Behind the mask: what the eyes can't tell. Facial emotion recognition in a sample of Italian healthcare students

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ABSTRACT

Wearing a facemask remains a pivotal strategy to prevent SARS-CoV-2 infection even after vaccination, but one of the possible costs of this protection is that it may interfere with the ability to read emotion in facial expressions. We explored the extent to which it may be more difficult for participants to read emotions in faces when faces are covered with masks than when they are not, and whether participants' empathy, attachment style and patient-centred orientation would affect their performance. Medical and nursing students (*N* = 429) were administered either a masked or unmasked set of 24 adult faces depicting anger, sadness, fear, or happiness. Participants also completed self-report measures of empathy, patient-centredness, and attachment style. As predicted, participants made more errors to the masked than the unmasked faces with the exception of the identification of fear. Of note, when participants missed happiness they were most likely to see it as sadness, and when they missed anger, they were most likely to see it as happiness. A multiple linear regression analysis showed that more errors identifying emotions in faces was associated with faces being masked as opposed to unmasked, lower scores on the empathy fantasy scale, and higher scores on the fearful attachment style. The findings suggest that wearing facemasks is associated with a variety of negative outcomes that might interfere with the building of positive relationships between health care workers and patients. Those who teach student health care workers would benefit from bringing this finding into their curriculum and training.

Keywords: facial emotion recognition, masks, DANVA, medical and nursing students, empathy, attachment style, patient-centredness

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Introduction

Despite the global efforts toward immunisation and the success of vaccines to prevent serious SARS-CoV-2 illness, facemask wearing remains an effective option for preventing SARS-CoV-2 (Sajed & Amgain, 2020). However, face masks impair the ability to accurately express and read emotions in facial expressions, and the mistakes that result from these errors can interfere with communication in everyday interactions (Knollman-Porter & Burshnic, 2020; Kelley, 2020; Marler & Ditton, 2021).

Because the communication of emotions is a significant aspect of social interaction, skill in recognizing emotions impacts both the process and outcome of relationship development (Van Kleef & Coté, 2022). Emotions As Social Information (EASI) theory suggests that people use information from facial expressions to make sense about what is happening in a social interaction by giving interactants information about how one another is feeling. In the healthcare context, wearing facemasks can make gathering this information more difficult, disrupting the interactive process (Treffers & Putora, 2020).

Previous studies of facial emotion recognition in masked faces suggest that the eye region is important in recognizing sadness and fear, while the mouth is more involved in identifying disgust and happiness (Wegrzyn et al., 2017). Typical adults made more emotion recognition errors when viewing masked (versus unmasked) facial expressions and expressed less confidence in their choices (Carbon, 2020; Grahlow et al., 2022; Fitousi et al., 2021; Kim et al., 2022; Parada-Fernández et al., 2022). The same was found to be true in healthcare students (Bani et al., 2021). Face masks also appear to reduce the perceived untrustworthiness of faces (Cartaud et al., 2020; Marini et al., 2021) and, in a continuous recognition task, make it more difficult to recognise unmasked faces when they were seen previously masked (Marini et al., 2021). Grundmann and colleagues (2021) found that face masks interacted with the valence of the expressed emotion in shaping social judgements, with negative emotional

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expressions in masked faces being associated with lower ratings of trustworthiness, likability, and closeness. Although myriad study results consistently support the idea that facemasks impair emotion recognition, few investigations have explored the possible impact of psychosocial factors on emotion recognition.

According to EASI theory, because effective healthcare communication and positive healthcare-patient relationships hinge on the ability to read and empathetically respond to patients' emotions, they can also impact on the shared decision-making process (Traffers & Putora, 2020). Empathy includes emotional and cognitive components (Davis, 1983). The emotional component refers to the appropriate affective arousal in response to the feelings of others. The cognitive component, in contrast, relates to the accurate cognitive understanding of others' experiences and a desire to help them (Hojat et al., 2001). For example, medical students who were more accurate in recognizing emotions in facial expressions and were more extraverted were rated as more empathic by simulated patients (Schreckenbach et al., 2018). Other studies have found a moderate but significant positive association between personal beliefs about the ability to take others' perspectives (a component of empathy) and more accurate emotion recognition (Israelashvili et al., 2019; Ramachandra & Longacre, 2022). Handford and colleagues (2013) found that a combination of greater empathy and greater clinical experience was associated with more accurate identification of emotions in facial expressions in clinical settings. They concluded that clinical practice, not medical education, was responsible for the positive development of empathy. A recent randomized control trial found that surgeons wearing clear masks were considered more empathic, more trustworthy, and clearer in their communication than those wearing standard masks (Kratzke et al., 2021). Finally, patients and healthcare providers found that mutual mask-wearing during appointments made listening more difficult and reduced the desire to engage in other clinical encounters (Lee et al., 2022).

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Facial emotion recognition not only appears to be affected by the level of individuals' empathy, it may also be influenced by attachment style. Attachment style refers to ways of feeling, interacting and behaving in relationships which was learned through interactions with caregivers during early childhood and can be classified as secure and insecure. Individuals with a secure attachment style have a positive model of the self as worthy of love and others as supportive. Individuals with insecure attachment style can be classified, according to the Bartholomew and Horowitz's (1991) model, as insecure preoccupied (with negative model of self and positive model of others), insecure dismissing (with positive model of self and negative model of other), or insecure fearful (with high levels of distrust of others and an image of the self as unworthy of support) (Hunter & Maunder, 2015). Studies have found that attachment styles affect the way in which emotional information is processed. Insecure attachment style has been found to be associated with reduced attention to threatening facial expressions and less accuracy in recognizing others' negative emotions. In contrast, secure attachment style has been found to be associated with greater attention to neutral and negative facial emotional expressions (Esposito et al., 2014; Kammermeier etal., 2020). Moreover, healthcare providers perceived patients with insecure attachment styles as more difficult to interact with, while providers with a secure attachment style were found to have better communication and clinical skills (Hooper et al., 2012; Hunter & Maunder, 2015). In psychiatry residents, the ability to recognise happiness was associated with a secure attachment style, while better sadness and surprise recognition was negatively related to an avoidant attachment style (Arango de Montis et al., 2013). Furthermore, attachment styles of medical students predicted empathy levels, and the ability to recognize and regulate self and other emotions mediated the relationship between attachment security and empathy (Ardenghi et al., 2020; Ardenghi et al., 2022).

The assumptions healthcare students make about the role patients should take in their own care may contribute to their effectiveness in identifying the patients' emotional state as

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shown in facial expressions. Medical students who have a patient-centred attitude have been found to be more empathetic as shown by a greater concern about their patients' feelings and points of view (Ardenghi et al., 2020). It is assumed that patient-centered healthcare professionals have both a caring and a sharing attitude (Ardenghi et al., 2019). A caring attitude makes physicians consider the patients' feelings, beliefs, and expectations, and a sharing attitude leads them to communicate cooperatively with their patients and engage with them as equals. Surprisingly, no one has explored the possible link between patient-centeredness care attitudes and emotion recognition of masked/unmasked faces even though previous studies have shown that face masks have a significant negative impact on perceived empathy and the quality of doctor-patient relationship (Banerjee et al., 2022; Wong et al., 2013).

The purposes of the present study are to 1) assess the impact of wearing face masks on facial emotion recognition; 2) describe and contrast the pattern of misattributions in unmasked and masked facial expressions (when an error was made what emotion was offered in place of the correct one) when assessing masked vs unmasked faces and 3) evaluate whether individual difference factors of attachment style, empathy and patient-centeredness predict emotion recognition in healthcare students.

Specifically we tested the following hypotheses:

- Participants in the masked condition will make more errors identifying emotions in the facial emotion recognition task than those in the unmasked condition.
- Participants with lower patient-centredness, lower empathy, and insecure attachment styles will make more errors identifying emotion in facial expression in both the masked and unmasked conditions.

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Method

Participants and Procedure

A convenience sample of 1,572 medical and nursing students from the University of Milano-Bicocca, Italy were invited to participate in the study by email invitation with the link to the study survey. The inclusion criteria were i) being enrolled in one of the medical or nursing degree programs; ii) being sufficiently proficient in Italian to complete the survey and provide informed consent.

Data were collected from October 2020 to March 2021 when wearing masks were compulsory in public spaces at a national level. The study received ethical approval from the ethical committee of the University of Milan-Bicocca (study n° 542 Prot. 0061750/20). Participation was voluntary and anonymous. In a between-subject design, after informed consent was digitally provided, participants were randomly allocated to one of the two study conditions (masked vs unmasked) and completed the online survey.

Measures

The survey completion required about 15 minutes and included a socio-demographic section, educational information, psychosocial variables and a facial emotion recognition task.

Facial emotion recognition

The facial emotion recognition ability was measured with the Diagnostic Analysis of Nonverbal Accuracy FACES2 adult faces (DANVA2-AF) (Nowicki & Carton, 1993). It includes 24 photos of adult faces, with each face showing one of four emotions: fear, happiness, sadness, and anger. For each emotion, there are three high- and three low-intensity stimuli. Each photo was presented for 2s as detailed in the DANVA2-AF manual (Nowicki & Duke, 2008). Using a forced-choice format, participants respond by selecting the best emotion label for each photo. The test scores reflect the number of errors made in identifying emotions. A

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modified version of the DANVA2-AF was created digitally adding a light blue surgical mask to each photo (Bani et al., 2021).

Attachment

The 4-item Relationships Questionnaire (RQ) measured participants' attachment style (Bartholomew & Horowitz, 1991). Participants were presented with four short paragraphs each describing a prototypical attachment pattern (Secure, Fearful, Preoccupied, Dismissing) as it applies in close adult peer relationships and rated their degree of correspondence to each prototype on a 7-point Likert scale.

Empathy

The Brief form of the Interpersonal Reactivity Index (B–IRI) (Ingroglia et al., 2016) assessed participants' empathy. The tool consists of 16 items answered on a 5-point Likert scale ranging from "Does not describe me well" to "Describes me very well". The measure has 4 subscales: *Perspective Taking* (PT; the tendency to adopt the psychological point of view of others; α = .778); *Fantasy* (FS; the tendency to transpose themselves imaginatively into the feelings and actions of fictitious characters; α = .878); *Empathic Concern* (EC; the concern for unfortunate others; α = .761); *Personal Distress* (PD; the unease in tense interpersonal settings; α = .722). Greater scores reflect greater empathy.

Participants' patient-centered orientation

The short version of the Patient Practitioner Orientation Scale (PPOS-8-IT) (Ardenghi et al., 2019) is an 8-item self-report measure of patient-centred attitude and has two subscales: (1) *Caring* (the extent to which respondents believe in a holistic and supporting medical approach); (2) *Sharing* (the extent to which respondents believe that the patient-physician relationship should be egalitarian). Participants are asked to indicate their degree of agreement about each item, using a 6-point Likert scale, ranging from 1 ("strongly disagree") to 6 ("strongly agree"). Greater scores reflect a greater patient-centered attitude. In this study, the

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reliability (Cronbach's alpha) of the PPOS-8-IT dimensions was α = .412 for the Caring subscale and α = .387 for the Sharing subscale.

Statistical Method

The primary outcome variable was errors on DANVA2-AF. Descriptive statistics included estimations of means, standard deviations, and frequency distributions of the investigated variables. We contrasted errors in masked vs. unmasked conditions with unpaired *t*-tests utilizing a Bonferroni multiple-significance-test correction of $p < .01$. We used analysis of variance (ANOVA) to explore differences in DANVA2-AF scores by emotion intensity and emotion type in the study groups. We explored emotion misattributions in masked vs. unmasked conditions with chi-square tests of homogeneity. Pearson's and Spearman's correlations assessed the association between performances at the facial emotion recognition task and the psychosocial variables considered in masked and unmasked conditions. A multiple linear regression analysis identified demographic and psychosocial factors that were associated with DANVA2-AF scores in the masked and in the unmasked condition. The model selection included major demographic factors, variables theoretically associated with the dependent variable and those variables found to have a significant relationship ($p < .01$) in bivariate analysis. All analyses were run using IBM SPSS statistical software version 26.

Results

Sample demographics characteristics, attachment style, empathy and patient-centeredness

Out of 1,572 students invited to take part in the study, 575 accessed the survey but 121 interrupted the completion and gave incomplete data leading to 429 (223 medical, 206 nursing) students completing the survey and being included in the analysis (response rate 27.3%). Participants' demographic characteristics, empathy levels, attachment style and patient-centred orientation by university program are presented in Table 1.

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--- Insert Table 1 about here ---

The impact of wearing face masks on facial emotion recognition

Overall, as hypothesized, participants in the masked condition made significantly more errors overall interpreting emotions than participants in the unmasked condition. When focusing on each emotion type and emotion intensity separately, this pattern was replicated (see Table 2).

--- Insert Table 2 about here ---

We performed a two-way mixed ANOVA to determine whether there was an interaction effect between emotion intensity (low vs high) and masking condition (masked vs unmasked) on error rate at the emotional facial recognition task. A statistically significant interaction between emotion intensity and masking condition on error rate emerged, $F(1, 427) = 8.62$, $p = .003$, $\eta_p2 = .02$. A significant effect of masking existed. A statistically significant higher error rate existed in the masked compared to the unmasked condition for both high intensity emotions $F(1, 427) = 337.29$, $p < .001$, $\eta_p2 = .441$, and low intensity emotions $F(1, 427) = 178.09$, $p < .001$, $\eta_p2 = .294$. There was also a statistically significant effect of emotion intensity on error scores for the unmasked condition group $F(1, 219) = 124.58$, $p < .001$, and for the masked condition group $F(1, 208) = 40.58$, $p < .001$. High intensity faces always resulted in fewer errors than low intensity.

A 4 x 2 mixed ANOVA was used to explore whether there was an interaction effect between emotion type and masking condition which led participants to have more difficulties identifying specific emotions in the masked versus unmasked condition. There was a statistically significant interaction between emotion type and masking condition on error rate, $F(3, 1281) = 70.89$, $p < .001$, $\eta_p2 = .142$. A main effect of masking existed such that there was a statistically significant higher error rate in the masked compared to the unmasked condition

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for happiness, $F(1, 427) = 437.69$, $p < .001$, $\eta_p2 = .506$, anger $F(1, 427) = 294.31$, $p < .001$, $\eta_p2 = .408$, and sadness $F(1, 427) = 64.07$, $p < .001$, $\eta_p2 = .130$, but not for fear $F(1, 427) = 5.52$, $p = .019$, $\eta_p2 = .013$.

There was also a statistically significant main effect of emotion type on error rate for the unmasked condition group $F(3, 657) = 70.29$, $p < .001$, where participants made fewer errors with happy and fearful faces (*M* = .23, *SE* = .07, *p* = .001) followed by sad (*M* = .8, *SE* = .09, *p* < .001) and angry faces, which did not statistically differ from each other (*M* = .14, *SE* = .09, p = .136). This contrasts with the pattern found in the masked condition, which also demonstrated a main effect, $F(3, 624) = 173.47$, $p < .001$, where fear had the lowest error rates followed by sadness (*M* = 1.33, *SE* =.11, *p* < .001) and happiness, which did not differ from each other (*M* = .08, *SE* =.11, *p* = .48). Anger had the highest error rates (*M* = 1.11, *SE* =.11, *p* < .001). See Figure 1.

--- Insert Figure 1 about here ---

Distribution of emotion misattributions in masked and unmasked conditions

We investigated whether emotion-specific misattributions occurred. Observed frequencies and percentages of the emotion misattributions for each masking condition are presented in Figure 2. A set of Chi-square tests of homogeneity highlighted that the distributions of misattributions were different in the masked vs unmasked condition for all emotions considered. Post hoc analyses after Chi-square tests using a Bonferroni correction to control for Type I error inflation were run to determine where the differences amongst misattributed emotions lied for each face emotion considered. Statistical significance was accepted at $p \leq .008$ (see Table 3).

For the happy faces stimuli, the analysis revealed that the proportion of participants in the masked condition who mistakenly selected fear was statistically significantly lower than

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participants in the unmasked condition, while the proportion of participants in the masked condition who selected anger was significantly higher compared to the unmasked group. No statistically significant differences existed in the proportion of sadness misattributed to happy faces between masking conditions.

--- Insert Figure 2 about here ---

--- Insert Table 3 about here ---

A similar pattern of emotion-specific misattributions emerged for fearful faces. Errors on sad faces were equally misattributed amongst the three erroneous alternatives in the masked condition, while fear and anger were the most prominent errors in the unmasked condition, achieving a combined 91.6% of the total misattributions. Happiness was selected statistically significantly more in the masked group and fear was selected statistically significantly less than in the unmasked condition.

Demographic and psychosocial characteristics associated with emotion recognition task performance in masked and unmasked groups

In order to discern whether and how demographic and psychosocial features may predict performances at the facial emotion recognition task DANVA2-AF we performed a multiple linear regression analysis. In particular, while controlling for gender and age, we explored whether university programmes, empathy facets, attachment style dimensions and patient-centred orientation predict DANVA2-AF scores in the masked and unmasked study groups. Partial support for this hypothesis existed. The model statistically significantly predicted the errors at the facial emotion recognition task DANVA2-AF, $F(14, 414) = 30.76$, $p < .001$ with an adjusted $R^2 = .493$. Greater errors were associated with being presented with masked faces, lower scores on the empathy fantasy scale and higher scores on the fearful

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attachment style scale, $p < .05$. No other significant predictor was found for DANVA2-AF scores (see Table 4).

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Discussion

The major goals of the study were (1) to replicate findings (Bani et al., 2021) showing that masked facial expressions of emotions were more difficult to identify than unmasked ones and (2) to evaluate if individual differences in patient-centredness, empathy, and attachment style were associated with accuracy in identifying emotion in facial expressions. We found partial support for the first goal. Masked emotional facial expressions were significantly more difficult to recognize than unmasked faces with the exception of fear. Kim et al. (2022) suggest that this is because the major aspects of fear are communicated in the upper part of the face and eyes.

The present findings are generally consistent with those gathered from studies that have used a variety of face recognition tasks and included a 'neutral' category of response (Carbon, 2020; Grahlow et al., 2022; Kim et al., 2022; Marini et al., 2021; Parada-Fernandenz et al., 2022).

While most researchers have found that masked faces made identifying emotions generally more difficult than unmasked ones, some also have found a lack of the wearing of masks to make no difference in identifying specific emotions. For example, Shepherd and Rippon (2022) found that though face masks significantly reduced accuracy in the recognition of disgust, fear, happiness, sadness, and surprise, they did not so for anger. This last finding in Shepherd and Rippon's study may be due to the fact that disgust was often mistakenly perceived as anger (which accounted for 20% of the total misattribution in the study). The

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authors pointed out that the result is not so surprising as both anger and disgust involve the upper part of the face and eyes.

A similar explanation can be advanced for Shepherd and Rippon's results on fear. The feared faces were often misperceived as surprised (which accounted for 60% of the misattributions) as these emotions have similar features in the upper part of the face and the eyes region. The presence of the surprise category can account for the difference between Shepherd and Rippon's and our results for the fear expressions. When looking at the distributions of misattributions, previous studies (Carbon, 2020; Carbon et al., 2022; Kim et al., 2022; Shepherd & Rippon, 2022) showed high variability in the error distributions in masked faces. In Carbon and colleagues' studies (2020; 2022), anger and happiness were more commonly mistaken for neutral, fear for disgust, and sadness for fear. Kim et al. (2022) reported that in masked faces happiness was more likely misread as neutral, fear as surprised, sadness as disgust or neutral, and anger as neutral or surprised. In Shepard and Rippon (2022), happiness in masked faces was misread as sadness and disgust, fear as surprise, anger as disgust, and sadness as disgust and fear.

The research done to evaluate the effect of masks on the ability to identify the expression of emotion in facial expressions has been hampered by a lack of consistency in the use of facial stimuli, the number of emotions tested, the time allowed to respond to stimuli, and small samples of participants. These differences make it difficult to compare findings of one study with another. However, in spite of all this variability, researchers have consistently found that masks generally have a significant negative impact on accuracy. In none of the studies reviewed did individuals recognize emotions in facial expressions better when faces were masked than when they were unmasked.

EASI theory suggests that interfering with interactants' ability to know how each other is feeling by what is showing on their faces will make the relationship process more difficult.

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While masks may create more errors, the errors can be compounded by what emotions participants in place of the correct one. For example, in the present study, EASI theory might suggest that misreading patients' sadness or anger as happiness could generate an inappropriate response that in a clinical situation could lead to negative relational outcomes (Traffers & Putora, 2020). If health care professionals made these misattributions, they would erroneously view patients as satisfied when they actually were either sad or frustrated and angry.

We predicted that participants with lower patient-centeredness, lower empathy and less secure attachment style, would make more errors in reading emotions in facial expression compared to those with higher patient-centeredness, higher empathy, and secure attachment style. We found partial support for these predictions. Those performing more poorly on the emotion recognition task were more likely to have a fearful than a secure attachment style and higher rather than lower scores on the empathy fantasy scale.

Previous studies showed that adults and children with a secure attachment style pay more attention to emotional stimuli (Kammermeier et al., 2020), but individuals with high attachment anxiety pay more attention to eyes and less attention to mouths when regarding facial expression (Wang et al., 2020). In the clinical context attachment styles can be reflected in the ways health care providers' different levels of care, sensitivities to topics raised by patients, setting appropriate boundaries for patient behaviors, and dealing effectively with patients' stress (Hunter & Maunder, 2015). Because clinicians with an anxious attachment style may have difficulties recognizing the emotion expressed by patients facial expressions, it may follow that face masks make them even more inaccurate leading to misperceiving patients' needs. Introducing the study of attachment styles in the healthcare students' curricula and helping students become more aware of their own and their patients' attachment styles could improve the quality of care future healthcare workers could provide to their patients by making them better able to identify real patients' needs.

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We found some support for our prediction that empathy would be associated with accuracy in identifying emotion in masked or unmasked facial expressions. Only the fantasy scale of the overall empathy measure was related to performance on the DANVA faces. While previous studies that have assessed empathy with different scales, have found it related to unmasked facial emotion recognition accuracy (Besel et al., 2010; Israelashvili et al., 2019; Laukka et al., 2021), others that have used the IRI reported significant but inconsistent results (Laukka et al., 2021; Schlegel et al., 2017; Ventura et al., 2023). For example, Beals et al. (2022) reported a positive association between fantasy scale scores and recognition of fear in facial expressions in typical participants, while Schmidt et al. (2021) found higher fantasy scale scores related to better scores in emotion recognition in actors when compared to dancers and psychologists (Schmidt et al., 2021). These results suggest that the tendency to use the imagination to take the perspective of a fictional character may improve emotion recognition ability.

Contrary to our results, researchers have found other aspects of empathy to be related to the identification of emotion in masked or unmasked facial expressions. Israelashvili and colleagues (2020) found a positive relationship between unmasked facial emotion recognition scores and higher empathic concern, and a negative association with personal distress; a similar pattern was reported by Shepard and Rippon (2022) that found a positive relationship between masked facial emotion recognition scores and higher empathic concern. Schreckenbach et al. (2018) using unmasked DANVA2-faces found that "simulated" patients who were extraverted rated medical students who were more accurate in identifying emotions in faces as more empathetic.

Overall, while there are strong theoretical reasons for predicting a positive relationship between empathy and facial emotion recognition, the specific role of empathy captured by the fantasy scale needs to be cautiously interpreted. Empathy appears to be a complex concept, and

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the measures used to assess it may not be comparable. While the IRI is a widely used general measure of empathy, it may not assess the specific empathy taking place in doctor-patient interactions (Costa et al., 2017); furthermore, the differences with previous studies can be related to the different experimental stimuli used or the use of the brief version of the IRI rather than the long version. Further investigation is needed to clarify how imaginary experience plays a role in the empathic exchange between healthcare workers and patients. Studies using virtual reality could be used both to assess the value of fantasy in doctor-patient interactions and provide training for healthcare workers to improve their ability to recognize emotion in facial expressions when the faces are masked. None of the scales focusing on patient-centeredness were significantly related to accuracy in identifying emotion in faces. One possible explanation for the lack of significance lay in the scale used to measure patient-centeredness; in fact, the low reliability of the PPOS measure has probably affected the outcome of the analyses.

Limitations

The use of a forced-choices format in emotion recognition tasks could have biased the answers, preventing respondents from advancing their thorough interpretation of the facial expressions (Gendron et al., 2018). A replication of the study using a less constrained answer mode as free labelling or valence/arousal description could more comprehensively explore people's accuracy in detecting facial emotions. When focusing on healthcare settings and medical interactions the emotion of strong fear is less common than anxiety (subtle or moderate); therefore, it could be extremely relevant to include the anxiety label and a wider emotional cluster of emotion labels in future studies.

The use of static faces is another limitation to highlight, and the inclusion of dynamic masked faces showing the transition between emotional expressions could bring a higher ecological validity. Another aspect that warrants further consideration is the ethnic variation of the DANVA stimuli and the study participants' perception of them as in-group or out-group

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members. This aspect could be relevant in moderating the effect of mask-wearing on facial emotion recognition given that an in-group advantage for confidence in emotion recognition has been found (Beaupré & Hess, 2006). Additionally, people's information search about in-group and out-group members is often different, with a tendency to confirm positive in-group and negative out-group stereotypical attributes (Sacchi et al., 2012).

The low reliability of PPOS-8-IT (reported also in other validation studies of this questionnaire, Jiang et al., 2022; Perestelo-Pérez et al., 2021) suggests using a more reliable tool to assess patient centredness. Furthermore, the use of only a self-report measure to assess empathy could be considered a limitation; future studies consider also including different empathy questionnaires as well as external measures (such as independent judges). For example, a study with medical students found a moderately significant correlation between self-reported and simulated patient-reported empathy and concluded that the two measures are not redundant (Berg et al., 2011).

Finally, we presented data from a sample of medical students from a single university centre limiting the generalizability of our findings. We look forward to more investigations with specific populations of professionals (physicians, nurses) and patients as well as considering other possible intervenient factors (e.g. burnout risk, psychological distress, personality traits; perceived trustworthiness and competence).

Conclusions

In healthcare settings, the quality of the relationship between health care professionals and their patients was significantly associated with patient outcomes. A significant aspect of building positive relationships in clinical settings is the ability to gauge one another's emotional states not only through the use of words, but also via nonverbal channels such as facial expressions.(Bani et al., 2021). Because of the recent pandemic, interactants in clinical settings have to deal with one another while wearing face masks. While wearing face masks has been

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useful in reducing the spread of viruses, it can have a negative effect on the communication taking place between healthcare professionals and their patients. Research shows that the wearing of face masks has hampered the healthcare professionals' ability to build empathic relationships because it interferes with accurate nonverbal communication of emotions through facial expressions (Bani et al., 2022a; Bani et al., 2022b).

Our findings suggest that wearing face masks may have both a general and a specific impact on the identification of emotion. In general wearing face masks makes the identification of emotion in faces more difficult for most expressions with the exception of fear. However analyses of misattributions revealed an interesting and potentially important pattern. When health care students misidentified a sad or an angry facial expression they were most likely to see it as happy. While seeing someone as happy when they are sad or angry might be seen as relatively harmless, within clinical settings it could create serious problems for the development of positive relationships. Misreading sad facial expressions as happy means missing potential signs of depression while misreading angry facial expressions as happy means missing indicators of dissatisfaction and frustration. Viewing patients as "happy" when they're not is a recipe for relationship failure. If this pattern is valid, then health care students and professionals could benefit from additional training to become more skilled at reading facial expressions of emotion, especially sad and angry. (Blanch-Hartigan & Ruben, 2013). Training may be necessary because research has shown there has been no improvement in the ability to recognize emotion in masked facial expressions one year after the SARS-CoV-2 pandemic outbreak (Carbon et al., 2022). Finally, two possible contributors to health care students' difficulties in identifying emotion in facial expressions were identified, an anxious attachment style and the fictional dimension of empathy. Further research needs to be completed to see if these two individual difference measures are reliably associated with a lack

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of nonverbal skill. If they are, they could be used to identify students who need extra training in reading emotion in facial expressions.

Credit authorship contribution statement

Marco Bani: Conceptualization, Methodology, Writing-original draft, Writing-review and editing, Project Administration

Selena Russo: Conceptualization, Methodology, Writing-original draft, Writing-review and editing, Data Analysis

Stefano Ardenghi, Giulia Rampoldi, Virginia Wickline, Stephen Nowicki: Conceptualization, Writing-review and editing

Maria Grazia Strepparava: Conceptualization, Writing-review and editing, Project Administration

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Figure Captions

Figure 1. *Facial Recognition Error Rates by Emotion Type*

Note. DANVA2 = Diagnostic Analysis of Nonverbal Accuracy.

Figure 2. *Matrix of Expressed and Perceived Emotions*

Note. Top matrix: faces without masks, bottom matrix: faces with a mask. Percentages compile up to 100% for each expressed emotion.

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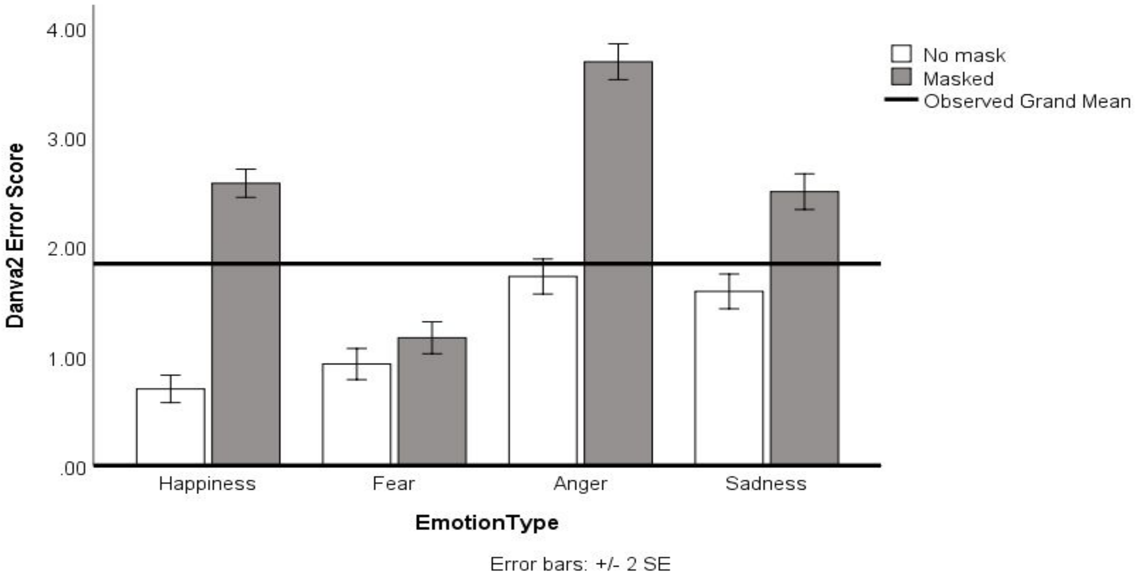

Figure 1. *Facial Recognition Error Rates by Emotion Type*

Note. DANVA2 = Diagnostic Analysis of Nonverbal Accuracy.

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	Perceived emotion	Expressed emotion: Anger	Sadness	Fear	Happiness
Unmasked	Happiness	16.5%	2.2%	10.9%	88.3%
	Fear	5.2%	12.8%	84.5%	4.5%
	Sadness	7.1%	73.7%	2.3%	5.8%
	Anger	71.2%	11.3%	2.3%	1.4%
Masked	Happiness	42.7%	14.3%	7.8%	57.0%
	Fear	8.4%	12.6%	80.5%	10.0%
	Sadness	10.4%	58.3%	3.2%	22.8%
	Anger	38.5%	14.8%	8.5%	10.2%

Figure 2. *Matrix of Expressed and Perceived Emotions*

Note. Top matrix: faces without masks, bottom matrix: faces with a mask. Percentages compile up to 100% for each expressed emotion.

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Table 1

Demographics, attachment style, empathy level and patient-centeredness by University Programs.

	Medicine and Surgery (N=223) N (%)	Nursing (N=206) N (%)	TOTAL (N=429) N (%)
Age	21.93 ±2.7	21.9 ±3.7	21.92 ± 3.23 (18-44)
Gender - Male (%)	75 (33.6%)***	26 (12.6%)***	101 (23.5%)
Female (%)	148 (66.4%)	180 (87.4%)	328 (76.5%)
Year of Course			
1st	38 (17%)	57 (27.7%)	95 (22.1%)
2nd	40 (17.9%)	42 (20.4%)	82 (19.1%)
3rd	36 (16.1%)	107 (51.9%)	143 (33.3%)
4th	34 (15.2%)	NA	34 (15.2%)
5th	42 (18.8%)	NA	42 (18.8%)
6th	33 (14.8%)	NA	33 (14.8%)
Interest in (0 to 10)			
Clinical area	8.57 (±1.52)	8.29 (±1.65)	8.44 (±1.59)
Surgery	6.93 (±2.62)	8 (±2)	7.45 (±2.34)
Marital Status			
Single	220 (98.7%)	199 (99.6%)	419 (97.7%)
Married or De Facto	1 (0.4%)	4 (1.9%)	5 (1.2%)
Prefer not to answer	2 (0.9%)	3 (1.5%)	5 (1.2%)

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Living Arrangement			
With family	170 (76.2%)	173 (84%)	343 (80%)
By him/herself	17 (7.6%)	8 (3.9%)	25 (5.8%)
With partner	7 (3.1%)	12 (5.8%)	19 (4.4%)
With other persons (friends, roommate, other family members)	27 (12.1%)	7 (3.4%)	34 (7.9%)
Prefer not to answer	1 (0.4%)	6 (2.9%)	7 (1.6%)
Attachment style dimensions (1 to 7)			
Secure	3.64 (±1.83)*	4.07 (±2.01)*	3.85 (±1.93)
Fearful	3.12 (±1.84)	3.15 (±1.95)	3.13 (±1.89)
Preoccupied	3.36 (±1.84)	3.34 (±1.94)	3.35 (±1.89)
Dismissing	3.35 (±1.73)	3.16 (±1.74)	3.26 (±1.73)
Empathy (1 to 5)			
Perspective Taking	3.72 (±.77)	3.64 (±.72)	3.68 (±.75)
Fantasy	3.43 (±1.04)	3.31 (±1.01)	3.37 (±1.02)
Empathic Concern	3.82 (±.75)	3.92 (±.73)	3.86 (±.74)
Personal Distress	2.16 (±.75)	2.22 (±.69)	2.18 (±.73)
Patient-centeredness			
PPOS Caring	1.64 (±.63)	1.55 (±.65)	1.59 (±.64)
PPOS Sharing	2.12 (±.75)*	1.95 (±.79)*	2.04 (±.77)

Note:*p<.05 **p<.01 ***p<.001

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Table 2

Facial Recognition Error Rates by Masking Condition (N=429).

	Unmasked DANVA2-AF (N=220) Mean (SD)	**Masked DANVA2-AF (N=209) Mean (SD)**	**T-test p-value**
DANVA Total Errors	4.95 (±2.79)	9.94 (±2.39)	*t*(427) = -19.84, *p* ≤ .001
HIGH intensity Errors	1.74 (±1.56)	4.52 (±1.57)	*t*(427) = -18.37, *p* ≤ .001
LOW intensity Errors	3.21 (±1.84)	5.42 (±1.57)	*t*(427) = -13.34, *p* ≤ .001
Happiness Errors	0.7 (±.84)	2.58 (±1.02)	*t*(427) = -20.92, *p* ≤ .001
Fear Errors	0.93 (±.9)	1.7 (±1.2)	*t*(427) = -2.35, *p* = .019
Anger Errors	1.73 (±1.2)	3.69 (±1.16)	*t*(427) = -17.16, *p* ≤ .001
Sadness Errors	1.59 (±1.16)	2.5 (±1.2)	*t*(427) = -8.00, *p* ≤ .001

Notes. DANVA2-AF = Diagnostic Analysis of Nonverbal Accuracy, Version 2, Adult Faces. Because of the large number of significance tests, a Bonferroni multiple-significance-test correction was applied, resulting in an alpha of 0.007.

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Table 3. *Frequencies of Emotion-Specific Misattributions by Masking Conditions*

Misattributions	**Unmasked DANVA2-AF N (%)**	**Masked DANVA2-AF N (%)**	
Happiness			
Fearful | Happy	59 (38.3%)*	125 (23.2%)*	
Sad | Happy	76 (49.3%)	286 (53.1%)	$\chi^2(2) = 17.98$, $N = 693$ $p<.01$
Angry | Happy	19 (12.3%)*	128 (23.8%)*	
Fear			
Happy | Fearful	144 (70.6%)*	98 (40.2%)*	
Sad | Fearful	30 (14.7%)	40 (16.4%)	$\chi^2(2) = 49.47$, N=448 $p<.01$
Angry | Fearful	30 (14.7%)*	106 (43.4%)*	
Anger			
Happy | Angry	218 (57.4%)*	536 (69.5%)*	
Sad | Angry	94 (24.7%)*	130 (16.9%)*	$\chi^2(2) = 16.95$, N=1151 $p<.01$
Fearful | Angry	68 (17.9%)	105 (13.6%)	
Sadness			
Happy | Sad	29 (8.3%)*	179 (34.2%)*	
Fearful | Sad	169 (48.7%)*	158 (30.2%)*	$\chi^2(2) = 80.31$, N=870 $p<.01$
Angry | Sad	149 (42.9%)	186 (35.6%)	

Notes. DANVA2-AF = Diagnostic Analysis of Nonverbal Accuracy, Version 2, Adult Faces. *expected value different from the observed value at an adjusted significance level of $p = .008$.

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Table 4. *Multiple Regression Results Exploring the Influence of Demographic and Psychosocial Features on Performances for the DANVA2-AF*

DANVA2-AF scores	*B*	95% CI for *B*		*SE B*	β	*R²*	*ΔR²*
		LL	*UL*				
Model	-.86	-4.30	2.58	1.75		.51	.49***
Constant							
Gender	.58	-.04	1.20	.32	.07		
Age	.06	-.02	.134	.04	.05		
University program	.34	-.17	.85	.26	.05		
Masking condition	4.86***	4.36	5.36	.25	.67***		
PPOS_Caring	.06	-.39	.51	.23	.01		
PPOS_Sharing	-.29	-.66	.08	.19	-.06		
Empathy							
Empathic Concern	.15	-.23	.53	.19	.03		
Personal Distress	-.32	-.69	.05	.19	-.06		
Perspective Taking	-.01	-.40	.30	.18	-.01		
Fantasy Scale	-.30*	-.57	-.03	.14	-.09*		
Attachment Style							
Dismissing	.001	-.17	.17	.09	.00		
Secure	.03	-.12	.18	.08	.02		
Fearful	.17*	.02	.32	.07	.09*		
Preoccupied	-.10	-.25	.04	.07	-.05		

Notes. DANVA2-AF = Diagnostic Analysis of Nonverbal Accuracy, Version 2, Adult Faces. PPOS = Patient Practitioner Orientation Scale. Model = "Enter" method; *B* = unstandardised regression coefficient; CI= confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standardised error of the coefficient; β = standardised coefficient; *R2* = coefficient of determination; ΔR^2 = adjust R^2

*p <.05 **p<.01 ***p<.001

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