aware of them.

As described in section 1, the feedback mechanism for feelings remains controversial. At the conscious level, it might be the effect of the misattribution of arousal on feelings, where persons attribute their physiological arousal to the wrong external factors [25]. Feelings of love can be misattributed [26, 27]. A feeling can be also subconsciously altered by behaviors. For example, a mere exposure effect is known, where repeated exposure to a stimulus increases the positive affect toward it [28, 29] (simply explained as “seeing increases liking”). Physiological feedback like the facial feedback hypothesis [30] could alter an individual’s feelings. These effects might be related to our results in which subject feeling were subconsciously evoked. The mechanism of the effect on increasing attraction needs further investigation.

The experiments assumed the subjects were heterosexual but we did not actually categorize them on a homo-hetero sexual scale. Some homosexual males possibly participated in the experiments. Our analysis was limited in this point.

We predicted that subjects would need to imagine their conversation partner on the robotic media for the behavioral feedback effect; however, we did not verify that prediction in this study. We should also examine whether Hugvie’s humanlike shape is necessary to cause the feedback. Affective behaviors other than hugging (e.g., stroking) and experiments with female subjects and a male conversation partner must be studied to make the effect to evoke affective feelings more convincing.

5 Conclusion

This paper explored the feedback of hugging on affective feelings toward a communication partner in robot-mediated tele-communication. Our result shows that hugging subconsciously evokes an attraction or affective feeling toward a stranger communication partner. This suggests that a robot-mediated communication involving virtual-physical interactions can support starting the development of a close relationship.

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