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Social sensitivity predicts accurate emotion inference from facial expressions in a face mask: a study in Japan

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Abstract

Most prior research examining whether emotions can be accurately inferred from facial expressions with masks have been conducted with Western samples. Thus, there is a current lack of studies on this topic, as well as on factors affecting individual differences in the accuracy of emotion inference, among non-Western samples. This study examined the effects of social anxiety and social sensitivity on the accuracy of emotion inference from masked facial expressions in a Japanese sample. The results showed that wearing a mask made it difficult to identify the emotions of sadness and fear, happy and neutral expressions remained unaffected, and angry expressions were read more accurately. Further, while the findings show that a general higher ability to infer emotions from facial expressions may help ensure the accuracy of emotion inference from facial expressions with a mask, social sensitivity directly predicted the accuracy of emotion inference from facial expressions with a mask. These findings suggest that people who can infer complex mental states of others from subtle cues may be less susceptible to the effects of face masks.

Keywords Face mask · Facial expression · Emotion inference · Individual difference · Social sensitivity

The COVID-19 pandemic, raging worldwide since 2020, has greatly impacted our lives (Farooq et al., 2021). One of the most significant lifestyle changes during the pandemic is the requirement of wearing a face mask to prevent infection (Khel et al., 2021). Thus, in daily life, people now often communicate with each other while wearing face masks. In daily communication, one of the major effects of waring such masks is their partial hiding of one's facial expressions, since the lower half of the face gets hidden. Facial expression is an important nonverbal cue for communicating one's intentions, attitudes, and emotions (Planalp et al., 1996), and it has been found that people usually infer others' emotions by integrating cues from the expressions of the eyes and mouth (Calvo et al., 2013). Therefore, if a part of the face is hidden, it leads to inaccurate inferences about emotions from facial expressions (Roberson et al., 2012).

Particularly since the spread of the COVID-19 pandemic, studies have pointed out that emotions cannot be accurately deciphered from facial expressions if the person is wearing a face mask. For example, Carbon (2020) presented 41 participants aged 18 – 87 years with six types of facial expressions (happy, angry, sad, fearful, disgusted, and neutral); each expression was shown both with and without a mask. The participants judged the emotions expressed in the photos, and reported their degree of confidence in the responses. The results showed that the percentage of correct responses decreased significantly for all expressions when face masks were worn, except for the fearful and neutral expressions. In addition, participants' confidence in their responses was significantly lower for all expressions when the mask was worn. Further, the results of a false-answer analysis suggested that wearing a mask increased the probability of misinterpreting disgusted expressions as angry and happy expressions as neutral. Thus, research has shown that masked facial expressions do not allow for accurate emotion inference (Grundmann et al., 2021; Parada-Fernandez et al., 2021).

Moreover, wearing a mask not only reduced the rate of correct responses but also increased the time taken to infer emotions from facial expressions (Fitousi et al., 2021). In a

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study examining the effects of masks on children aged 3 – 5 and 6 – 8 years and adults aged 18 – 30 years, toddlers (3 – 5 years old) showed a lowered ability to read emotions from faces with a mask than adults (Gori et al., 2021). However, even among adults, wearing a face mask has been shown to impair the accuracy of emotional inferences.

Studies have pointed out the factors at the individual level that affect emotion inference from facial expressions wearing masks, including empathy (Ramachandra & Longacre, 2022), autistic traits (Pazhoohi et al., 2021), and emotional intelligence (Cannavò et al., 2022). Although some studies have been conducted in the Eastern region (Kim et al., 2022), studies reporting the difficulty of inferring emotions from facial expressions when wearing a mask have been mainly conducted in Western countries. However, people in Japan have been wearing masks in general since before the COVID-19 pandemic (Miyazaki et al., 2021). Therefore, people from Eastern countries may be more accustomed to inferring emotions from facial expressions while wearing face masks compared to people from Western countries. In addition, it has been shown that people from Eastern countries, including Japan, tend to pay more attention to the eyes when inferring emotions from facial expressions (Jack et al., 2009), and to place more importance on emotions expressed in the eyes (Jack et al., 2012; Yuki et al., 2007). Considering these findings, it is possible that Japanese people are relatively less susceptible (vs. people from Western countries) to the effects of wearing a mask that hides the lower half of the facial expression. The present study investigated the accuracy of inferring emotions from facial expressions covered by a mask in Japanese university students.

Furthermore, this study focused on personal characteristics that may affect emotion inference from facial expressions in a mask. The two characteristics examined here were social anxiety and social sensitivity. Social anxiety is the tendency to feel anxious or fearful about being negatively evaluated by others (Schlenker & Leary, 1982; Turner et al., 1987), and research has identified individual differences in social anxiety tendencies (Watson & Friend, 1969). It has been suggested that people with higher social anxiety are more sensitive to the eyes when inferring others' emotions (Ikeda, 2020). This may be because the eye area is difficult to control intentionally and is therefore more likely to express authentic emotion (Ekman et al., 1988), and social anxiety is a very important personality trait that may explain cultural differences in emotion recognition (Ikeda, 2020; Ishii et al., 2011). People with high social anxiety are highly motivated or anxious to know what others are really feeling. Social anxiety is also associated with factors influencing the accuracy of emotion inference from masked facial expressions, such as autistic tendencies and empathy (Pittelkow et al., 2021; Spain et al., 2018). Considering these findings, it is possible that people with social anxiety are less affected by the loss of reference to the lower half of the facial expression when others are wearing a face mask.

This study also examines social sensitivity. Social sensitivity, as measured by the "Reading the Mind in the Eyes" test, is the ability to perceive the mental states of others (Baron-Cohen et al., 1997, 2001). In this test, participants are presented with various facial expressions of the eye region and provided with four options to identify the state of mind that the expression represents. It has been noted that social sensitivity is an important trait and strongly related to emotional intelligence, especially the ability to perceive and understand others' emotions (Megías-Robles et al., 2020). Furthermore, social sensitivity was shown to correlate with influencing factors of the accuracy of emotion inference from masked facial expressions, such as autistic tendencies and empathy (Olderbak et al., 2015; Peñuelas-Calvo et al., 2019). Thus, people with high social sensitivity, that is, those who can read complex emotions from others' eyes, may be able to accurately read emotions even when the lower half of the facial expressions are covered by a mask.

In summary, this study examined whether Japanese people can accurately infer emotions from facial expressions when a face mask is worn, as well as the factors that affect individual differences in the accuracy of emotion inference from facial expressions covered by a mask. It was hypothesized that the effects of wearing a mask on emotion inference of facial expressions in the Japanese population differ from those in the Western population; the current study attempts to preliminarily confirm this hypothesis by comparing the current research results with those of a prior study by Carbon (2020) with a Western sample. Another hypothesis was that people with high social anxiety and high social sensitivity are more likely to infer emotions accurately from facial expressions when a face mask is worn.

Method

Participants

One hundred twenty-three students (53 women, 66 men, 3 others, 1 non-response; M_{age} = 19.91 years, SD = 1.04) from a Japanese university participated in the experiment. Participants were recruited by posting a notice at the university and were informed in advance that they were free to withdraw from the study any time. They were asked to provide informed consent for participation and publication of the results. In addition, a QUO card worth 1,000 yen was paid as a reward for participation. The study procedure was approved by the ethical review board of the author's institution (Approval No. 20–506).

Fig. 1 Examples of the Facial Expression Stimuli. Note. **A** shows photographs of facial expressions in the without mask condition; **B** shows photographs of facial expressions in the mask condition

Materials

Standardized photographs depicting facial expressions (https://www.atr-p.com/products/face-db.html) of three Japanese males and three Japanese females were used as stimuli. This set of facial expression stimuli comprises the Japanese expression of Ekman's basic emotions (Ekman & Cordaro, 2011), and its validity was verified by a rating based on the six emotions. Five types of facial expressions were selected for each of the six emotions: happy, angry, sad, fearful, and neutral. For each photograph, an illustration of a mask (https://commons.nicovideo.jp/material/nc215602) that completely covered the nose, mouth, and chin was created using Power Point version 2111 (Microsoft 365 apps). The masks were synthesized manually to fulfill the above criteria, taking into account the differences in the shape of each individual's face. A total of 60 photographs were produced: 30 photographs showing facial expressions with a face mask and 30 photographs showing the same expressions without a mask. These 60 photos were used in the main trial. Additionally, four photos of happy and angry expressions were selected for practice trials, and face masks were synthesized for these photos as well. Examples of the experimental stimuli are shown in Fig. 1.

The experiment was conducted using Lab.js (https://lab.js.org/), a free experimental program that runs on a web browser. Firefox version 94.1.2 was launched on a tablet (Huawei MediaPad T5) to run the experimental program. The facial expression stimuli were presented in the size of 8 cm (width) × 10 cm (height), and participants observed the stimuli from a distance of approximately 30 cm.

In addition, the Short Fear of Negative Evaluation Scale for Japanese (Sasagawa et al., 2004) and the Asian version of the Reading the Mind in the Eyes Test[1] (Adams et al., 2010) were administered to assess the differences in the participants' individual characteristics. The Short Fear of Negative Evaluation Scale for Japanese is used to measure social anxiety. It is a validated Japanese version of the Fear of Negative Evaluation Scale (Watson & Friend, 1969), which is widely used in social anxiety research (Herbert et al., 2001). These scales were administered in the form of online questionnaires using Google Forms, and the participants responded using the same tablets as in the experiment.

Procedure

The experiment was conducted individually for each participant in a university experimental room. At the beginning of the experiment, as a practice trial, eight photographs showing happy and angry facial expressions (four with masks and four without masks) of one man and one woman were presented in a random order. The following instruction was displayed on the screen: "From the following five choices, please select what emotion is represented by the facial expression on the screen." Then the participants were asked to identify the emotion expressed in each picture by selecting one of the five response buttons displayed at the bottom of the screen: "happy," "angry," "fearful," "sad," and "neutral." When the participant pressed a button, a gazing point was displayed in the center of the screen for 500 ms, a blank screen was displayed for 500 ms, and then the next stimulus was presented. An example of the tablet screen during the experiment is shown in Fig. 2. No specific feedback was

[1] The Asian version of the Reading the Mind in the Eyes Test was created by Sakiko Yoshikawa (Kyoto University) and Mitsue Nomura (Kansai University of Nursing and Health Sciences). The author would like to thank them for permission to use it.

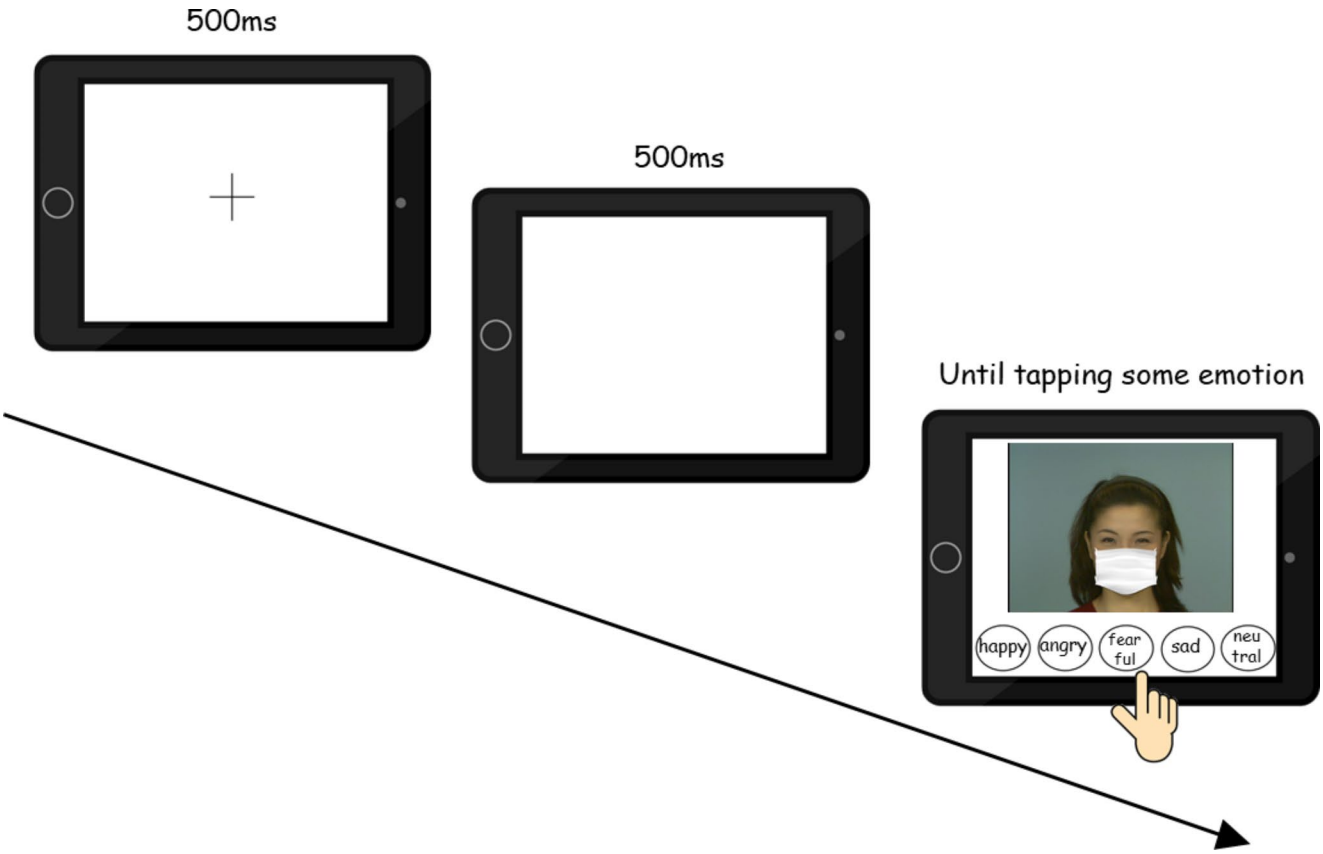

Fig. 2 Flow of the Experimental Tablet Screen. Note. In the actual experiment, the buttons to be tapped were labeled in Japanese

provided to the participants. In the main experiment, 60 stimuli were presented in a random order, resulting in a total of 60 trials.

After the experiment, participants completed the Short Fear of Negative Evaluation Scale for Japanese (Sasagawa et al., 2004) and the Social Sensitivity Test (Adams et al., 2010) on a tablet. The Social Anxiety Scale required participants to indicate the extent to which each of the 12 items applied to them, using a 5-point scale. In the Social Sensitivity Test, participants selected from four options the mental state represented by pictures of eyes displayed on the screen. A total of 37 photographs were presented, the first of which was for practice and not for analysis. No specific feedback was given on correctness or incorrectness.

Coding

In the main experiment, the percentage of correct responses was calculated and scored for each of the facial expressions with and without a mask. In the Social Anxiety Scale, after processing the reversed items, the scores were summed and the total score, ranging from 12 to 60 points, was calculated; a higher score indicated a higher tendency for social anxiety. In the Social Sensitivity Test, for ease of understanding, the percentage of correct answers to a total of 36 questions was taken as the total score; the higher the score, the higher the social sensitivity.

Data analysis

Regarding data analysis, first, to examine the effect of wearing a mask on emotion inference, a 5 (facial expression: happiness, anger, sadness, fear, neutral) × 2 (mask: with mask, without mask) analysis of variance was conducted on the correct response rate; both variables were within-participant factors. Incorrect answers found in the emotion inferences from facial expressions covered by a mask were examined. Finally, a mediation analysis using the statistical analysis software HAD (Shimizu, 2016), which runs on Microsoft Excel, and the bootstrap method (2,000 repetitions) was performed to analyze the relationship between social anxiety, social sensitivity, and emotion inference, as well as the effects on emotion inference from facial expressions covered by a mask.

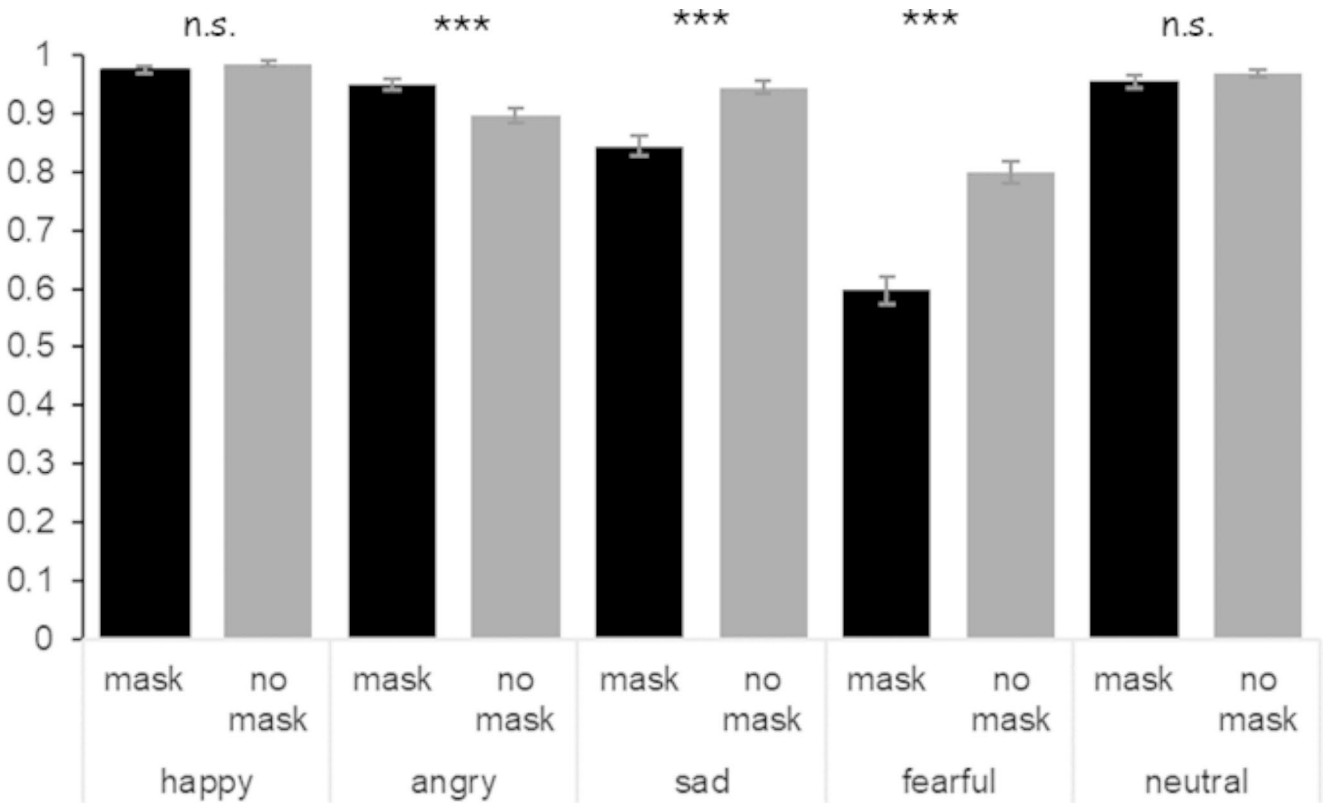

Fig. 3 Percentage of Correct Responses for Each Facial Expression. Note. Error bars represent standard errors. *** $p < .001$

Results

The effect of wearing a mask on emotion inference from facial expressions

Figure 3 shows the percentage of correct responses in the emotion inferences from facial expressions. The results showed that the main effect of facial expression ($F(4, 488) = 113.716$, $p < .001$, $\eta_p^2 = 0.482$), the main effect of wearing a mask ($F(1, 122) = 68.105$, $p < .001$, $\eta_p^2 = 0.358$), and the interaction effect ($F(4, 488) = 42.530$, $p < .001$, $\eta_p^2 = 0.280$) were all significant. Since the interaction was significant, a simple main effect test was conducted.

First, the results were analyzed to identify differences in the percentage of correct responses for the five types of facial expressions with and without a mask. The simple main effect of wearing a mask was significant for the angry ($F(1, 122) = 14.418$, $p < .001$, $\eta_p^2 = 0.106$), sad ($F(1, 122) = 14.418$, $p < .001$, $\eta_p^2 = 0.106$), and fearful ($F(1, 122) = 14.418$, $p < .001$, $\eta_p^2 = 0.106$) expressions, but not for the happy ($F(1, 122) = 14.418$, $p < .001$, $\eta_p^2 = 0.106$) and neutral expressions ($F(1, 122) = 14.418$, $p < .001$, $\eta_p^2 = 0.106$). As shown in Fig. 3, when the mask was worn, the correct response rate was higher for the angry expression but lower for the sad and fearful expressions. For the happy and neutral expressions, there was no difference in the percentage of correct responses between the expressions with and without masks.

Then, an analysis was performed to examine whether there were any differences in the percentage of correct responses for each of the five emotions in the pictures with and without the masks. Multiple comparisons using the Holm method showed that, for the pictures without a mask, there was a significant difference between all the pairs of expressions ($ps < 0.01$), except for the happy and neutral ($p = .067$) and sad and neutral ($p = .067$) pairs. For the facial expressions with a mask, there were no significant differences between the happy and angry, happy and neutral, and angry and neutral expressions ($ps > 0.05$), but all other pairs of expressions showed a significant difference ($ps < 0.001$).

False answer analysis of the emotion inference from facial expressions

Next, an analysis was conducted to examine the errors made by the participants when inferring emotions from facial expressions. Figure 4 shows the response rates for each expression. For the pictures without a mask, the emotions expressed were correctly recognized in most cases. For the pictures with a mask, fear was often misinterpreted as anger or sadness. Furthermore, in the above analysis, the percentage of responses correctly inferring anger was higher when

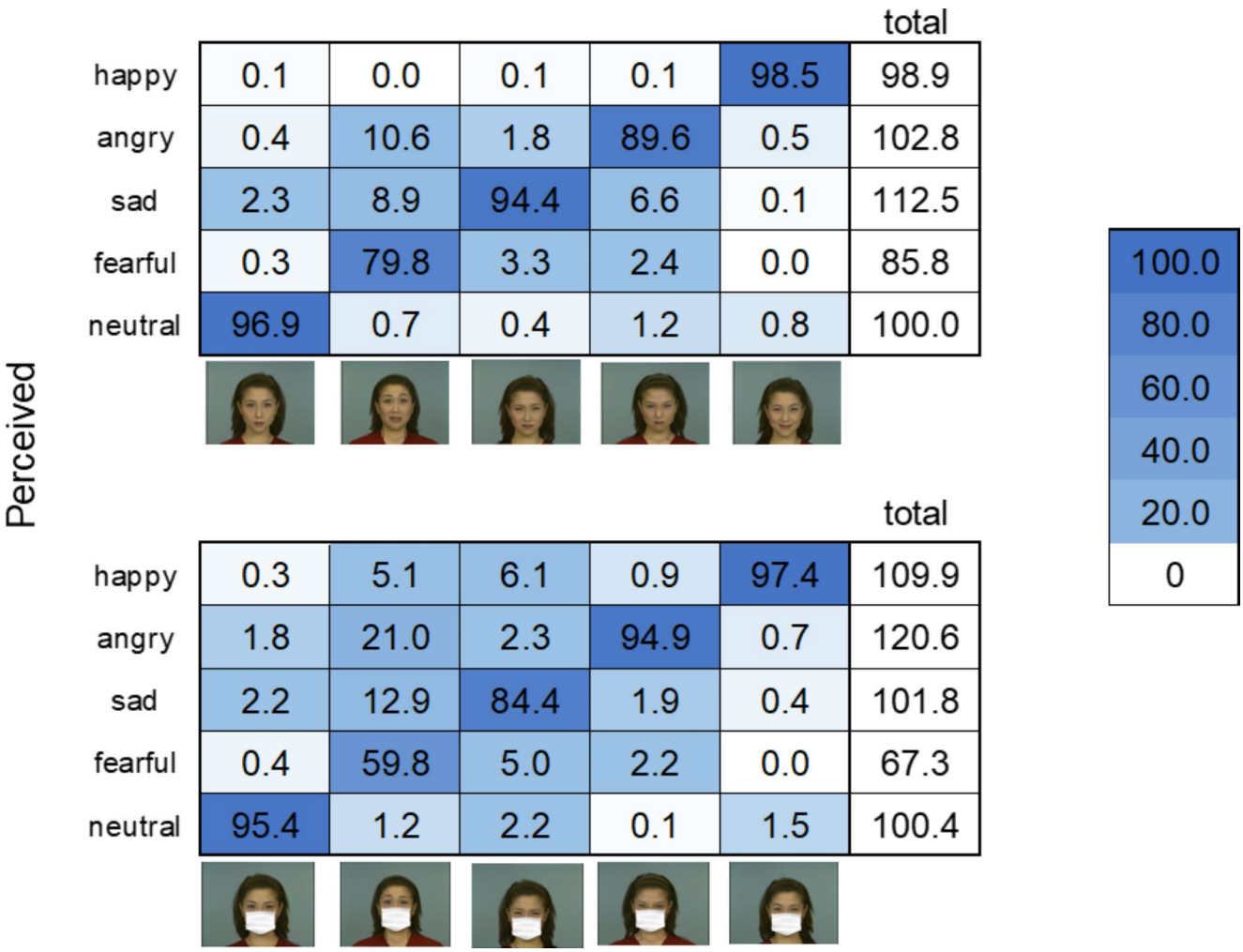

Fig. 4 Percentages of Each Emotion Selected for Each Facial Expression Stimulus

Table 1 Correlation between the Study Variables

	Social anxiety	Social sensitivity	Without mask	With mask
Social anxiety		0.274	0.822	0.566
Social sensitivity	0.099		< 0.001	< 0.001
Without mask	− 0.020	0.345***		< 0.001
With mask	0.052	0.372***	0.489***	

Note. The bottom of the diagonal line represents the correlation coefficient, and the top of the diagonal line represents the p-value. *** $p < .001$

the face mask was present. Figure 4 shows that the percentage of responses misinterpreting anger as sadness decreased when masks were present. Thus, overall, the face mask made it harder to recognize fear but easier to recognize anger.

Factors affecting emotion inference from facial expressions when face masks are worn

This study also investigated the factors that affect emotion inference from facial expressions with masks. First, the mean of the correct response rates for the five facial expressions in each condition was calculated (without mask: $M = 0.918$, $SD = 0.080$; with mask: $M = 0.864$, $SD = 0.062$). The correlation matrices of social anxiety, social sensitivity, correct response rate with mask, and correct response rate without mask are shown in Table 1. The results showed that the correlations between social sensitivity and the percentage of correct responses in the mask condition ($r = .372$, $p < .001$), the percentage of correct responses in the without mask condition ($r = .345$, $p < .001$), and the percentage of correct responses in the mask and without mask conditions ($r = .489$, $p < .001$) were significant. That is, social sensitivity was associated with the accuracy of emotional inferences with and without masks. Furthermore, those who correctly

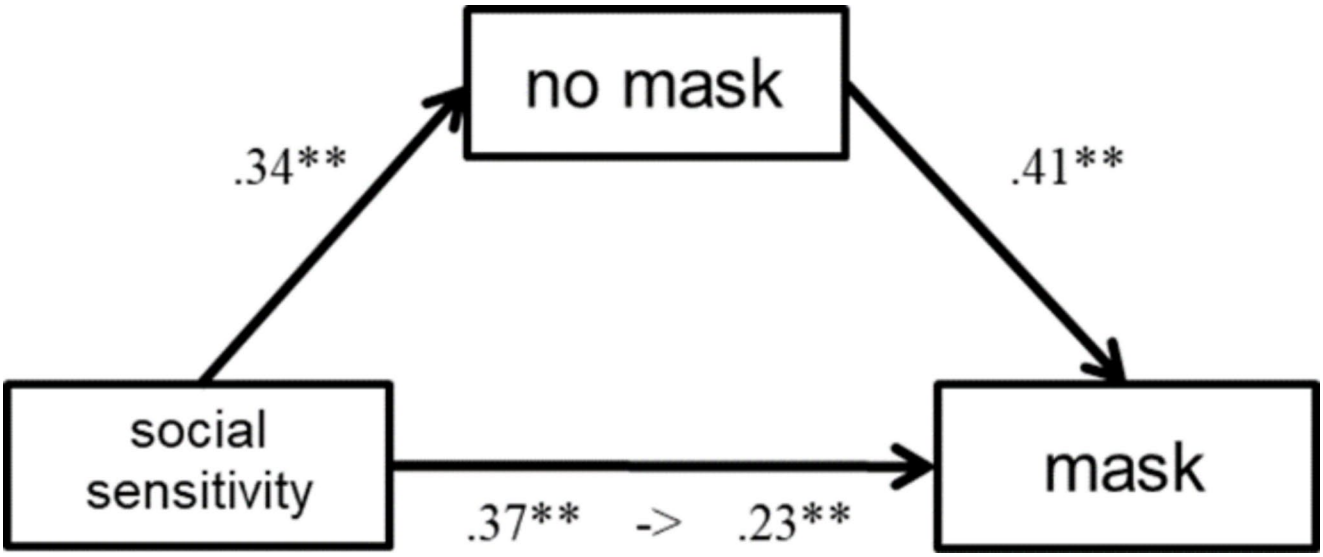

Fig. 5 Results of the Mediation Analysis. Note. The effect of social sensitivity in the mask condition was significant even when the effect of the without mask condition was controlled for. ** $p < .01$

interpreted emotions from facial expressions without a face mask also showed good ability to infer emotions from facial expressions with a face mask. In addition, social anxiety tendencies did not affect the accuracy of emotion inference from facial expressions.

The correlation analysis results indicated that the accuracy of emotion inference from facial expressions with masks was related to that from facial expressions without mask. Therefore, a mediation analysis was performed to examine whether social sensitivity affects the accuracy of emotion inference from facial expressions, has a direct influence on emotion inference from facial expressions wearing a mask, and is the only predictor of the accuracy of emotion inference from facial expressions wearing a mask (Fig. 5). The results showed that the indirect effect of social sensitivity was significant ($\beta = 0.141$, $p = .003$, 95% CI [0.059, 0.230]). However, the standardized regression coefficients from social sensitivity to facial expressions with masks and without masks were both significant. Furthermore, the path from social sensitivity to facial expressions with a mask remained significant even after controlling for the effect of the without mask condition. This implies that, first, high social sensitivity enables people to accurately infer emotions from facial expressions; this, in turn, leads to greater accuracy in emotion inference from facial expressions with a mask. The findings also indicate that high social sensitivity directly affects the accuracy of emotion inference from facial expressions with a mask.

Discussion

The present study examined the accuracy of emotion inference from facial expressions with a mask in a Japanese sample, as well as the individual differences that affect the accuracy of emotion inference. First, the hypotheses and main findings of this study are described. It was hypothesized that, for the Japanese people, the trend of inferring emotions accurately from facial expressions would be different than that found in the West, because wearing masks was a common practice in Japan even before the COVID-19 pandemic (Miyazaki et al., 2021). In addition, it was predicted that social anxiety and social sensitivity would affect the accuracy of emotion inference from facial expressions when a mask was worn.

The results showed that the percentage of correct responses decreased only for the sad and fearful expressions when a mask was worn, but did not change for the happy and neutral facial expressions. Meanwhile, the percentage of correct responses increased for the expression of anger in the mask condition. Although this study did not directly collect data from a Western sample nor make direct comparisons between a Japanese and a Western sample, the current findings for the Japanese sample can be compared with those of prior research conducted in other Western and Eastern countries. It seems that the current evidence differs from that of a prior study with a Western sample (e.g., Carbon, 2020), which showed a decrease in correct responses for many facial expressions, including anger, disgust, happiness, and sadness, when a face mask was worn. Then, based on a comparison of the current findings with those of the aforementioned Western sample and those of a study with

a Korean sample (i.e., also from the Easter region; Kim et al., 2022), it appears that the effect of wearing a mask may be relatively weak in the Eastern region. Specifically, in the Western study, wearing a mask reduced the correct response rate by up to 50% (Carbon, 2020), whereas neither the Korean study nor the present Japanese study showed such significant effect. Furthermore, compared with the effect on the Korean study, the effect of wearing a mask on the current Japanese participants was smaller. Japanese people are used to wearing masks (Miyazaki et al., 2021), and they tend to focus on the eyes to infer emotions from others' facial expressions (e.g., Jack et al., 2009; Yuki et al., 2007); these descriptions provide insights as to the participants of the current study having potentially been less affected by the presence of a face mask, and that this may be related to Japanese people having prior daily experience of wearing masks and placing a greater focus on eyes for emotion inference. This description, nonetheless, is speculative and warrants further examination in the future.

Regarding the facial expression of anger, the correct response rate was higher when the mask was worn. The false-answer analysis (Fig. 4) showed that without the mask, facial expressions of anger were sometimes mistaken for expressions of sadness (6.64%), but such misinterpretations were reduced when the mask was worn (1.90%). In other words, the presence of the mask enabled participants to accurately recognize angry facial expressions without confusing them with other expressions. This can be attributed to the fact that angry and sad expressions are mainly recognized using cues from the upper half of the face (e.g., Calder et al., 2000; Gouta & Miyamoto, 2000). These results suggest that the mask made it possible to eliminate the confounding information from the lower half of the face and for the upper half to be observed more carefully, making it easier to recognize anger. In addition, study in the West have not reported an increase in the correct response rate for inferring emotions from facial expressions with a mask. This may be because people in Western countries may generally be less familiarized with masks (vs. Japanese people), such that it may be more difficult for them to infer emotions from facial expressions when half the face is covered. Meanwhile, the Japanese people may be more familiar with face masks, and this may have enabled them to more effectively process facial expressions with relatively less interference from the masks. Once more, these descriptions are speculative because the current study did not explore them directly, but researchers are urged to examine them in the near future.

In the present study, the facial expression of happiness was not affected by wearing a mask, and this differs from the results of the Western study conducted by Carbon (2020). This cited research shows that when a mask is applied to a happy expression, it is likely to be misrecognized as a neutral expression. Meanwhile, it has been pointed out that Japanese people are sensitive to the boundary between happy and neutral facial expressions (Ishii et al., 2011), and that such sensitivity is caused mainly by focusing on the differences in the eye area (Ikeda, 2020). Therefore, it may be that Japanese people are less likely to confuse happy and neutral facial expressions and more likely to correctly identify them even when people wear masks.

Furthermore, social sensitivity was found to affect the accuracy of emotion inference from facial expressions with masks. The results showed that people who were able to accurately infer emotions from unmasked expressions were also able to accurately read emotions from masked expressions. A mediation analysis was used to examine whether social sensitivity directly affected the accuracy of emotion inference from facial expressions with a mask. It was found that, apart from an indirect effect of social sensitivity on the accuracy of emotion inference from facial expressions without masks, there was also a direct effect of high social sensitivity on the accuracy of emotion inference from facial expressions with a mask. In other words, people who are good at inferring emotions from facial expressions in general can accurately infer emotions even when a mask is worn; however, independent of this, people with high social sensitivity can accurately read emotions from facial expressions with a mask. Social sensitivity refers to the ability to infer complex mental states of others from subtle cues (Baron-Cohen et al., 2001). Coupled with the current results, it may be that Japanese people with high social sensitivity are more likely to be able to accurately infer emotions from facial expressions, even when the emotional cues are reduced because of a face mask. Social sensitivity, as measured by the Reading the Mind in the Eyes test, is strongly related to emotional intelligence, especially the perception and understanding of others' emotions (Megías-Robles et al., 2020). Coupled with the current research results, it seems that the higher the social sensitivity, the better the ability to infer the emotions of others, and therefore, the more accurate the inference of emotions from facial expressions that are partially hidden by masks.

Meanwhile, no effect of social anxiety was found in the present study. It has been reported that social anxiety is associated with sensitivity to changes in facial expressions, such as the fading of happiness and the emergence of sadness (Ikeda, 2020; Ishii et al., 2011). In these cited experiments, videos of composites of happy or sad facial expressions and neutral facial expressions were used as stimuli, whereas the facial expression stimuli used in the present study were static pictures. Thus, social anxiety may be related only to sensitivity to dynamic changes in facial expressions. Social anxiety is a personality trait that reflects sensitivity to

negative evaluation by others. Accordingly, social anxiety may not be sensitive to static facial expressions (e.g., anger or sadness) but rather to dynamic changes in the negative evaluation of oneself as it is perceived through changes in facial expressions. This is yet another speculation that warrants further confirmation in the near future.

Limitation

This study had several limitations. First, it did not conduct direct cultural comparisons. Furthermore, although the participants were Japanese students attending Japanese universities, they were not strictly surveyed for their nationality and upbringing. Therefore, it was not possible to directly examine or describe the differences in emotion inference from masked facial expressions between people in Japan and in Western countries. Future studies comparing people from Western and Eastern cultures are necessary.

Second, because the present study included only university students, it could not determine if and how the accuracy of emotion inference from masked facial expressions changes with age. Western studies have shown that emotional inferences from facial expressions in masks are inaccurate even in early childhood (Gori et al., 2021; Ruba & Pollak, 2020); it is necessary to examine whether young Japanese children, who are accustomed to seeing masked faces, are also hindered by the masks when inferring emotions. In addition, and in connection therewith, the mediation effect of social sensitivity may change over time. Since this study used a cross-sectional design, future longitudinal studies are warranted to continue to explore the effects of wearing a mask and social sensitivity on emotion inference.

Third, this study only examined the influence of social anxiety and social sensitivity on emotion inference, albeit previous studies have shown the influence of empathy (Ramachandra & Longacre, 2022), autistic trait (Pazhoohi et al., 2021), among others. In the future, researchers could attempt to more comprehensively examine the factors affecting emotion inference and the extent of their influence. In doing so, they could also further investigate social anxiety, which did not show any influence in the present study. As the COVID-19 infection situation settles down, the requirement to wear masks will be lifted and communication without masks will increase. In such a society, we need to continue to monitor how individuals' emotional inferences will change, while taking into account the possibility that different infectious diseases may become more prevalent.

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Data availability The datasets generated and analyzed during the current study are available in an open science framework, and can be accessed at https://osf.io/mxgb5/?view_only=bc43008a83064f3ba756f4fefb505262. The facial expression stimuli used in this study cannot be released freely due to rights issues, but can be shared by contacting the author.

Declarations All procedures performed in studies involving human participants were in accordance with the ethical standards of the Kyoto University of Advanced Science and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Conflict of interest The author has no conflict of interest to declare.

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