Universality and Cultural Specificity in the Emotion Perception from Touch

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Abstract

Can people communicate distinct emotions by touch? Previous studies in Western cultures have indicated that certain emotions could be perceived above the chance level when an encoder conveys emotions by touching a decoder's arm. However, the perception of emotions from touch has not been investigated in Japan, where it is uncommon to use touch as a method of daily communication. Therefore, we conducted an experiment with Japanese participants, which was nearly identical to previous studies with non-Japanese people. Results indicated that anger, love, and gratitude were categorized above chance, and fear, disgust, surprise, envy, and sympathy could also be accurately recognized above chance at a less detailed level such as pleasant or unpleasant, and aroused or non-aroused. These findings suggest universality and differences between Japanese and Westerners regarding the perception of emotions by touch.

Keywords: Emotion, Perception, Touch, Cultural differences

Introduction

Nonverbal information is an essential clue in emotional communication. Many studies, beginning with Darwin (1872), investigated the perception of emotions from the face (Schirmer & Adolphs, 2017), and several the emotional voice (Scherer, 2003). However, little research has focused on interpersonal touch as an emotional clue, although some has studied non-human touch (e.g., Harlow, 1958; Guest, Dessirier, Mehrabian, McGlone, Essick, Gescheider, Fontana, Xiong, Ackerley, & Blot, 2011). In addition, previous studies on human affective touch did not focus on the perception of discrete emotions, but on emotional valence (e.g., Guest, Essick, Dessirier, Blot, Lopetcharat, & McGlone, 2009; Gentsch, Panagiotopoulou, & Fotopoulou, 2015). As a result, little is known about the perception of discrete emotions from interpersonal touch.

Research on the perception of discrete emotions from touch has only been undertaken over the last few decades (e.g., Hertenstein, Keltner, App, Bulleit, & Jeskolka, 2006; Hertenstein, Holmes, McCullough & Keltner, 2009; App, McIntosh, Reed, & Hertenstein, 2011). Hertenstein et al. (2006) reported that several emotions could be conveyed by touch. Their study was conducted in Western cultures, and consisted of dyads of participants, with one member of the dyad assigned the roll of encoder and the other the decoder. In their experiment, the encoder touched the decoder's bare arm

from the elbow to the end of the hand and tried to convey an emotion instructed by the experimenter. The encoder expressed one of 12 emotions: anger, fear, happiness, sadness, disgust, and surprise (basic emotions); embarrassment, envy, and pride (self-focused emotions); or love, gratitude, and sympathy (prosocial emotions). After the encoder conveyed each emotion, the decoder, who could not visually observe the touch, chose the perceived emotion from 13 response options, which included the 12 terms of emotions and the term "none of these terms are correct." The results indicated that anger, fear, disgust, love,

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gratitude, and sympathy were decoded above the chance level. This suggests that these six emotions could be robustly communicated through touch. The authors also reported that happiness is more likely and anger less likely to be conveyed accurately in dyads consisting of women (Hertenstein & Keltner, 2011).

Hertenstein et al. (2006) conducted experiments in Western countries (the United States and Spain), where the frequency of interpersonal touch in daily communication was different. Actually, the frequency of interpersonal touch differs across cultures. Based on Hall (1963), Neulip (2006) divided the cultures into three levels according to the frequency of touch: contact culture (e.g., South and Central America and South Europe), moderate-contact culture (e.g., the United States), and non-contact culture (e.g., many Asian countries). The study by Hertenstein et al. (2006) showed that there are no cultural differences in the perception of emotions from touch, even though the frequency is different between the United States (moderate-contact culture) and Spain (contact culture).

However, this finding only indicates commonality within the West. In cognitive and social psychology, cultural differences have been reported in various domains mainly from comparison between the West and the East (visual attention: Ueda, Chen, Kopecky, Cramer, Rensink, Meyer, Kitayama, & Saiki, 2018; gaze fixation: Fung, Gong, Ngo, & Isaacowitz, 2018; emotion perception from face: Matsumoto, 1992; from voice: Paulmann & Uskul, 2013; from face and voice: Tanaka, Koizumi, Imai, Hiramatsu, Hiramoto, & de Gelder, 2010; from emoticon: Yuki, Maddux, & Masuda, 2007; contextual effect in emotion perception: Masuda, Ellsworth, Mesquita, Leu, Tanida, & Veerdonk, 2008; decision making: Wang, Tang, & Wang, 2015). Therefore, it is possible that there is also cultural difference in the perception of emotions from touch between the West and the East. To further confirm the commonality of the perception of emotions from touch in the West (Hertenstein et al., 2006), additional research is needed from largely different cultures such as East Asian countries.

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Therefore, the present study examines the universality and the characteristics of the perception of emotions from touch in Japan.

In this study, we experimented with Japanese participants using a procedure nearly identical to that of Hertenstein et al. (2006) and examined whether emotions could be accurately perceived by touching the arm. Hertenstein et al. (2006) examined the communication of basic, self-focused, and prosocial emotions and indicated that touch can convey not only some basic emotions, but also various prosocial emotions such as love, gratitude, and sympathy. Therefore, we examined the perception of prosocial emotions as well as basic and self-focused emotions.

Previous studies reported the accuracy of perception at the level of emotional categories. However, it is possible that the decoder perceived the encoder's expressed emotion at a level less detailed than the categorical level. Hertenstein et al. (2006) reported some confusions. For example, happiness was often perceived as gratitude, both of which have positive valence. Sadness was often perceived as sympathy, both of which have low arousal. Therefore, we focused on quadrant accuracies, which refer to the accuracy at the quadrant level consisting of a two-dimensional space described by the levels of valence and arousal of an emotion. This method is based on the dimensional approach, which describes general features common to different emotions, rather than discrete emotions (Russell, 1997). The quadrant approach enables placing a discrete emotion in a two-dimensional space (i.e., valence and arousal). We calculated quadrant accuracies by placing discrete emotional categories in a two-dimensional space. Quadrant accuracy refers to the congruence between the quadrant of expressed and perceived emotions.

How universal is the perception of emotions from touch? Possibly, touch can communicate discrete emotions universally like "basic emotion" in the perception of emotions from the face (Ekman, 1973). In the Western cultures, anger, fear, disgust, love,

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gratitude, and sympathy were perceived accurately (Hertenstein et al., 2006). Therefore, if the perception of emotions from touch is universal, the six emotions mentioned above are also likely communicated through touch in Japan.

On the other hand, it is also possible that there are cultural differences in the perception of emotion from touch between the West and the East, as with various phenomena in cognitive and social psychology. Therefore, if the perception of emotions from touch is culture-specific, Japanese participants may not be able to communicate one or any of the emotions through touch.

Method

Experimental design

The emotion (anger, fear, happiness, sadness, disgust, surprise, embarrassment, envy, pride, love, gratitude, and sympathy) expressed by the encoder served as the independent variable, and the decoder's response as the dependent variable.

Participants

Japanese women, who were students at Tokyo Woman's Christian University ($N = 106$, $M = 20.00$ years, $SD = 1.00$), participated in this study. They submitted verbal consent. The study was approved by the Ethics Committee of Tokyo Woman's Christian University.

They were randomly assigned dyads. One member of each dyad was assigned the role of touching (encoder: $n = 53$), and the other member the role of being touched (decoder: $n = 53$). The participants did not know any information about their partner.

A binomial simulation indicated we need minimum 31 decoders to detect decoding accuracy over 40% as significant. Hertenstein et al. (2006) showed that decoding accuracy over 35% was significantly higher than chance level. Then we calculated sample size to

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detect the decoding accuracy over 40% as significant, as with Hertenstein et al. (2006). Our

initial sample size exceeded the estimate to account for expected attrition.

Apparatus

A desk (Sanwa Supply, RAC-EC2SN) was divided into two sections using a black curtain. The encoder and decoder were seated on the two sides of the desk across the curtain (see Figure 1). A video camera (Sony, HDR-PJ540) on a tripod was set on the encoder's side (Libec, TH-650DV), which recorded the encoder's display.

[Figure 1]

Procedure

In the experiment, we conducted 12 trials in total (anger, fear, happiness, sadness, disgust, surprise, embarrassment, envy, pride, love, gratitude, and sympathy). The encoder entered the laboratory first. After being informed that she was going to play the role of the encoder, she practiced expressing each emotion once by touching a hand mannequin. After the practice session, the experimenter instructed the encoder that she could touch the decoder's arm as far as she can see from the curtain in any way she thought appropriate, as long as she did not hurt the decoder. Moreover, the experimenter told her not to speak until the end of the experiment. Next, the experimenter informed the other participant, who had been waiting in another room, that she was going to play the role of the decoder, and requested her not to speak until the end of the experiment. Then, the decoder entered the laboratory. When the experiment started, the decoder extended her arm to the encoder's area. The experimenter informed the encoder of the name of an emotion by showing a card that had the name of one emotion written on it. Then, the encoder touched the decoder's arm and tried to convey the instructed emotion by touching the decoder. The order of the instructed

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emotions was randomized across participants. After the encoder finished touching, the experimenter handed out a response sheet to the decoder. The decoder indicated the perceived emotion by selecting one of 13 response options, which included the names of the 12 emotions and the statement “none of these terms are correct.” The instruction in the response sheet stated: “Please choose the term that best describes what this person is communicating to you.” The procedure used in the current study was nearly identical to that in the study by Hertenstein et al. (2006). The placement of the 12 emotions on the response sheet was randomized across participants. After recovering the response sheet, and the next trial began. This process was repeated 12 times.

Coding procedure

Based on the recorded video movies, two coders independently coded all encoders' expressions as action categories and duration of the action. Their actions were coded as 22 categories according to Hertenstein et al. (2006). Five categories were removed by prescreening, and the remaining 17 categories were merged into 11 items, because there are no one-to-one correspondences in action verbs between English and Japanese. For example, pushing and pressing were grouped into a single category of “*osu*” in our study. In addition, because some actions could not be categorized as any of the words above, two new categories, namely “*tsutsumu*” (overlapping) and “*soeru*” (putting on) were established. Thus, the following 13 categories were used for coding the encoders' actions: *osu* (pushing, pressing), *nigiru* (shaking, squeezing), *sasuru/naderu* (stroking, rubbing), *oshinokeru/mukouniyaru* (poking), *yowaku-tataku* (patting, tapping), *tsuyoku-tataku* (hitting, slapping), *tsuneru* (picking, pinching), *furu/yurasu* (swinging), *kusuguru* (tickling), *furuesaseru* (trembling), *mochiageru* (lifting), *tsutsumu* (overlapping), and *soeru* (putting on). The durations were calculated based on the number of frames from the beginning of touch to the end of the action.

Data analysis

To examine whether the decoder can perceive the encoder's expressed emotion as categorical, we calculated categorical accuracy showing the degree to which the decoder's response (perceived emotion) was congruent with the emotion expressed by the encoder (expressed emotion). Then, binomial tests were conducted. We used two different chance levels. The first one was 7.7%, which corresponds to the actual chance level. The second one was 25%, which corresponds to a more conservative chance level used in previous study (Hertenstein et al., 2006) and enable us to compare our data with their results. Hertenstein et al. (2006) argued that people's judgments of emotional stimuli may be guided by the four categories along the axes of those two dimensions: pleasant and aroused, pleasant and unaroused, unpleasant and aroused, and unpleasant and unaroused, following critics of forced-choice methodology (Frank & Stennett, 2001). Therefore, they set a chance guessing rate of 25%. In addition to categorical accuracy, a confusion matrix was constructed from participants' responses.

Furthermore, to examine the possibility that the decoder perceives emotions at a level less detailed than category, we calculated the quadrant level accuracy in the two-dimensional space consisting of the valence and arousal of each emotion (quadrant accuracy) and binomial tests were conducted. Based on our pilot study, we decided the placement of each emotion as follows: happiness and pride were placed in the first quadrant (pleasant - aroused); anger, fear, disgust, surprise, and envy in the second quadrant (unpleasant - aroused); sadness and embarrassment in the third quadrant (unpleasant – not aroused); and love, gratitude, and sympathy in the fourth quadrant (pleasant – not aroused) of the two-dimensional space. These results were consistent with previous studies that showed the placement of various emotions (e.g. Russell, 1980; Russell & Lemay, 2000).

Results and Discussion

Categorical accuracy

Categorical accuracies of each expressed emotion were calculated from the responses of the 53 decoders after excluding the data from one participant who selected multiple emotions for surprise. A response was counted as correct when perceived and expressed emotions were identical. Then, binomial tests were conducted to confirm whether the proportion of correct answers for each emotion was significantly above chance level. As for actual chance, results indicated almost all emotions except for envy and pride were decoded significantly above the chance level (all p s < .05). As for conservative chance, results indicated that anger (accuracy 37.7%, p < .05, 95% confidence interval [CI] [24.8, 52.1]), love (43.4%, p < .01, 95%CI [29.8, 57.7]), and gratitude (37.7%, p < .05, 95%CI [24.8, 52.1]) were decoded significantly above the chance level. Happiness demonstrated a significant tendency (34.0%, p = 0.09, 95%CI [21.5, 48.3]).

[Figure 2]

Confusion matrix

A confusion matrix was constructed from the 12 emotions expressed by the encoder and the decoder's 13 response options (Table 1). 12×13 chi-square test was significant (χ^2 = 684.37, df = 132, p < .001, ϕ = .31). Therefore, we used the residual analysis to demonstrate whether percentage of each cell was significantly higher than the expected value. Residual analysis uses expected value modulated by the frequency of choosing each response alternative and then shows whether the percentage was significantly higher than the expected. For example, the categorical accuracy of sadness was 17.0%, which was below the conservative chance (25%). However, the residual analysis revealed that the congruence of sadness was significantly higher. The frequency at which sadness was chosen as a perceived

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emotion regardless of the expressed emotion was less than for the other alternatives, which reduced its expected value. Results of the residual analysis indicated that all expressed emotions except for sympathy were perceived significantly above the expected level ($ps < .05$). Moreover, some emotions were perceived significantly above the expected level even when they were different from the expressed emotion. Anger was perceived as disgust, happiness as gratitude and sympathy, sadness as love, disgust as anger and embarrassment, envy and surprise as disgust, embarrassment as fear, envy as disgust, pride as gratitude, and sympathy as happiness and gratitude ($ps < .05$). There was only one case of confusion between positive and negative emotions, in which the encoder expressed sadness that the decoder answered love. These results suggested that the valence values could be perceived correctly from touch.

[Table 1]

Quadrant accuracy

We also calculated quadrant accuracy to examine the possibility that emotions could be perceived at a level less detailed than their categorical accuracy. For example, when the encoder expressed anger and the decoder's response was disgust, this response was counted as correct in terms of quadrant accuracy, because anger and disgust are in the same quadrant.

The average quadrant accuracy was calculated from the data of 53 decoders for each expressed emotion. The chance level was 25%. Results showed that anger (accuracy 83.0%, 95%CI [70.2, 92.0]), fear (52.8%, 95%CI [38.6, 66.7]), disgust (64.2%, 95%CI [49.8, 76.9]), surprise (55.8%, 95%CI [40.4, 68.4]), envy (58.5%, 95%CI [44.1, 71.9]), love (81.1%, 95%CI [68.0, 90.6]), gratitude (67.9%, 95%CI [53.7, 80.1]), and sympathy (69.8%, 95%CI [55.7, 81.7]) were perceived significantly above the chance level ($ps < .001$), whereas

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 happiness demonstrated a significant tendency (35.8%, $p = 0.05$, 95%CI = [23.1, 50.2]).

These eight emotions converged in the second (unpleasant - aroused) and fourth (pleasant – unaroused) quadrants.

[Figure 3]

Encoder's display

Action of touch. Results are summarized in Table 2. Although it is difficult to compare the results with Hertenstein et al. (2006) because of the differences in coding categories, the actions were similar to previous studies for some emotions (e.g., fear, happiness), but not for others (e.g., envy, love). In addition, the frequency of each action was relatively low, suggesting that there might be no universal action expressing a certain emotion (at maximum 51% for happiness (shaking)). The results suggest that touch can convey some discrete emotions despite the differential actions between cultures and individuals.

[Table 2]

Duration. We calculated the average duration of the displays decoded correctly for each emotion using the same method as the previous study (Hertenstein et al., 2006). There was a positive correlation between studies ($r = .82$, see Figure 4). Therefore, the duration of the encoder's display in this study was similar to the previous study.

[Figure 4]

General discussion**Summary of results**

The primary purpose of this research was to identify the universality and/or culture-specificity of the perception of emotions by touch. The study was based on research by Hertenstein et al. (2006) which demonstrated the characteristics of the perception of emotions from touch in Western cultures. We conducted an identical experiment to Hertenstein et al. (2006) with Japanese participants. The results indicated that the categorical accuracies of almost all emotions except for envy and pride were higher than the actual chance. The accuracies of three emotions, anger, love, and gratitude, were higher than the conservative chance. Moreover, confusion matrix suggested that all emotions except sympathy were perceived above expected. Furthermore, anger, fear, disgust, surprise, envy, love, gratitude, and sympathy were perceived correctly at the quadrant level.

Comparison with Western culture

Our results indicated that emotions conveyed by touch were perceived less correctly at the categorical level, although they were perceived at the quadrant level with sufficient accuracy. Interestingly, our results for certain emotions differed from those of Hertenstein et al. (2006). This might reflect culture-specific and universal aspects of perceiving emotions by touch. Anger, love, and gratitude were decoded above chance at the categorical level which is consistent with the previous study (Hertenstein et al., 2006). The results suggest that the perception of these emotions from touch is universal. On the other hand, fear, disgust, and sympathy were not perceived above the chance level at the categorical level.

How were anger, love, and gratitude universally communicated, but not fear, disgust, and sympathy? Among basic emotions (anger, fear, happiness, sadness, disgust and surprise), anger was perceived above chance across cultures, whereas fear and disgust were conveyed

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in the West but not in Japan. This is consistent with previous studies (Takagi, Hiramatsu, & Tanaka, 2014; Laukka & Elfenbein, 2020, for a review) which reported that fear and disgust were perceived less correctly in the perception of emotions from voice. For example, Takagi et al. found that fear (24.2%) and disgust (38.9%) tended to be perceived less accurately than anger (53.0%).

Among prosocial emotions (love, gratitude, and sympathy), love and gratitude were perceived above chance across cultures, whereas sympathy was conveyed in the West but not in Japan. The findings of love and gratitude provide further empirical support for the idea discussed on Hertenstein et al. (2006) that tactile communication of prosocial emotions signal prosocial intent and then prosocial intent facilitates cooperation. The reason for the low accuracy of sympathy may be due to linguistic differences. The term "*kyoukan* (共感)" was used as a translation of the English term "sympathy" in this study. However, the term "*kyoukan*" refers to both sympathy and empathy which are not strictly distinguished in Japanese language. As a result, it is possible that some participants expressed sympathy while others expressed empathy in this condition.

Comparison with face and voice

Our results indicated that anger, love, and gratitude could be conveyed by touch. Other studies suggested that six emotions including anger, fear, happiness, sadness, disgust, and surprise can be communicated universally from the face (e.g., Ekman & Friesen, 1971) and voice (Sauter, Eisner, Ekman, & Scott, 2010). Together with these earlier studies, our results suggest that anger can be perceived universally from the face, voice, and through touch.

Moreover, we found that positive emotions including love and gratitude could also be communicated by touch. These findings suggest that it is possible to identify positive emotions other than happiness by touch. This is consistent with the findings for voice, but not

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consistent with the findings for face, as the face may not allow for the communication of more specific positive emotions (Ekman, 2003; Sauter, 2010; Shiota, Campos, Oveis, Hertenstein, Simon-Thomas, & Keltner, 2017).

Comparison of categorical accuracy, quadrant accuracy, and the confusion matrix

The results of this study could be interpreted by assuming that multiple processes are involved in the perception of emotions from touch. Our results showed little confusion when perceiving an emotion by touch in terms of the negative or positive value of an emotion, suggesting that we might first perceive the negative or positive valence value of the tactile stimulus. The focus might then shift to the arousal dimension. We speculate that positive and negative emotions are biased toward the unaroused and aroused quadrant, respectively. This notion is supported by the fact that all eight emotions with quadrant accuracies above the chance level converged on the second (unpleasant - aroused) and fourth (pleasant - unaroused) dimensions. It is also supported by the observed confusion that the emotions on the third quadrant (unpleasant - unaroused) were confused with those on the second quadrant (unpleasant - aroused), and that those on the first quadrant (pleasant - aroused) were confused with those on the fourth quadrant (pleasant - unaroused). Last, the perceived emotions might be categorized (e.g., anger). This process can be cultural-specific, whereas the former processes might be universal. Although these assumptions are speculations at the moment, the results are well explained by assuming these processes. Future study should clarify the validity of these assumptions.

Limitations and future research

The first limitation of this study is that only women were sampled. Hertenstein & Keltner (2011) reported gender differences in Western cultures related to the perception of emotions from touch, which might also be the case in Japan. Therefore, similar to Hertenstein

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et al. (2006), gender differences should be considered in future studies by including men and women in the sample.

A second limitation of this study is that the accuracies were lower than in studies of faces and voices. For example, Takagi et al. (2014) investigated whether basic emotions could be perceived correctly from either face or voice using Japanese stimuli. They showed that the range of accuracies are roughly 14 to 95 % for face ($M = 63.07$, $SD = 24.82$) and 24 to 61 % for voice ($M = 47.77$, $SD = 12.54$). The range in this study was between 13 to 43 % ($M = 26.94$, $SD = 9.86$), which is much lower than that of face and voice. The accuracies also took the range of 18 to 63 % (average from nine emotions: $M = 42.70$, $SD = 16.44$) reported in the previous study for touch (Hertenstein et al., 2006), which is similar or relatively lower than that of voice.

However, it is possible that the accuracies of touch are apparently low than that of face and voice due to different numbers of response alternatives. Consequently, the chance level was different among modalities (i.e. face (1/6), voice (1/6), and touch (1/13)). We compared accuracies of touch with that of face and voice using Proportion Index (PI: Rosenthal & Rubin, 1989; Laukka & Elfenbein, 2020), which enable to fix the number of response alternatives. The results showed that they were almost similar for face (PI = 0.85, based on Takagi et al., 2014), voice (PI = 0.80, based on Takagi et al., 2014) and touch (PI = 0.87 in the West, based on Hertenstein et al., 2006; PI = 0.79 in the East, based on the current study). Therefore, the accuracies in this study are not dramatically lower than that of previous studies.

Based on the above argument, the lower accuracies observed in touch studies might be due to the difference in methodology employed in the studies of face, voice, and touch. Most studies in the emotion perception from face and voice use recorded and controlled stimuli, such as photographs, videos and audio files. In contrast, touch studies use free

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expression method since physical contact is not possible to be recorded and to present again.

Thus, the accuracies may be lower than the case that stimulus is controlled. In order to examine whether the lower accuracies are a phenomenon specific to the perception of emotions from touch or are due to methodological differences, future research will need to compare the perception of emotions from face, voice, and touch using free expression method, which has been used in touch studies.

Methods of communication that do not depend on face-to-face interactions such as those on social network services (SNS) are increasing in contemporary society, whereas the use of interpersonal touch in face-to-face situations is decreasing (Gallace & Spence, 2010). However, touch remains an effective and essential nonverbal clue especially when communicating with partners such as infants, older adults, and foreigners. We consider that investigating the perception of emotions from touch in addition to research on the face and voice would identify the specific roles of each modality and improve the communication of emotions.

We communicate emotions through touch as well as the face and voice and then we integrate multisensory clues. de Gelder & Vroomen (2000) examined the multisensory perception of emotions from the face and voice. As well as the combination of the face and voice, touch can also be combined with clues from other sensory modalities in our daily multisensory communication. Imagine a scene of negotiation: After a successful negotiation, you might shake hands (positive touch) with smile and speak in a positive vocal tone to make the relationship better. However, if the negotiation fails and you shake hands in a similar way, your face might show sadness or the tone of your voice might be depressed. In such a situation, the client may be confused as to whether your real emotion is displayed in your face, voice, or touch. How do we perceive an emotion from the combination of negative face/voice and positive touch? It is important to examine the multisensory perception of

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emotions including touch in future research. Therefore, this study is an effort to understand emotional communication by touch, which might inspire future research.

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Figure 1 *Apparatus on current study.*

Note. The view from the experimenter and that from the side of the encoder are shown in (A) and (B), respectively. The encoder and decoder could not see each other due to the curtain. The encoder could touch the decoder's arm as far as she can see from the curtain in any way she thought appropriate, as long as she did not hurt the decoder.

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Figure 2 Categorical accuracy (i.e. mean accuracy calculated from the congruence

between the category of expressed and perceived emotions) of 12 emotions.

Note. The labels of emotions refer below: AN = anger, FE = fear, HA = happiness, SA = sadness, DI = disgust, SU = surprise, EM = embarrassment, EN = envy, PR = pride, LO = love, GR = gratitude, and SY = sympathy. We used two different chance levels. The first one was 7.7%, which corresponds to the actual chance level (i.e. actual chance). The second one was 25%, which corresponds to a more conservative chance level (i.e. conservative chance) used in previous study (Hertenstein et al., 2006). Error bars represent standard errors.

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Figure 3 *Quadrant accuracy (i.e. mean accuracy calculated from the congruence between the quadrant of expressed and perceived emotions) of 12 emotions.*

Note. The 25% line indicates the chance level. The labels of emotions refer below: AN = anger, FE = fear, HA = happiness, SA = sadness, DI = disgust, SU = surprise, EM = embarrassment, EN = envy, PR = pride, LO = love, GR = gratitude, and SY = sympathy. Error bars represent standard errors.

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Figure 4 Pearson's correlation between average duration of the displays decoded

correctly for each emotion on Hertenstein et al. (2006) and those on current study.

Note. The horizontal axis shows average duration of each emotion on previous study while the vertical axis shows those on current study. The labels of emotions refer below: AN = anger, FE = fear, HA = happiness, SA = sadness, DI = disgust, SU = surprise, EM = embarrassment, EN = envy, PR = pride, LO = love, GR = gratitude, and SY = sympathy. There was a positive correlation between studies ($r = .82$).

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Table 1 Confusion matrix of expressed and perceived emotions. Underbars refer to the

categorical accuracy of each emotion.

	<i>perceived emotion</i>												
	AN	FE	HA	SA	DI	SU	EM	EN	PR	LO	GR	SY	Non e
<i>expressed emotion</i>	AN	<u>37.</u> 7	11. 3	1.9	1.9	15. 1	15. 1	0.0	3.8	0.0	0.0	1.9	5.7
	FE	11. 3	<u>24.</u> 5	7.5	3.8	1.9	7.5	9.4	7.5	0.0	5.7	3.8	5.7
	HA	1.9	1.9	<u>34.</u> 0	0.0	0.0	1.9	1.9	3.8	1.9	1.9	24. 5	24. 5
	SA	3.8	11. 3	3.8	<u>17.</u> 0	0.0	1.9	5.7	0.0	3.8	20. 8	7.5	15. 1
	DI	15. 1	3.8	1.9	3.8	<u>32.</u> 1	1.9	13. 2	11. 3	0.0	3.8	0.0	0.0
	SU	3.8	3.8	11. 5	1.9	15. 4	<u>30.</u> 8	5.8	1.9	0.0	0.0	7.7	13. 5
	E M	1.9	15. 1	5.7	5.7	3.8	11. 3	<u>17.</u> 0	5.7	0.0	11. 3	0.0	7.5
	EN	9.4	11. 3	11. 3	0.0	18. 9	3.8	1.9	<u>15.</u> 1	0.0	1.9	5.7	9.4
	PR	3.8	5.7	5.7	0.0	0.0	1.9	1.9	0.0	<u>13.</u> 2	15. 1	37. 7	13. 2
	LO	0.0	1.9	3.8	1.9	0.0	1.9	0.0	1.9	5.7	<u>43.</u> 4	18. 9	18. 9
	GR	0.0	3.8	17. 0	3.8	0.0	0.0	1.9	0.0	3.8	15. 1	<u>37.</u> 7	15. 1
	SY	0.0	1.9	18. 9	0.0	0.0	1.9	3.8	0.0	3.8	17. 0	32. 1	<u>20.</u> 8

(%)

Note. The labels of emotions refer below: AN = anger, FE = fear, HA = happiness, SA = sadness, DI = disgust, SU = surprise, EM = embarrassment, EN = envy, PR = pride, LO = love, GR = gratitude, and SY = sympathy. “None” refers to the response, “None of these

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terms are correct.” Asterisks indicate significantly higher value of the percentage of choosing

each response alternative than the expected value ($*p < .05$).

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Table 2 The three most frequent types of touch and the percentage of frequencies in each emotion.

		Frequent types of touch (<i>action</i> , percentage)					
Encoded emotion		1st		2nd		3rd	
Basic emotions							
Anger	<i>yowaku-tataku</i>	30.2	<i>nigiru</i>	23.6	<i>tsuyoku-tataku</i>	17.9	
	(patting, tapping)		(shaking, squeezing)		(hitting, slapping)		
Fear	<i>furuesaseru</i>	20.8	<i>nigiru</i>	16.0	<i>osu</i>	11.3	
	(trembling)		(shaking, squeezing)		(pushing, pressing)		
Happiness	<i>furu/yurasu</i>	50.9	<i>furuesaseru</i>	14.2	<i>mochiageru</i>	10.4	
	(swinging)		(trembling)		(lifting)		
Sadness	<i>soeru</i>	32.1	<i>sasuru/naderu</i>	15.1	<i>tsutsumu (tie)</i>	15.1	
	(putting on)		(stroking, rubbing)		(overlapping)		
Disgust	<i>osinokeru/mukouniyaru</i>	28.3	<i>yowaku-tataku</i>	21.7	<i>tsuneru</i>	12.3	
	(poking)		(patting, tapping)		(picking, pinching)		
Surprise	<i>yowaku-tataku</i>	32.1	<i>nigiru</i>	18.9	<i>mochiageru</i>	15.1	
	(patting, tapping)		(shaking, squeezing)		(lifting)		
Self-focused emotions							
Embarrassment	<i>yowaku-tataku</i>	25.5	<i>soeru</i>	16.0	<i>sasuru/naderu</i>	12.3	
	(patting, tapping)		(putting on)		(stroking, rubbing)		
Envy	<i>nigiru</i>	21.7	<i>tsuneru</i>	18.9	<i>soeru</i>	11.3	
	(shaking, squeezing)		(picking, pinching)		(putting on)		
Pride	<i>nigiru</i>	30.2	<i>tsutsumu</i>	17.0	<i>furu/yurasu</i>	16.0	
	(shaking, squeezing)		(overlapping)		(swinging)		
Prosocial emotions							
Love	<i>tsutsumu</i>	50.0	<i>nigiru</i>	24.5	<i>soeru</i>	7.5	
	(overlapping)		(shaking, squeezing)		(putting on)		

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Gratitude	<i>tsutsumu</i>	30. 2	<i>furu/yurasu</i>	26. 4	<i>nigiru</i>	19. 8
	(overlapping)		(swinging)		(shaking, squeezing)	
Sympathy	<i>furu/yurasu</i>	30. 2	<i>nigiru</i>	26. 4	<i>furuesaseru</i>	12. 3
	(swinging)		(shaking, squeezing)		(trembling)	

Note. The following 13 categories were used: osu (pushing, pressing), nigiru (shaking, squeezing), sasuru/naderu (stroking, rubbing), oshinokeru/mukouniyaru (poking), yowaku-tataku (patting, tapping), tsuyoku-tataku (hitting, slapping), tsuneru (picking, pinching), furu/yurasu (swinging), kusuguru (tickling), furuesaseru (trembling), mochiageru (lifting), tsutsumu (overlapping), and soeru (putting on).