


# Gender-Impression Modification Enhances the Effect of Mediated Social Touch Between Persons of the Same Gender

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**Abstract** The main contribution of this study is realization of a method that enhances the effect of touch in remote communication between persons of the same gender by changing the gender impression with a voice changer during telecommunication. Although psychological studies have revealed that touch has various positive effects such as triggering altruistic behavior and persuading others, these effects are restrained in some cases, especially in same-gender communication, because a touch between persons of the same gender tends to cause unpleasant feelings. However, “Transcendent Telepresence,” which

enhances positive psychological effects and suppresses negative effects by modifying the information transmitted via telecommunication, enables us to overcome this problem. We hypothesized that telepresence that modifies people’s gender impression reduces this unpleasantness and enhances the effect of touch. We tested the effectiveness of this method in a situation in which a male operator asked male participants to perform a monotonous task. The results showed that a touch by a male operator whose voice was changed to female-like could reduce the boredom of the task and improve the friendliness toward the operator. We believe this method realizes effective communication in various fields including telemedicine, crowdsourcing, and remote education.

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## Introduction

Interpersonal communication consists of complex signals in many modalities including not only spoken language but also nonverbal information, such as facial expression, voice intonation, body language, eye contact, and touch. All of these elements influence the quality of communication through mutual interaction. Above all, the sense of touch is the most personal and intimate means of human interaction. Touch that forms part of a social action is known as “social touch.” Psychological studies have revealed that social touch has various positive effects such as triggering altruistic behavior, persuading others, and reducing stress.

On the other hand, the advent of cell phones and videophones enabled us to communicate with people in

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physically distant places. The technique involved is known as “telepresence” and provides communicating parties in distant places with a sense of reality as if they were actually meeting. Whereas the popularity of remote communication devices such as cell phones and videophones has placed great importance on auditory and visual information, many telepresence systems capable of conveying tactile sensation have been devised [2, 19, 32]. These systems are expected to benefit from the positive effects of touch in telecommunication. For example, a doctor could provide relief for a patient by using telemedicine, an employer could persuade an employee engaged in remote work, and a teacher could encourage a student to follow their instructions.

However, it has been revealed that the effects of touch are influenced by gender, regardless of whether it is carried out face-to-face or remotely. In particular, touch between persons of the same gender tends to cause resistance and is either unable to sufficiently evoke the effects of social touch or has contrary effects. This means that the effects of touch are very limited and depend on the people involved (especially their gender). We addressed this problem by using the advantage of telepresence to enable us to transmit information in a modified form.

Many previous studies on telepresence extensively investigated ways in which to precisely convey distant places. For example, high-definition images and three-dimensional sound reproduction, which reproduce visual and auditory information from distant places, enhance the sense of reality. In addition, there are many studies on telepresence having substance, which can convey nonverbal information such as a gaze or a sense of touch that we cannot convey by transmitting visual or auditory information. *Talking Head* is intended to convey visual information exactly using a three-dimensional display, which is difficult to accomplish with a two-dimensional screen [3]. The telepresence surrogate anthropomorphic robot (*TELESAR V*) is equipped with tactile transmission technology capable of conveying differences in materials including cloth and paper. It realizes a sense of reality as if a person directly touched an object in front of them at a remote place [9]. These studies aim to bring remote communication closer to face-to-face communication.

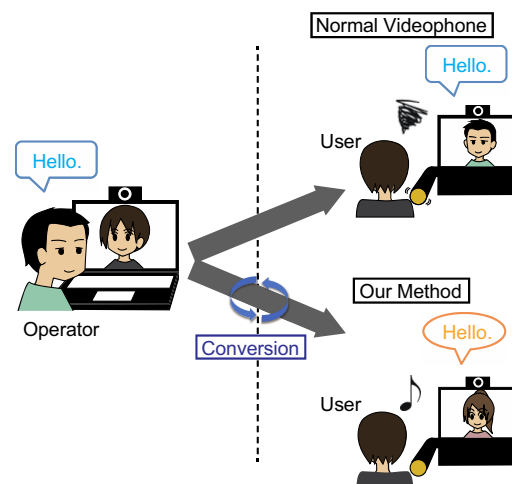
However, conveying exact information is not necessarily effective. We believe that the capability to transmit information in a modified form is an advantage of telepresence. Consequently, we proposed “Transcendent Telepresence,” which uses this advantage positively [21]. We believe that telepresence can augment the elements of communication by intervening between people to realize remote communication that is superior to face-to-face communication. For example, Nakazato et al. [28] showed that *Smart Face* succeeded in improving users’ creativity

by changing their facial appearance into smiling faces in real time. Yokoyama et al. [33] devised *PoliTel*, which can autonomously adjust the interpersonal distance. Kinoshita et al. [21] proposed an eye avatar, which controls the range of the gaze cone by switching convex/hollow eye and allows speakers to make eye contact with various listeners at once. As for touch, a touch transmitted in a simple way is also influenced by gender difference and its positive effects have limitations that depend on the gender of the participants. Thus, in this study, we proposed a method to enhance the positive effects of touch during remote same-gender communication by changing the gender impression (Fig. 1) and investigated its effectiveness. Modifications to information such as this cannot be carried out in face-to-face communication.

## Touch in Communication

### Social Touch

Many researchers have investigated the effect of touch in communication. For example, Crusco et al. [4] experimentally demonstrated the effect of social touch. They instructed one-half of the waitpersons in a restaurant to touch the elbow or shoulder of visitors when they handed them the bill, and the other half not to do so. The result was that waitpersons who touched visitors received more tips than those who did not. Guéguen et al. [14] conducted an experiment at a bus stop. An experimenter asked passersby the way to a famous place and dropped a disk on purpose



**Fig. 1** Conceptual view of the proposed method. When a touch between persons of same gender is transmitted in a simple way, it tends to feel unpleasant and its positive effects have limitations. In this study, we proposed a method to enhance the positive effects of touch during remote same-gender communication by changing the gender impression

after thanking them and walking about 2 m away. They examined the ratio of passersby who picked up the disk, and it was shown that the ratio became higher when the experimenter touched their upper arm when expressing their thanks than when the experimenter did not. These studies showed that social touch results in a favorable impression to others and triggers altruistic behavior.

Social touch has also been shown to have persuasive effects. Guéguen et al. [13] showed this effect in various scenarios: In an investigation on a street about an imaginary “TV program appropriate for children,” the rate of those who agreed to answer increased when they were touched during the explanation; at a sampling sale of an aperitif in a pedestrian zone, briefly touching visitors increased the purchase rate [15]; when a waitperson touched a visitor at the time of an order at a restaurant, the rate of those who chose that day’s recommended dish increased [16] and so on. Eaton et al. [8] also showed that when a female nurse promoted a meal for the elderly with touching, they consumed more calories and protein.

It has also been revealed that social touch has the effect of reducing stress. Koole et al. [22] asked university students walking on campus to fill out some questionnaires about death anxiety. They revealed that the death anxiety of respondents with low self-esteem decreased when a female experimenter touched them on the shoulder. Ditzen et al. [6] showed that physical contact by one’s spouse reduces the saliva cortisol level, which is used to evaluate stress, and the heart rate after a Trier Social Stress Test. According to Nilsen et al. [29], a touch in a known context reduces participants’ heart rate and blood pressure, whereas a touch in unfamiliar context increases them.

If we can enhance these positive effects of social touch, richer communication will be realized.

### Mediated Social Touch

As the number of interactions through the media increases in daily life, many examinations on conveying a sense of touch have been conducted. In remote communication, a touch is called “mediated social touch.” Haans et al. [19] defined mediated social touch as “*the ability of one actor to touch another actor over a distance by means of tactile or kinesthetic feedback technology*”. We extended that idea to this study.

Various devices have been designed to realize mediated social touch. For example, *inTouch* consists of two of the same devices connected, with each having three cylindrical rollers. When one of the rollers is rotated, the corresponding roller on the other device also rotates. This makes it possible for two people, separated by distance, to interact physically with each other [2]. *Huggy Pajama* enables parents and children to hug one another in remote communication.

Parents can send hug signals to children via a hugging interface device, which is a mobile doll with force sensors. A hug-reproducing pajama receives the signal and actuates air pockets and heating elements to simulate the feeling that the children are being hugged [32]. *The Hug* consists of two connected pillows in a shape that expresses the gesture of hugging. Two people separated by distance can communicate by stroking, squeezing, and rubbing *The Hug*, which translates these gestures into heat and tactile vibration. This was designed to address a very human need for physical closeness in remote communications [12].

Haans et al. revealed that the effects of social touch in triggering altruistic behavior were also evoked in touches in remote communication. They had male participants, who were asked to evaluate a haptic communication system, place an arm strap equipped with a vibration motor on their left upper arm. This arm strap simulated the sense of touch by vibration. A female interviewer, who was an experimental cooperator, then asked participants questions and indicated a sense of touch to them through the arm strap. The interviewer and participants were separated by an opaque screen and talked via a chat system on a PC without being able to see each other’s faces. Experimenters anticipated that the reaction to a touch would be larger in communication between persons of opposite gender and set the conditions in that way. After the conversation, the interviewer dropped a pencil on purpose, and it was observed whether participants picked it up. The ratio of those who picked up the pencil was higher for those who received the sense of touch than those who did not [17].

### Influence on Social Touch by Gender

Although it has been shown that touch has various positive effects in communication, regardless of whether face-to-face or remote communication is used, it is also known that these positive effects are limited or become contrary effects in some cases, especially in same-gender communication.

Dolinski conducted an experiment in a subway station yard. In his experiment, a male/female experimental cooperator approached a passerby who walked alone and asked him/her to mail a letter. The passersby were divided into two groups: those who were touched during the request and those who were not. The results were as follows: The ratio of those who mailed the letter increased when a female touched a female, a female touched a male, and a male touched a female. Conversely, it decreased when a male touched a male [7].

Heslin et al. [20] investigated the difference in how they felt about the touch according to a partner’s gender or their relationships. They used a body map that divided the human body into 11 areas and asked 208 respondents to answer a questionnaire concerned with the meaning of touch. In their

study, respondents had to keep in mind the question “What does it mean to me when a close person (or stranger) of the opposite gender (or same gender) touches the indicated area of my body in a certain manner?” They had to answer for the 11 body areas, four modes of touch (squeeze, stroke, brush, and pat), and six meanings categories (e.g., invasion of privacy, pleasantness). A touch from a close person of the opposite gender was rated as less invasive of personal privacy than a touch from a close person of the same gender and a strange person of the opposite or same gender. In addition, males paid more attention to their partner’s gender for the invasion of privacy than females. As for pleasantness, a touch from a person of the same gender was rated as unpleasant; in particular, a touch from a stranger of the same gender was rated as much more unpleasant.

Other studies have also shown that a touch from a person of the same gender feels more unpleasant than a touch from someone of the opposite gender for both men and women [1, 24]. Further, the influence of whether the touch is initiated by a person from the same or opposite gender is larger for males than for females [5, 10].

In addition, it was shown that a touch carried out in remote communication has a similar effect resulting from the difference in gender. Haans et al. [18] conducted an experiment using a vest and arm straps equipped with vibrotactile actuators. Participants were invited to believe that the study was about the evaluation of a haptic communication system with another unknown (fictional) participant who touched them remotely. They received a series of remote touches from their partner and answered questions about the touch. They were explicitly told the name of their partner (e.g., William or Julia) to infer the partner’s gender. As a result, both males and females were apt to experience a touch from the same gender as less pleasant, although they did not observe a significant effect.

However, the factors responsible for this limitation are not only touch itself but also the combination of modalities such as visual and auditory information. Thus, it might be possible to get rid of this limitation in telecommunication because telepresence can transmit information in a modified form.

## Mediated Social Touch with Gender-Impression Modification

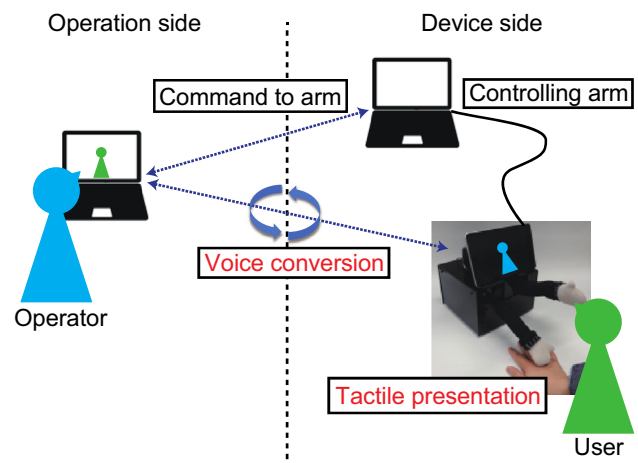
### Proposed Method

We focused on the fact that the “perceived” rather than the “real” gender of the touching person influenced the effects of the social touch. According to a study by Gazzola et al. [11], the subjective evaluation and physiological reaction of the touched person are largely dependent on the recognition

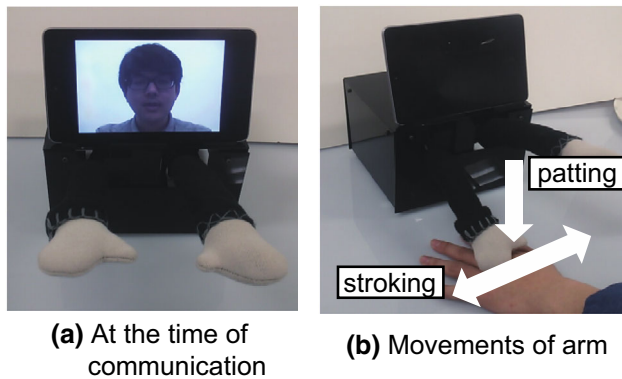
of the touching person. On the basis of this knowledge, we anticipated that we could evoke the effects of social touch regardless of the partner’s gender by converting information related to the partner’s gender, such as their voice and appearance, and controlling the touched person’s perception of their partner’s gender. That is, we proposed a method for evoking the effect of social touch between persons of the same gender such that it sufficiently equaled the effect between persons from the opposite gender by changing his/her voice to that of the opposite gender using a voice changer and replacing the appearance of the touching person with an avatar of the opposite gender. Figure 1 illustrates the concept underlying our proposed method.

### Implementation

We built a remote communication system that transmits sounds and images as well as the tactile sensation of social touch in order to investigate the effectiveness of our proposed method. Figure 2 shows the system configuration. The tactile presentation device conveys a sense of touch to a user with a two-degree-of-freedom arm controlled by motors (Fig. 3). For the following experiments, we implemented selected movements such as patting and stroking a hand placed in front of the device. The hands of the arm, which touched the user directly, were made of nylon cloth filled with cotton for comfort. An operator was able to control the arm via a PC on the operator side. The operator and user were able to use video chat via the PC on the operator side and a tablet terminal on the device. The operator could change his/her voice using a voice changer installed on the PC on the operator side. For imaging, we did not implement a system capable of converting the appearance in real time; instead, we used a recorded movie for the preliminary user study (described later).



**Fig. 2** System configuration. The operator is able to have a conversation with the user via video chat using a voice changer and to give a sense of touch to the user using tactile presentation device



**Fig. 3** Overview of the tactile presentation device. Each figure shows the appearance of the device at the time of communication (a) and the movements of the arm (b)

## Experiment

We conducted an experiment to examine the effects of modifying the impression that the communication partner was of the other gender on enhancing the effect of social touch in same-gender remote communication. In this section, we describe the experimental details.

### Experimental Overview

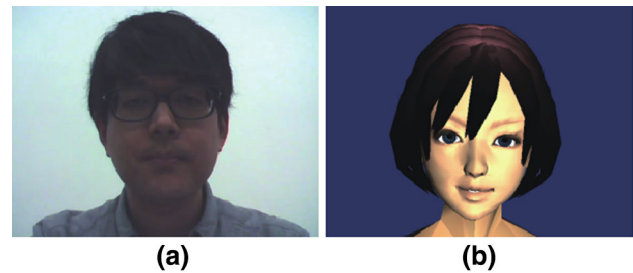
We focused on the effect of social touch as having a positive influence on participants' behavior as an evaluation index. In particular, we measured the improvement in motivation by remote touch. We evaluated participants' improvement in motivation by requiring them to perform a monotonous on-screen task and then measured the duration and degree of achievement. Participants were asked to perform the task via our system as much as possible with the help of an operator at a remote location.

Because the touch between male strangers was perceived as particularly unpleasant, as described in “[Touch in Communication](#)” section [5, 7, 10, 20], we dealt with the communication between male strangers in the following studies.

### Preliminary User Study

For the purpose of inspecting the effectiveness of our proposed system and to identify problems, we conducted a preliminary user study in which we changed the impression of the operator's gender by converting the voice and appearance. The study is briefly summarized as follows.

We gathered six participants (male university students) and a male operator asked them to perform a monotonous task via our system. This task was similar to the task adopted to measure the effect of a robot's active touch on



**Fig. 4** Images of the operator. Each figure shows the unchanged appearance of the operator (a) and the image of 3DCG female avatar used instead of the operator (b)

people's motivation [27]. The tactile presentation device stroked the back of each participant's hand during the request. Participants were exposed to the operator's voice and appearance via two different approaches. In the first approach, the operator's voice and appearance remained unchanged (Fig. 4a), whereas in the second approach a voice changer was used to change his voice to a female-like voice and his appearance was replaced with an image of a 3DCG female avatar (Fig. 4b). We used a video recording of the operator, although participants were told that the operator was in another room and operating the device in real time. For comparison purposes, we added a standard condition under which the touch was not conducted and the operator's voice and appearance were unchanged.

Subsequently, although there were no significant differences in the workload, we obtained useful information by conducting interviews with participants after all the trials. These results suggested that changing the impression of the operator's gender suppresses the feeling of resistance to being touched by a male; however, the 3DCG model gave participants a sense of incongruity because it did not change its facial expression and they could not read its intention. Therefore, some improvements are needed to reduce this incongruity, such as synchronizing the movements of the avatar and operator. However, these improvements would require further implementation and might cause difficulties for the operator. Furthermore, it may result in more awkwardness for the participants if the expressions and movements of the avatar were to approximate those of a human being via “the uncanny valley” effect [26]. Therefore, we conducted the following experiment that excluded information about the appearance and changed the impression of the operator's gender only by voice.

## Experiment

The effects of changing the male operator's voice to female-like on enhancing the effect of social touch in same-gender communication were examined by requiring participants to perform a monotonous task requested by a

male operator. This enabled us to measure the duration and degree of achievement to evaluate participants' motivation. We ensured that the experimental environment remained constant for all participants by using the sound-recorded voice data of the operator, which were played back to participants according to their behavior, even though they were told that the operator was present in another room and was actually operating the device.

### Task

We prepared a monotonous on-screen task to measure participants' behavior objectively. We improved the task used in the preliminary user study by enhancing the interaction with the operator. Figure 5 shows screenshots of the task. In this task, a gray circle was displayed at the center, and a black square appeared on both sides of the screen. Participants could drag the circle into either of one of the squares with a mouse, following the operator's instruction: "left" or "right." When the circle was dragged into the directed square, the screen returned to the initial state, and participants were then given the next instruction: "left" or "right." The participants repeated this series of movements.

### Conditions

We conducted a within-participant experimental design with four conditions:

- *Male*: A male operator asked participants to perform the task and provided instructions by only using his voice.
- *Male + Touch*: In addition to the *Male* condition, participants were touched on the back of their left hand by the tactile presentation device up to two times: once

when participants were first asked to perform the task and again when they were asked to restart the task if they were going to stop.

- *Female*: In addition to the *Male* condition, participants were touched on the back of their left hand by the tactile presentation device up to two times: once when participants were first asked to perform the task and again when they were asked to restart the task if they were going to stop.
- *Female + Touch*: In addition to the *Female* condition, participants were touched on the back of their left hand by the tactile presentation device up to two times: once when participants were first asked to perform the task and again when they were asked to restart the task if they were going to stop.

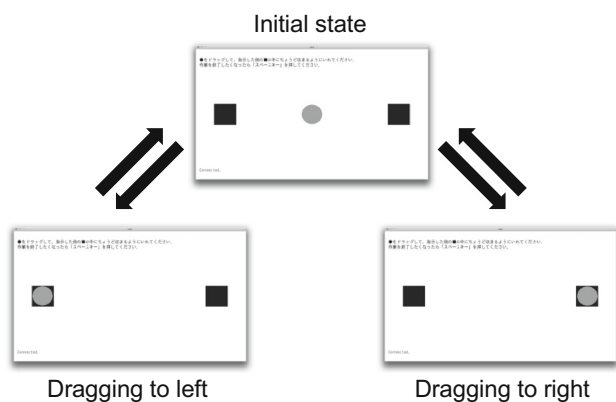
We avoided giving participants a visual image of the operator and any preconception about their gender by showing an anonymous image on the tablet terminal during experiments (Fig. 6). Under the *Female* and *Female + Touch* conditions, we did not tell participants that the operator's voice would be changed. Strictly speaking, we would have had to compare a male voice with a female voice to purely check the influence of gender on touch, but this was not our purpose. As we considered our system to be a real-time system, we had to use a converted male voice.

### Participants

The participants consisted of 27 male university students in their twenties. The conditions for each participant changed each day; thus, they participated in these experiments for 4 days in total. They were paid 1850 yen (roughly US \$15) for 2 h of participation. We randomly selected the order in which the different conditions were introduced such that they varied for each participant.

### Experimental Procedure

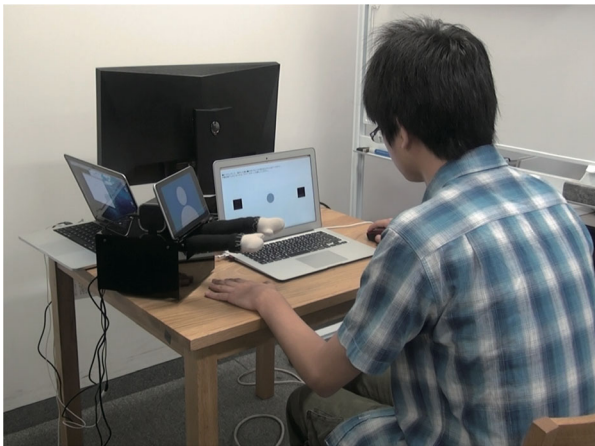
The experiments were conducted in a laboratory. The experimental setting is shown in Fig. 7. First, an experimenter told participants that the experimental procedure would be explained by a male operator at a remote location



**Fig. 5** Screenshots of the experimental task. *Upper figure* presents the initial state. When the circle was dragged into either of the squares correctly following the operator's instruction (*lower left* or *lower right*), the screen returns to the initial state (*upper*)



**Fig. 6** Operator's image shown to participants in the experiment



**Fig. 7** Experimental environment. Participants sat down in front of the PC for the task. The tactile presentation device was placed in the left front of the participants

instead of by the experimenter, that the operator was able to observe the state of working with a PC, and that their left hand should be opened and placed in front of the tactile presentation device during the experiment.

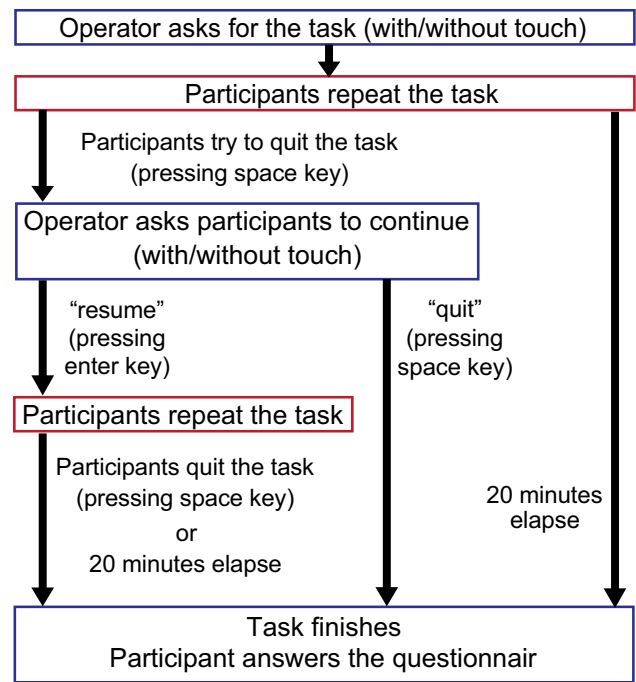
After the experimenter pretended to start remote communication with the operator and to have a short conversation to confirm the connection, the operator explained the task to the participants and asked them to perform it following his instructions as much as possible. In addition, participants were directed to determine a time to finish the task by themselves and to press the space key when they wanted to do so. Under the *Male/Female + Touch* conditions, the tactile presentation device stroked the back of their left hand for about 20 s during this explanation.

When participants pressed the space key once, the task was stopped, and they were asked to continue performing the task a little longer by the operator.

This time, the tactile presentation device patted their left hand under the *Male/Female + Touch* conditions. Participants could choose to either press the space or enter keys to finish or resume the task, respectively. If they chose to resume, they could finish the task arbitrarily by pressing the space key again. If the working time exceeded the maximum time (20 min), the task automatically finished. Participants were not informed of this maximum time. Figure 8 shows the experimental procedure utilized in each trial.

**Measurements**

- Objective measurement: We measured both *the number of actions* (the number of circles correctly dragged into squares) and *the working time* (the time spent on the task) to investigate participants’ motivation. Because



**Fig. 8** Experimental procedure utilized in each trial

the time at which the task was stopped was decided by each participant and the average workload varied between participants, we adopted the rate of change (the value normalized by the *Male* condition) as the objective measurement.

- Subjective measurement: We investigated the subjective impressions of the participants by preparing a questionnaire that inquired about their impressions of performing the task (*enjoyment, boringness, and willingness to perform an additional task*) and their feelings toward the operator (*friendliness, trust, and authority*). After each experiment, participants answered a questionnaire on a Likert scale of one to seven, where one is the most negative and seven is the most positive. The actual questions asked of participants were as follows (these questions were actually asked in Japanese):

*Enjoyment*: “Was the task enjoyable?”

*Boringness*: “Was the task boring?”

*Willingness*: “Are you willing to perform an additional task?”

*Friendliness*: “Did you feel friendliness toward the operator?”

*Trust*: “Did you think you could trust the operator?”

*Authority*: “Did you feel the authority of the operator?”

In addition, participants were required to describe their feelings toward the operator and the experiment after each trial.

*Hypothesis*

We hypothesized that if male participants were touched by a male operator, they feel resistance to the touch; thus, the effects of social touch would be limited. Therefore, their impression of the task and feelings toward the operator would remain unchanged or worsen, and the workload would remain unchanged or decrease (Hypothesis 1).

On the other hand, we hypothesized that if the operator’s voice was changed to a female-like voice, participants’ feeling of resistance to being touched by a male would be suppressed. Therefore, their impression of the task and feelings toward the operator would be improved, and the workload would increase (Hypothesis 2).

*Results*

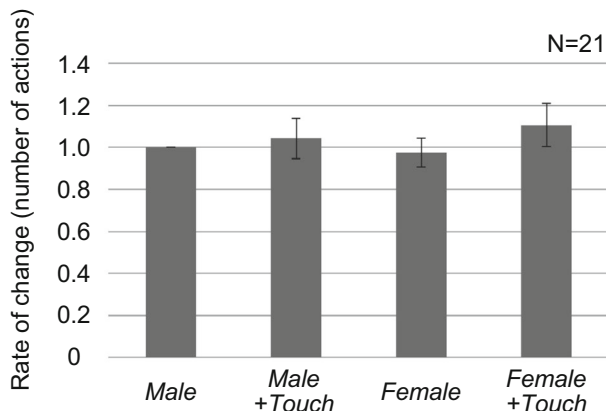
Five participants performed the task for the maximum time under all conditions, and one participant had an extremely small workload under the *Male* condition. The rate of change under the other conditions was extremely large and exceeded  $3\sigma$  under the *Male + Touch* condition. Consequently, we excluded their data.

Figures 9 and 10 show the rate of change in the number of actions and the working time for each condition. The error bars represent the standard error. Multiple comparisons using the Holm method showed that there was no significant difference between any combinations of conditions.

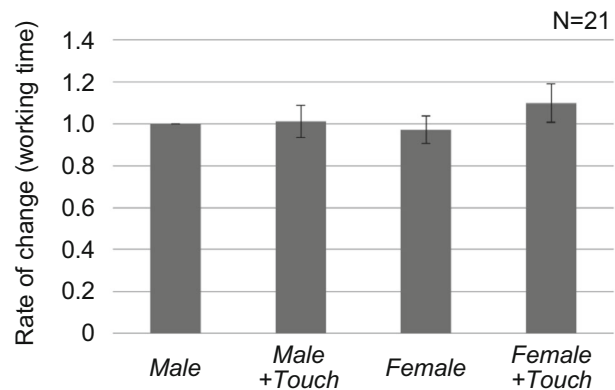
Figure 11 shows the subjective impressions of the task for each condition. The error bars represent the standard error. Multiple comparisons using the Holm method showed that there was a significant difference for the

*boredom: Male condition > Female + Touch condition* ( $p = 0.041$ ), whereas there were no significant differences between any other combinations of conditions. This suggests that touch and the change in the operator’s voice to female-like reduced the boredom associated with performing the monotonous task.

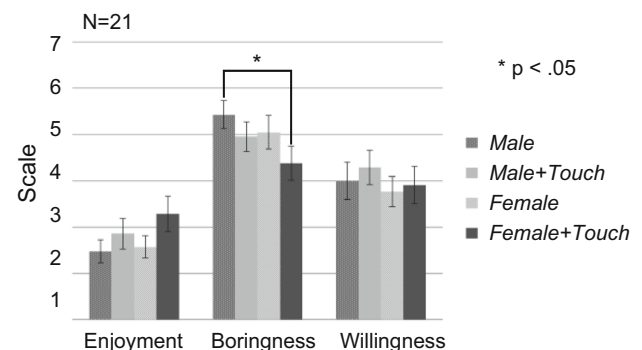
Figure 12 shows the subjective feelings toward the task for each condition. The error bars represent the standard error. Multiple comparisons using the Holm method showed that there was a significant difference for the *trust: Male condition > Female condition* ( $p = 0.041$ ) and a marginal



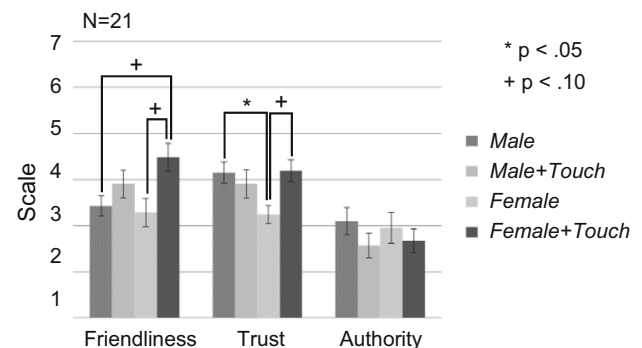
**Fig. 9** Rate of change in the number of actions



**Fig. 10** Rate of change in the working time



**Fig. 11** Impression of the task



**Fig. 12** Feelings toward the operator



difference for the *Female + Touch* condition  $>$  *Female* condition ( $p = 0.083$ ). This suggests that changing the voice of the operator without touch resulted in participants becoming distrustful. Furthermore, there were marginal differences in the *friendliness: Female + Touch* condition  $>$  *Male* condition ( $p = 0.071$ ) and the *Female + Touch* condition  $>$  *Female* condition ( $p = 0.079$ ). This suggests that touch in combination with a change in the operator's voice to female-like increased the friendliness toward him.

## Discussion

Touch by the male operator whose voice was changed to female-like had a significant effect on reducing the boredom associated with the monotonous task and a marginally significant effect on improving the operator's friendliness, whereas touch without the change in voice did not. This means that our proposed method enhanced the effect of social touch, which is typically limited in male-to-male communication. Thus, Hypotheses 1 and 2 were partially supported.

Work performed by Reeves et al. revealed that people apply gender stereotyping to a partner according to whether their voice is male-like (low and loud) or female-like (high and soft), even if they know the real gender of the partner [31]. This might apply to our study.

However, there was no significant difference in the rate of change in the workload (both *the number of actions* and *the working time*), although they increased by about 10 % under the *Female + Touch* condition. This might be caused by the fact that the order effect was larger than we anticipated. We randomly assigned the order in which conditions were introduced to eliminate the order effect on average for each condition, but the workload for the first trial tended to be smaller than those for the following three trials. This resulted in a large dispersion for each condition. For the last three trials, it was assumed that the participants knew the overall process of one trial, and their workload was larger because they were accustomed to it.

For the *Female* condition, we found that the change in the voice itself did not improve the operator's friendliness according to the marginally significant difference between the *Female* and *Female + Touch* conditions. In addition, the change to a female-like voice caused a loss of trust. According to the free descriptions after each trial, some participants were confused when they heard the high-pitched voice after the experimenter's explanation that the operator was male. Some participants also mentioned the awkwardness of the voice, probably due to the limitations of the voice changer. This confusion and awkwardness might have caused the loss of trust. However, the feeling of trust was not lower under the *Female + Touch* condition

than under the *Male* condition. Social touch is known to have the effect of improving the feelings of security and trust [23, 25]. This improvement in the trust by touch might offset the distrust caused by confusion and awkwardness.

It should be noted that the workload did not decrease and there were improvements in *boredom* and *friendliness* under the *Male + Touch* condition, although they were not significant, whereas there was a possibility that the rather bad effect of touch would come out. The simple fact that the touch was performed remotely (not directly) might suppress the unpleasantness from being touched by a male.

## Limitations

This study had a number of limitations. Firstly, the experiment conducted excluded information about appearance considering the need for further implementation and the possibility of more incongruity. However, technologies that can track the participants' faces via a webcam and map their facial movements in real time onto the animated 3D avatars, without putting a burden on participants, have emerged [30]. If those technologies develop and we become able to add pictorial information without inducing incongruity by using them, we may obtain more effects of social touch and make use of the advantages of using images, such as conveying the operator's movement and facial expressions.

Secondly, the reaction to touch is significantly influenced by generation, breeding, and culture. Naturally, the relationship between participants and the operator also has a significant influence on the reaction to touch. In our experiment, all participants were Japanese university students in their twenties and were not acquainted with the operator. However, investigation as to whether our proposed method is applicable to a general situation would require us to gather additional participants from various backgrounds. Furthermore, we dealt with the communication between males in our experiment considering the fact that a touch between males particularly felt unpleasant; however, we also need to investigate communication between females.

Thirdly, we focused on the positive effect of social touch on participants' behavior and feelings toward the operator as an evaluation index. It is thought that the results would change according to the effect of the type of social touch we adopt as an evaluation index.

Finally, we expressed the sense of touch via a patting and stroking arm. The modes of touch (e.g., squeeze, brush) obviously influence the results. Nonhuman-like tactile presentation methods (e.g., heat, vibration, electricity) can also be adopted. In addition, the appearance of the device might influence the results. We need to examine

an adequate way to present touch and appearance for generality.

## Conclusion

In this study, we proposed a method for evoking the positive effects of social touch in communication between persons of the same gender, which are limited in face-to-face communication, by converting information about the operator's gender using telepresence. Further, we built a telepresence system to implement this method and assessed its effectiveness.

We conducted a within-participant experiment in which a male operator asked a male participant to perform a monotonous task via telepresence under four conditions: with and without touch and with and without conversion to a female-like voice. The results showed that the touch by a male operator whose voice was changed to female-like had a significant effect on reducing the boredom associated with the task and a marginally significant effect on increasing the friendliness toward the operator. This indicates that use of telepresence can evoke the effects of social touch between persons of the same gender and shows the new possibilities of telepresence for realizing effective communication peculiar to remote communication.

Telepresence came to be utilized in various fields including telemedicine, crowdsourcing, and remote education. Therefore, the study of telepresence with the possibility to produce an effect superior to face-to-face communication is expected to become more important. This study shows that transcendent telepresence may possibly surpass face-to-face communication in certain aspects, and augments our ability by enhancing positive psychological effects. Currently, we are approaching the research on transcendent telepresence in various ways. Communication consists of many other elements, such as facial expression and body language. All of these elements can possibly be augmented by transcendent telepresence. Although the effects of various types of nonverbal information are under investigation individually, we can integrate those effects and realize a telepresence system that enables users to use their nonverbal communication ability as intended. Transcendent telepresence may be more ideal for users than face-to-face communication in the future.

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