Facial Occlusion with Medical Masks: Impacts on Emotion Recognition Rates for Emotion Types and Intensities

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Facial Occlusion with Medical Masks: Impacts on Emotion Recognition Rates for Emotion Types and Intensities

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Abstract

During the COVID-19 pandemic, mask-wearing became prominent or required worldwide as a predominant preventative strategy up until and even after vaccines became widely available. Because masks make emotion recognition more challenging for both the face and voice, medical and behavioral/mental health providers became aware of the disruptions this generated in practitioner-patient relationships. The current set of studies utilized two adult samples, first from United States college students (*N* = 516) and second from the U.S. American general public (*N* = 115), to document the severity and types of errors in facial expression recognition that were exacerbated by medical mask occlusion. Using a within-subjects experimental design and a well-validated test of emotion recognition that incorporated multi-ethnic adult facial stimuli, both studies found that happy, sad, and angry faces were significantly more difficult to interpret with masks than without, with lesser effects for fear. Both high- and low-intensity emotions were more difficult to interpret with masks, with a greater relative change for high-intensity emotions. The implications of these findings for medical and behavioral/mental health practitioners are briefly described, with emphasis on strategies that can be taken to mitigate the impact in healthcare settings.

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Occlusion of Emotion with Medical Masks:
Impacts on Facial Recognition Rates by Emotion Type and Intensity

While John Hopkins University Coronavirus Resource Center (2023) tracked the first three years of the Coronavirus Disease 2019 (COVID-19) worldwide pandemic, over 276 million COVID-19 cases claimed nearly 7 million victims. Face masks emerged as a crucial protection tool, but their widespread use presented complexities. Face masks interfere with the ability to accurately interpret others' emotions (Rinck et al., 2022; Williams et al., 2023), which became a concern for healthcare workers. Interpreting emotions is a foundational aspect of human contact and communication, supporting successful social interactions and relationship development (Izard, 2009; Lane & Smith, 2021; Ventura et al., 2022). In healthcare professions, emotion recognition informs crucial decisions during patient interactions, fosters empathy that benefits client progress (Fuller et al., 2021; Moudatsou et al., 2020), and is vital for practitioner-patient relationships (Kozlowski et al., 2017; Weilenmann et al., 2018), which has direct implications for patient care. Mask-wearing disrupts interpersonal engagement in care-focused professions. For example, masking made it harder for medical students to correctly identify facial emotions (Bani et al., 2021, 2023). Thus, the current study sought to shed light on just how much more difficult medical masks make emotional interpretations, focusing on the kind and intensity of emotions that masks disrupt in two distinct U.S. American samples (college students and other adults). Our work offers valuable interdisciplinary insights for improving patient care and therapeutic outcomes.

COVID-19 and Facial Masking

Masks have been used in historical medical contexts for epidemics like the 17th Century Black Plague, 1918 Spanish Flu, and recent COVID-19 pandemic (Matuschek et al., 2020). Those in the medical profession during COVID-19 tended to rely on surgical-grade masks and

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surgical respirators, while the general populace more commonly used fabric or cloth face masks (Gurbaxani et al., 2022). During COVID-19, public masking was a relatively new concept in many geographical locations, most notably in the Western hemisphere. Due to government mandates, United States citizens were suddenly required to wear masks. However, many U.S. Americans protested them due to the rapid politicization of mask-wearing (Kahane, 2021; Kemmelmeier & Jami, 2021; Wickline et al., 2022). Masks were seen by many as a symbol of political liberalism and government oppression, also adding practical inconveniences that disrupted communication (Mheidly et al., 2020; Taylor & Asmundson, 2021). Masks muffle verbal language and occlude most of the face, prohibiting sending and receiving of nonverbal information including emotions from everything but the eye region (Ross & George, 2022).

Facial Occlusion Research

Facial occlusion research, where facial features are blocked by any object on the face (Akhtar & Rattani, 2017; Su et al., 2015), has established definitively that emotion recognition impairments happen when facial elements are hidden (e.g., Yang et al., 2018; Zeng et al., 2021). Numerous research approaches have utilized occluded faces. Real-world occlusion utilizes items placed physically on the face while the person is photographed such as–but not limited to–hands, hats, scarves, sunglasses, reading glasses, full or partial masks, and head scarves (Fitousi et al., 2021; Zhang et al., 2018). Ambient occlusion involves gradients, lighting, and shadows within an image (simulated or real-world) to partially block facial features (Zeng et al., 2021). Lastly, simulated occlusion superimposes upon an image after it is taken through image editing software (Poux et al., 2022), including blocks, bubbles, or objects like masks (Bani et al., 2021, 2023). When faces are occluded, emotion recognition is more difficult (Cuzzocrea et al., 2023; Gori et

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al., 2021; Grahlow et al., 2022; McCrackin et al., 2023; Rinck et al., 2022), except when the body posture is also visible as a secondary cue (Ross & George, 2022).

The Importance of Emotion Recognition

Emotions are a state of short-term, intense affect in reaction to a stimulus (Radvansky & Ashcraft, 2014). Being able to recognize emotional information from facial features has arguably always been crucial for humans, with written description about it dating back to ancient China (Song, 2021). Physiological, neurological, and cognitive theories of emotion exist (Cherry, 2010). Most of these theories concur that a set of basic emotions is shared by humans and other animal species for evolutionary advantage (Darwin, 1872; Plutchik, 1980). Emotions are important for developing and managing interpersonal relationships (Ekman, 1992). These expressions appear to be hardwired so as to be interpreted quickly and accurately, facilitating rapid and effective communication within social groups (Schmidt & Cohn, 2001).

Basic emotions are marked by their brevity, intensity, and targeted response to stimuli. Although some emotion researchers define emotion by dimensional approaches rather than type, basic emotion theorists consider them separate and distinguishable, serving as building blocks for complex emotions (Dalgleish & Power, 2000). Among basic emotion theorists, consensus largely exists whereby happiness, sadness, anger, and fear are at least somewhat universal, recognizable at above-chance levels (Ekman, 1992; Gu et al., 2019). Each of these basic emotions serves a distinct adaptive function (Scherer & Ekman, 2014). Happiness signals cooperation and social bonding, strengthening group cohesion and attracting potential mates. Sadness elicits care and support, fostering prosocial behavior. Anger serves as a warning against threats, protecting individuals and groups from harm while asserting dominance. Fear signals

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immediate danger, triggering the fight-or-flight response for self-preservation. To facilitate rapid communication, each emotion evolved with its own distinct facial expression.

Facial Occlusion and Emotions

Human brains have evolved specialized neural pathways for processing full faces and their subtle cues (Tsao & Livingstone, 2008). Face masks restrict access to facial features like the mouth and nose, which are crucial for accurate emotion recognition, particularly subtle expressions (Ekman, 1973). Masking hinders interpretation of facial expressions, forcing people to rely on less reliable cues and potentially activating alternative, less efficient processing mechanisms. This can lead to increased cognitive load and processing demand, making it more difficult to interpret the remaining cues, which rely on subtle changes in facial features.

Recognition of various emotion types is influenced differently by occlusion. This effect is predicted by two theories: holistic processing theory and feature-based processing theory. *Feature-based processing theory* posits that people identify emotions by analyzing individual facial features like the eyes and mouth (Pandurangan, 2023). Masks directly interfere with this process, occluding key cues like mouth curvature (Grahlow et al., 2022; Schyns et al., 2002; Zeng et al., 2021). This aligns with evidence from occlusion studies that emphasize the critical role of these specific features for accurate recognition (Ventura et al., 2022). *Holistic processing theory* contends that people recognize emotions by analyzing the entire facial configuration, including the spatial relationships between features (McKone et al., 2009). Masking disrupts this gestalt, preventing the seamless integration of facial elements as demonstrated by the composite face effect (Maurer et al., 2002), where feature recognition becomes difficult when face halves are swapped. Similarly, Richler and Gauthier (2014) suggest individual features are automatically integrated into the overall gestalt, impacting how people process each element.

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This aligns with the idea that configural processing is crucial for emotion recognition (Zafaruddin & Fadewar, 2014), even though advantages of local processing have also been observed (Martin et al., 2012). Concealing facial parts as by masking hinders this integration, leading to decreased accuracy (Ventura et al., 2022). Taken together, both theories predict significant challenges in emotion recognition when key facial features are obscured.

With facial expressions of basic emotions like happiness, sadness, anger, and fear, the impact of occlusion varies (e.g., Carbon, 2020; Grahlow et al., 2022). Happiness, typically considered one of the more easily recognizable emotions (Palermo & Coltheart, 2004), is often conveyed through a smile, the appearance of crinkles around the eyes, and raised cheeks (Ekman, 1992). Sadness is portrayed by a downturned mouth, raised inner eyebrows, and lowered eyelids (Ekman, 2004; Ekman et al., 2013). Anger is conveyed through furrowed brows, narrowed eyes, a tightly closed mouth, and tension in the facial muscles and jaw (Ekman et al., 2013). Lastly, fear is often expressed through wide-open eyes, raised eyebrows, an open mouth, flaring nostrils, and paler skin (Cannon, 1915; Dalgleish & Power, 2000; Ekman et al., 1990; Ekman et al., 2013; Kohler et al., 2004). The interpretation of happiness, sadness, and anger all become more challenging in the presence of facial occlusion as these emotions rely heavily on features often obscured by masks (Carbon, 2020; Grahlow et al., 2022; Kotsia et al., 2008).

In contrast, fear presents a captivating case, where the effects of masking are less consistent. Most (but not all) studies showing non-significant differences in fear when facial occlusion is introduced (Bani et al. 2021, 2023; Carbon, 2020; Carbon & Serrano, 2021; Carbon et al., 2022; Parada-Fernández et al., 2022). Evolutionary theory insinuates that fear elicits urgent signals of immediate danger, triggering attempts toward self-preservation (Darwin, 1859), potentially reinforcing reliance on the eyes even when the lower face is obscured. While the wide

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eyes and raised brows remain visible despite masks, some argue that the subtle nuances around the mouth and nose play a critical role in interpreting fear (Cannon, 1915; Ekman et al., 2013), which occlusion may compromise. Interestingly, eyes as the crucial fear cue remain unobstructed by masks, suggesting potentially less impact on recognition compared to other emotions.

In summary, within the occlusion literature on facial emotion recognition, fear tends to be the most easily recognizable emotion with occluded faces, followed by happiness. In contrast, sadness and anger present more varied findings regarding which of the two emotions is the most challenging to identify in masked conditions (Carbon & Serrano, 2021; Grahlow et al., 2022; Palermo & Coltheart, 2004).

Facial Occlusion and Intensity

While masking hinders general emotion recognition, its impact by emotional intensity poses a unique challenge. Crucial regions like the mouth and nose–vital for deciphering subtle intensity cues–are often obscured (Wong & Estudillo, 2022). This occlusion impedes differentiation between high and low-intensity expressions, creating ambiguity (e.g., Does a furrowed brow mean mild concern or intense anger?). Moreover, masking increases cognitive load, leading to attempts to compensate for missing information (Lee et al., 2022). This mental strain can further reduce the ability to perceive subtle intensity variations. Evolutionarily, high-intensity emotions like fear or anger signal immediate threats or opportunities, demanding rapid and accurate interpretation (Adolphs, 2013). However, masking's heightened cognitive load directly conflicts with this pressure for fast but accurate responses.

Although the impacts of facial occlusion on emotion type are becoming widely studied, the impacts of facial occlusion on the interpretation of emotion by intensity have only been studied in limited instances. Gori et al. (2021) noted with both adult and young child participants

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that no interaction existed between masking and intensity for facial emotion error rates. However, Bani et al. (2021, 2023) found two main effects and an interaction for masking and intensity: Facial interpretation errors were always higher for low-intensity images than high-intensity images and errors for masked faces were always higher than unmasked faces, but masking increased the rate of errors in the masked condition more steeply than the unmasked condition. Given the contradictory findings across these studies, further research is warranted.

Facial Occlusion of Emotion Recognition: Impacts on Health and Healthcare

Emotional connection is a human necessity, which face masks disrupted during COVID-19 (Martino et al., 2017). Masks and other forms of personal protective equipment (PPE) worn during COVID-19 disrupt the emotional connection needed for patient-professional alliance in multiple healthcare fields, which is especially important to mitigate the pandemic's physical and psychological effects (Banerjee et al., 2022; Ventura et al., 2022). The interferences were felt in health professional and mental health fields and in the emotional and behavioral health of the general public. Healthcare professionals were the most affected by the negative impact of PPE, which included not only masks but face shields and sometimes goggles (Samarasekara, 2021). When PPE was worn by professionals, communication with patients was less efficient, effective, and equitable (Marler & Ditton, 2020). Healthcare professionals attempted to combat disconnect in the patient-clinician relationship by using technology and providing assistance via mail or virtual appointments, but it was still problematic (Bender et al., 2021).

Not only has masking disrupted doctor-patient relationship in healthcare fields, but in the mental and behavioral health fields, therapeutic alliance seemed to suffer due to masking during COVID-19 (Mehta et al., 2020). Masking made verbal and nonverbal communication more

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difficult, which impacted the strength of therapeutic relationships, including specific elements of the alliance such as therapeutic collaboration (Ribeiro et al., 2021).

In addition to feeling the effects on communication with their health and mental health professionals, the effect of masking was felt in the general population. Masking impacted emotional and behavioral health, which led to an overall decline in well-being in the general public (Vindegaard & Benros, 2020). Moreover, people's daily emotional well-being also suffered as they spent more time inside but socially distanced (Lades et al., 2020).

The Current Studies

Although myriad paradigms have shown how occluded faces provoke emotion interpretation difficulties, a select but growing number of studies have investigated emotion recognition accuracy rates with medical masks worn commonly during COVID-19. Only three studies have used a well-validated, standardized emotion recognition measure that included emotion intensity as well as type (Bani et al., 2021, 2023; Gori et al., 2021). None of these studies has utilized a within-subjects design, which controls for unsystematic variability. Moreover, many if not most of psychology research studies are conducted with college students in departmental research pools. Our first study utilizes these participants as well, but a second sample from Amazon Mechanical Turk (Mturk) is more demographically diverse, aiding the generalizability and robustness of the findings.

The inherent advantages of a two-study design encompass heightened confidence in research outcomes, a diminished susceptibility to unsystematic variability, and an enriched comprehension of the targeted phenomenon. The replication of findings across two studies instills a heightened level of confidence in the validity of the results, contributing to the overall robustness of the study. Importantly, the two-study approach significantly curtails the risk of

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errors, such as measurement inaccuracies or biases, which may otherwise manifest in a single-study paradigm. Employing dissimilar samples in each study contributes to a more exhaustive and resilient assessment of the phenomenon under scrutiny. Beyond a mere replication exercise, this dual-study design facilitates a comparative analysis. This deeper exploration not only informs more refined interpretations of the findings but also unveils potential moderators or boundary conditions that may influence the observed phenomenon.

Given past research, we predicted that participants would have greater overall difficulty reading emotion in the masked (versus unmasked) condition. Second, we predicted that participants would be less accurate identifying happy, sad, and angry faces in the masked condition (versus unmasked), with a less clear prediction for fear. Finally, we expected that participants would have a more difficult time with all intensities of expressions in the masked (versus unmasked) condition, with a higher relative increase for masked high-intensity emotions.

Study 1 (College Sample) Method

Participants

The university undergraduate research pool provided a convenience (self-selected) sample of college students from three campuses of a large, public institution in the Southeast United States, compensated with a course-based research credits. Participants under 18 and those currently in a course with the first author were excluded from participation. Data were collected during the height of the COVID-19 pandemic (September 2020 - September 2021) when masks were highly encouraged or required in the community and on campus. Of the 588 participants enrolled in the study, 516 participants were included in the final analyses (for more information, please see Data Diagnostics below).

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Participants had an average age of 19.69 years (*SD* = 3.71). They primarily identified as cisgender female (*N* = 358, 69.5%), followed by male cisgender (*N* = 142, 27.5%), gender non-binary (*N* = 8, 1.6%), with 7 participants (1.4%) self-describing or choosing not to respond. Regarding ethnicity, 10 (1.9%) identified as Asian/Asian American. 14 (2.7%) as biracial, 131 (25.4%) as Black/African American, 23 (4.5%) as Hispanic/Latin(x), 321 (62.2%) as White/European American, and 16 (3.1%) self-describing or choosing not to identify. Sexual orientation was an open-ended response question where 417 (80.8%) identified as Straight/Heterosexual, 11 (2.1%) identified as Gay/Lesbian, 66 (12.8%) identified as Bisexual/Pansexual/Demisexual/Omnisexual, and 22 (4.3%) identified with a self-description or opted not to respond. Self-reported annual household income ranged from $0 to $1,000,000 USD (*M* = $103,672.78, *Mdn* = $80,000 USD).

Sample Size, Power, and Precision

The intended sample size was 600; the achieved sample was 588. A priori power analyses determined that 204 participants would be needed for a 2 X 4 MANOVA to attain a large effect size ($\eta^2 = 0.14$). For the 2 X 2 MANOVA to attain a large effect size ($\eta^2 = 0.14$), the required number of participants was 228. Thus, even if the sample were to need refinement, it was more than sufficient to determine the effect size expected.

Measures

Diagnostic Analysis of Nonverbal Accuracy, Adult Faces 2 (DANVA2-AF)

Nowicki and Carton's (1993) DANVA2-AF served as the primary outcome measure. Widely used and well-validated, the DANVA2-AF—which includes individuals from a variety of U.S. ethnic groups—has shown acceptable test-retest reliability, construct validity, criterion-related validity, and convergent and discriminative validity with data from over 600 studies

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(Nowicki, 2015)[1]. The 24-item DANVA2-AF test incorporates six static photos of non-actors in each of four emotion types (happy, sad, angry, fearful), which are divided evenly by two levels of intensity (high and low). Using a forced-choice format, participants select the best emotion label for each head-and-shoulders color photograph after viewing the digital image for two seconds. Although the most traditional method of scoring the DANVA2-AF is the error rate (number of items missed in each of the respective categories), we used the actual hit rate (number of items correct) or, in the case of emotion type analyses, unbiased hit rate (H_u). In addition to the original DANVA2-AF faces photographs, we utilized digitally modified photographs which were superimposed with a standard, blue, disposable medical mask (Bani et al., 2021, 2023).

Mask Attitude Survey for COVID-19 (MASC; BLINDED, 2021)

The first author (BLINDED, 2021) created a 24-item measure of attitudes toward mask-wearing during the COVID-19 pandemic (see the online Supplementary Material) after a review of websites and popular press articles summarizing reasons why people do or do not wear masks. After one item ("Wearing a face mask is really uncomfortable") was removed because of a pattern of low inter-item correlations, Cronbach's reliability analysis indicated that the remaining 23 items (11 positively worded; 12 negatively worded, reverse scored) demonstrated strong internal consistency (α = .96). A higher score indicated more positive attitudes toward wearing masks.

Demographic Information

To help describe the sample, we gathered a battery of sociodemographic information items. This included gender, age, ethnicity, year in school, income, and sexual orientation.

[1]Sample images are not shared to protect test integrity. However, the stimuli are free for use in research and clinical practice and can be accessed by emailing the first author.

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Procedure

After receiving Institutional Review Board (IRB) approval, participants provided informed consent and completed the study online via Qualtrics, a secure survey platform. Utilizing an experimental, within-subjects design, we randomly assigned participants to one of two conditions, counterbalanced for whether participants saw the masked (n = 244) or unmasked (n = 268) photographs first; participants were not aware of the other research condition. As originally designed by the DANVA2-AF authors, and because stimuli exposure time can affect accuracy (e.g., Derntl et al., 2009), each photograph was shown for a 2-second duration before participants indicated the emotion type. Then, participants completed the mask attitude and demographic information before receiving the study debriefing information.

Design and Planned Analytic Strategies

The 24 DANVA2-AF facial stimuli include 12 high-intensity and 12 low-intensity emotions, with 6 emotion stimuli for each emotion type (happy, sad, angry, fearful). Each participant saw these emotions masked and unmasked, for a total of 48 stimuli viewed per participant. Hypothesis 1 utilized a dependent samples t-test to determine the mean hit rate (accuracy) made by participants in the masked and unmasked conditions. Hypothesis 2 utilized a 2 (masked, unmasked) X 4 (happy, sad, angry, fearful) repeated measures MANOVA, with post-hoc analyses utilizing a Bonferroni correction to avoid Type 1 error. Hypothesis 3 utilized a 2 (masked, unmasked) X 2 (high intensity, low intensity) repeated measures MANOVA, also with post-hoc testing (Bonferroni correction).

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Study 1 Results

Sample Refinement to Increase Validity

The total number of participants enrolled in Study 1 was 588, with the final analysis size being 516. First, 45 outliers of 3+ *SDs* ($Z = 3$ or $Z = -3$) for the amount of time taken to complete the study were removed, resulting in 543 cases. Second, 27 cases were deleted due to outliers of 3+ *SDs* on their Z scores for emotion intensity and emotion recognition scores, resulting in the final sample of 516 participants. No data transformations were performed.

Facial Recognition Accuracy Rate by Masking Condition

The first prediction that participants would have a more difficult time identifying emotion in the masked versus unmasked condition was supported: Participants in the masked condition ($M = 14.37$, $SD = 2.59$) were less accurate reading emotions in facial stimuli than when they were in the unmasked condition ($M = 18.71$, $SD = 2.20$) with a large effect, $t\ (515) = 36.18$, $p < .001$, $d = 1.59$.

Facial Recognition Accuracy Rate by Emotion Type

To reduce the influence of response bias and account for base rate probability, analyses for emotion type utilized a more conservative estimate known as the unbiased hit rate (H_U). The H_U is "…the joint probability that a stimulus category is correctly identified given that it is presented at all and that a response is correctly used given that it is used at all" (Wagner, 1993, p. 3). Based on a confusion matrix of responses, the H_U was arcsine transformed to convert the H_U from a proportion for each emotion before using it as a dependent variable.

Utilizing a 4 (emotion type) x 2 (masked versus unmasked) repeated measures MANOVA ($\alpha = .05/8 = .00625$, Bonferroni correction), the second prediction that participants

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would have a more difficult time identifying specific emotion in the masked versus unmasked condition was supported: Utilizing multivariate analyses, a main effect of masking existed, $F(1, 515) = 839.38$, $p < .001$, $\eta_p^2 = .62$, such that unmasked faces ($M = 1.64$, $SE = .02$) had a higher accuracy rate than unmasked faces ($M = 1.01$, $SE = .02$). Please see Figure 1[2]. There was also a main effect of emotion type, $F(3, 513) = 156.67$, $p < .001$, $\eta_p^2 = .48$, where happy ($M = 1.67$, $SE = .03$) and fear ($M = 1.45$, $SE = .03$), which did not differ from each other, had a higher hit rate than sad ($M = 1.24$, $SE = .03$), which had a higher hit rate than anger ($M = 0.95$, $SE = .03$). However, there was also a significant emotion x mask interaction, $F(3, 513) = 130.57$, $p < .001$, $\eta_p^2 = .43$. All emotions became significantly harder to read with masks on, with the relative level of difficulty change being least pronounced for fear, when compared to anger**,** sadness, or happiness**.** When comparing the masked and unmasked conditions, happiness showed the greatest relative increase in difficulty. Further, in terms of overall emotion recognition pattern, in the unmasked condition, happy was easier to read than all other emotions, and anger was the most difficult to identify, with fear and sadness being fairly similar in their hit rates. However, in the masked condition, fear was easiest to identify, anger remained the most difficult, but happiness and sadness showed similar accuracy rates.

Facial Recognition Accuracy Rate by Intensity

Utilizing a 2 (emotion intensity) X 2 (masked versus unmasked) repeated measures ANOVA ($\alpha = .05/4 = .0125$, Bonferroni correction), the hypothesis was supported that participants would have a more difficult time reading emotions of different intensity in the

[2] A 2 x 4 MANCOVA, controlling for order of facial stimuli (masked or unmasked first), indicated a significant 3-way interaction, $F(3, 508) = 19.23$, $p < .001$, $\eta_p^2 = .10$. However, the pattern of responses was, overall, very similar to the MANOVA. On the masked faces, happiness hit rate tended to increase slightly and anger hit rate decreased slightly if the unmasked faces were viewed first.

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masked condition (relative to unmasked). As shown in Figure 2[3], a significant main effect existed for both masking condition, $F(1, 515) = 1138.64$, $p < .001$, $\eta_p^2 = .69$, and intensity level, $F(1, 515) = 909.77$, $p < .001$, $\eta_p^2 = .64$, with a significant interaction, $F(1, 515) = 110.36$, $p < .001$, $\eta_p^2 = .18$. High-intensity faces ($M = 9.40$, $SE = .05$) always resulted in higher accuracy than low-intensity ($M = 7.42$, $SE = .06$), and unmasked faces ($M = 9.28$, $SE = 0.5$) always resulted in higher accuracy than masked faces ($M = 7.45$, $SE = 0.06$). Accuracy rate for high-intensity faces in the unmasked condition was the highest ($M = 10.66$, $SD = 1.13$), followed by high-intensity faces in the masked condition ($M = 8.15$, $SD = 1.69$), low-intensity faces in the unmasked condition ($M = 8.09$, $SD = 1.63$), with low-intensity faces in the masked condition being the lowest (M = 6.74, SD = 1.65).

Exploratory Analysis

To investigate whether people's attitudes toward wearing masks predicted their facial recognition accuracy, we ran several Spearman correlations given slight negative skew in the mask attitudes scale. A small, significant positive relationship existed between mask attitudes ($M = 3.41$, $SD = 0.92$) and overall unmasked facial interpretation accuracy rate ($M = 18.71$, $SD = 2.20$), $r_s(508) = .11$, $p = .01$, but not masked facial interpretation accuracy ($M = 14.37$, $SD = 2.59$), $r_s(508) = .05$, $p = .24$.

Study 1 Discussion

All three hypotheses were supported by the data. The current results suggest that masks hinder facial emotion recognition by obscuring important visual components in the lower face. First, participants had greater overall difficulty reading emotion in the masked versus unmasked

[3] A 2 x 2 MANCOVA, controlling for order of facial stimuli (masked or unmasked first), indicated a significant 3-way interaction, $F(1, 510) = 22.82$, $p < .001$, $\eta_p^2 = .04$. However, the pattern of responses was, overall, very similar to the MANOVA.

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condition. Second, participants had a more difficult time identifying happy, sad, angry, and fear in the masked condition (relative to the unmasked), with relatively less change for fear compared to the other emotions. The sample for Study 1, however, was predominantly young, White, and middle-income, with all participants having at least some college education. It is possible that results could differ from a sample that is more demographically diverse. The generalizability of the current findings is limited, which is mitigated by using a two-study design.

Study 2 (Amazon MTurk) Method

Participants

Study 2 consisted of a direct replication of study one, with identical hypotheses and theoretical supports. The convenience sample of 120 Master Workers (vetted for their diligence and high performance) was recruited through Amazon's Mechanical Turk (MTurk) and paid $3.50 for their participation. Data were collected during the COVID-19 pandemic (May 2021) when masks were highly encouraged or required in the United States. Five participants were removed because they were outliers (>3 standard deviations) on the total time spent on the study, resulting in a final sample of 115 participants.

The mean age of participants was 46.33 (*SD* = 11.15), ranging from 27 to 77. Participants identified roughly equally as cisgender female (*N* = 56, 48.7%) and cisgender male (*N* = 59, 51.3%). As for ethnicity identification, 3 (2.6%) identified as Asian/Asian American, 2 (1.7%) as biracial, 5 (4.3%) as Black/African American, 2 (1.7%) as Hispanic/Latin(x), 102 (88.7%) as White/European American, and 1 chose not to identify. Sexual orientation was an open-ended response question where 104 (90.4%) identified as Straight/Heterosexual, 3 (2.6%) identified as Gay/Lesbian, 5 (4.3%) identified as Bisexual, and 2 (1.7%) opted not to respond. Self-reported

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annual familial income ranged from $5,000 to $1,245,000 USD (*M* = $64,184.65, *Mdn* = $60,000 USD).

Measures and Procedure

The same items were used for Study 2, and the mask attitude survey had very strong internal consistency ($\alpha = .98$). The demographics questionnaire was largely identical, except removing college-related demographics questions. Again utilizing an experimental, within-subjects design, we randomly assigned participants to one of two conditions on Qualtrics, counterbalanced for whether participants saw the masked ($n = 52$) or unmasked ($n = 63$) photographs first, both of which were shown before the demographic items and debriefing.

Study 2 Results

Facial Recognition Accuracy Rate by Masking Condition

The first prediction that participants would have a more difficult time identifying emotion in the masked versus unmasked condition was supported: Participants in the masked condition ($M = 15.87$, $SD = 2.58$) were less accurate reading emotions in facial stimuli than when they were in the unmasked condition ($M = 20.30$, $SD = 1.98$) with a large effect, $t\,(114) = 18.59$, $p < .001$, $d = 1.73$.

Facial Recognition Accuracy Rate by Emotion Type

Utilizing a 4 (emotion type) x 2 (masked versus unmasked) repeated measures MANOVA ($\alpha = .05/8 = .00625$, Bonferroni correction), the second prediction that participants would have a more difficult time identifying specific emotion in the masked versus unmasked condition was supported. Please see Figure 3[4]. Using multivariate analyses, a main effect of

[4] A 2 x 4 MANCOVA, controlling for order of facial stimuli (masked or unmasked first), indicated a significant 3-way interaction, $F(3, 111) = 7.96$, $p < .001$, $\eta_p^2 = .18$. However, the pattern of responses was still similar to the MANOVA.

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masking existed, $F(1, 114) = 260.35$, $p < .001$, $\eta_p^2 = .70$, such that unmasked faces ($M = 2.01$, $SE = .04$) had a higher accuracy rate than masked faces ($M = 1.23$, $SE = .04$). There was also a main effect of emotion type, $F(3, 112) = 10.60$, $p < .001$, $\eta_p^2 = .22$, where happy ($M = 1.85$, $SE = .06$), fear ($M = 1.67$, $SE = .07$), and sad ($M = 1.63$, $SE = .07$), which did not differ significantly from each other, all had higher hit rates than anger ($M = 1.35$, $SE = .07$). However, there was also a significant interaction, $F(3, 112) = 45.28$, $p < .001$, $\eta_p^2 = .55$. Happy, sad, and angry became significantly harder to read with masks on, but there was no significant difference for fear**.** When comparing the masked and unmasked conditions, happiness showed the greatest relative increase in difficulty. Further, in terms of overall emotion recognition pattern, in the unmasked condition, happy was easier to read than all other emotions, with anger and fear being most difficult, and sadness being in between. However, in the masked condition, fear was easiest to identify, anger remained the most difficult, but happiness and sadness showed similar hit rates.

Facial Recognition Accuracy Rate by Intensity

Utilizing a 2 (emotion intensity) X 2 (masked versus unmasked) repeated measures ANOVA ($\alpha = .05/4 = .0125$, Bonferroni correction), the hypothesis was supported that participants would have a more difficult time reading emotions of different intensity in the masked condition (relative to unmasked). As shown in Figure 4[5], a significant main effect existed for both masking condition, $F(1, 114) = 317.89$, $p < .001$, $\eta_p^2 = .74$, and intensity level, $F(1, 114) = 166.14$, $p < .001$, $\eta_p^2 = .59$, without a significant interaction, $F(1, 114) = 1.63$, $p = .21$, $\eta_p^2 = .01$. High-intensity faces ($M = 10.05$, $SE = 0.10$) always resulted in greater accuracy

[5] A 2 x 2 MANCOVA, controlling for order of facial stimuli (masked or unmasked first), indicated a significant 3-way interaction, $F(1, 113) = 12.00$, $p < .001$, $\eta_p^2 = .10$. However, the pattern of responses was still similar to the MANOVA.

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than low-intensity (*M* = 8.29, *SE* = 0.12), and masked faces (*M* = 8.17, *SE* = 0.11) always resulted in less accuracy than unmasked faces (*M* = 10.17, *SE* = 0.09).

Exploratory Analysis

To investigate whether people's mask-wearing attitudes predicted their facial recognition accuracy, we ran several Spearman correlations due to significant Komolgorov-Smirnov tests for each variable. A small, significant positive relationship existed between mask attitudes (*M* = 3.53, *SD* = 1.19) and masked facial interpretation accuracy (*M* = 15.87, *SD* = 2.58), $r_s(113) = .25$, $p = .01$) but not unmasked facial interpretation accuracy (*M* = 20.30, *SD* = 1.98), $r_s(113) = .14$, $p = .14$.

Study 2 Discussion

As in Study 1, all three hypotheses were supported by Study 2 results. First, participants had greater overall difficulty reading emotion in the masked versus unmasked condition. Second, participants had a more difficult time identifying happy, sad, and angry in the masked condition (relative to the unmasked), with relatively less change for fear compared to the other emotions. Third, participants had a more difficult time identifying both low- and high-intensity expressions in the masked (versus unmasked) condition.

General Discussion

Across both studies, we have demonstrated that facial occlusion by masking inhibits the interpretation of both high- and low-intensity facial expressions, with a greater relative impact on high-intensity faces. The negative impact of masking is most noticeable for happy faces, with a significant impact for angry and sad faces, and with lessened impact for fearful faces. Largely commensurate with past studies worldwide (e.g., Bani et al., 2021, 2023; Carbon, 2020; Carbon & Serrano, 2021; Carbon et al., 2022; Li et al., 2023; Wong & Estudillo, 2022), the robustness of

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the negative impact of masking on facial emotion interpretation is clear, with generalizable results that demonstrate external validity.

Whether emotional intensity is separated into high or low, as we and others have done, or in three levels (Saxena et al., 2022), emotion intensity seems to influence emotion recognition accuracy rates. We also found that participants had a more difficult time identifying both low- and high-intensity expressions in the masked (versus unmasked) condition, with the relative impairment being greater for high-intensity emotions, which replicates findings by Bani et al. (2021, 2023). Even without masks, emotion recognition accuracy tends to be more difficult with emotions of lower intensity (Hess et al. 1997), a finding that was not replicated in Japan, where emotional expressions tend to be expressed less intensely (Shimizu et al., 2024). The relative greater impairment in facial emotion recognition for high-intensity emotions seems to exist because high-intensity emotions are typically associated with more exaggerated facial expressions in the lower half of the face. Other research has shown that when the mouth and nose are covered, participants tend to perceive emotional expressions as less intense (Tsantani et al., 2022).

Regarding study limitations, we did not assess the impact of different types of masks on facial emotion recognition. For example, it is possible that some types of masks (e.g., surgical) could result in less impairment than others (e.g., cloth). Moreover, static images with superimposed masks do not capture mask movements that could happen from moving the face with the mask on. In future studies, video expressions could remove or address this concern. Additionally, the study was conducted online, and the results could be different in a face-to-face laboratory setting; this study did not consider contextual cues such as environment or body language on emotion recognition. Regarding methodological approach, we did find that the order

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of the stimuli presentation (masked or unmasked first) was a significant covariate, although in all cases, the hit rate pattern did not shift drastically or become non-significant. In the future, we recommend either a distraction task between the two sets of stimuli to reduce possible priming effects, a shift to a between-subjects design, or intermixing the masked and unmasked trials so that each participant either sees an image masked or unmasked but not both. Finally, the limited number of facial stimuli in each emotion type by intensity category (e.g., happy high intensity, *n* = 3) prevented us from looking at statistical interactions between emotion type and intensity. Although there were benefits to using a well-validated and frequently used emotion recognition measure like the DANVA2, a battery including a larger number of emotion stimuli could be helpful in future studies.

We also did not assess the impact of long-term mask use on facial emotion recognition. Barrick et al. (2020) demonstrated that greater mask exposure led people to focus more on the eye region when processing emotion, which has further implications for healthcare professionals such as surgeons and nurses. As such, more research regarding the impact of long-term mask use on facial emotion recognition would be beneficial. Researchers should also consider the long-term impacts of masking on compassion fatigue in populations of health professionals. Finally, the current study did not assess the impact of masks on the recognition of other facial cues, such as identity, cultural differences, and age. Because masks may also impair the recognition of these signals, future research should investigate the impact of masks on the recognition of a wider range of facial cues.

Conclusions and Implications

Given the negative impact that medical masking has on emotion recognition, what practical implications does this work have for behavioral/mental health and medical healthcare

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providers? First, healthcare practitioners' job of taking care of patients becomes significantly more difficult when masks are involved. They should be mindful of just how much emotional information they and their patients/clients are naturally missing out on during masked interactions and thus to be purposeful about seeking out more nonverbal information. If masks result in healthcare providers rating clients' emotions as less intense, and then categorizing their emotions incorrectly, this almost certainly would have impacts on client-clinician or patient-practitioner rapport, which could subsequently affect their diagnosis and treatment, especially in counseling or therapy settings. Facial occlusion also seems to affect older adults' interpretations much more than younger individuals (Shen & Zuo, 2023). Barrick et al.'s (2020) work suggests that with extended mask exposure, people shift their focus more to the eye region for emotional cues. We encourage providers to be intentional about focusing on the eye region while working with clients or patients to make the most of the information provided by this nonverbal channel, even with the more limited cues the eyes alone can provide when the lower face is covered. Moreover, practitioners can focus their attention on other helpful nonverbal channels, like paralanguage (tone of voice), body posture, gestures, chronemics (timing and pausing), proxemics (closeness), clothing, and gaze (eye contact). Seeking or providing additional training in receptive nonverbal emotion processing could likewise help to maximize emotional processing information in healthcare settings.

Second, professionals who really need to see the mouth might consider ways to make the face more visible. Several experimental studies have demonstrated the effectiveness of personal protective equipment (PPE) like clear face shields for limiting bioaerosol exposure (Singh et al., 2021; Wendling et al., 2021). Finally, while telehealth reduces the physical connection and number of proximal cues between patient and practitioner, thus having its own limitations, it also

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provides easier access to care for many clients and patients (Goldin et al., 2020). Moreover, telehealth does not restrict facial emotion cues and might promote more emotional connection and communication between provider and client than would being physically present but masked.

Supplementary Material

The Supplementary Material is available at: qjep.sagepub.com

Data Accessibility Statement

The data from the present experiment are publicly available at the Open Science Framework website: https://osf.io/5xfwb/

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Authors' Notes

We have no conflicts of interest to disclose.

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Figure Captions

Figure 1. Facial Emotion Accuracy Rate by Stimuli Condition (Unmasked or Masked) and Emotion Type

Note. Study 1: 4 (Emotion Type) X 2 (Masking Condition) Repeated Measures MANOVA, college sample.

Figure 2. Facial Emotion Accuracy Rate by Stimuli Condition (Unmasked or Masked) and Intensity

Note. Study 1: 2 (Masking Condition) X 2 (Intensity) Repeated Measures MANOVA, college sample.

Figure 3. Facial Emotion Accuracy Rate by Stimuli Condition (Unmasked or Masked) and Emotion Type

Note. Study 2: 4 (Emotion Type) X 2 (Masking Condition) MANOVA, MTurk sample.

Figure 4. Facial Emotion Accuracy by Stimuli Condition (Unmasked or Masked) and Intensity

Note. Study 2: 2 (Masking Condition) X 2 (Intensity) MANOVA, MTurk sample.

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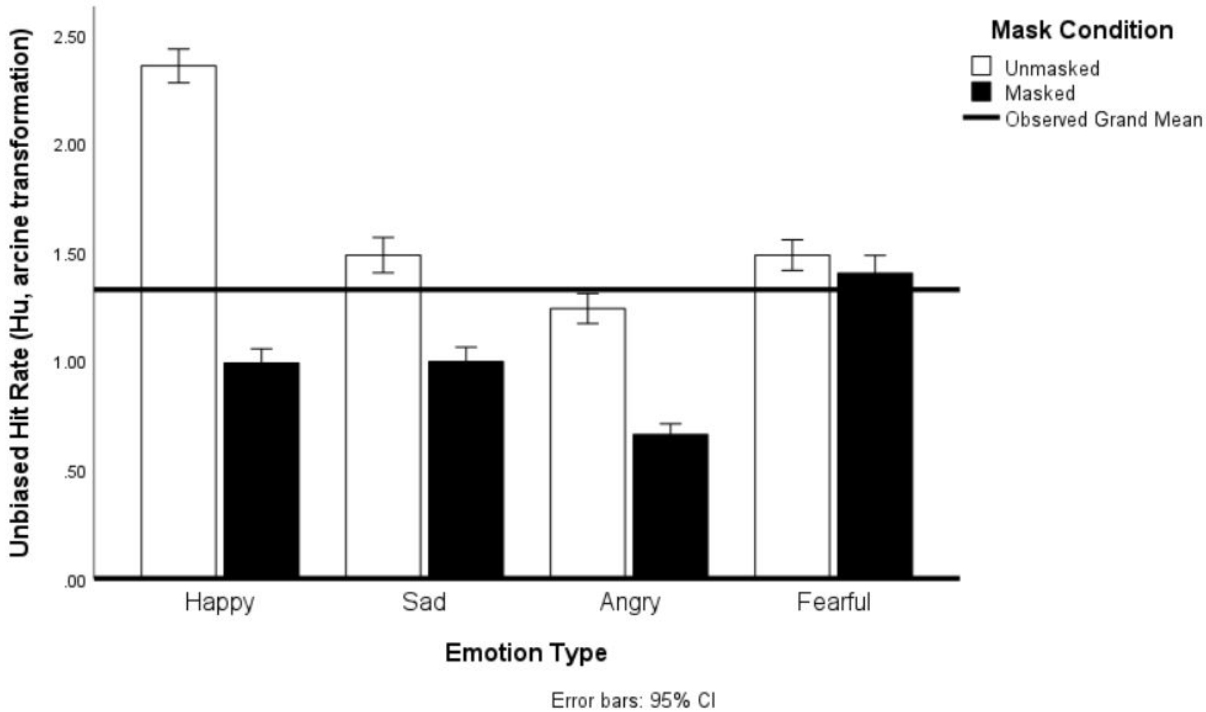
Figure 1

Facial Emotion Accuracy Rate by Stimuli Condition (Unmasked or Masked) and Emotion Type



Note. Study 1: 4 (Emotion Type) X 2 (Masking Condition) Repeated Measures MANOVA, college sample.

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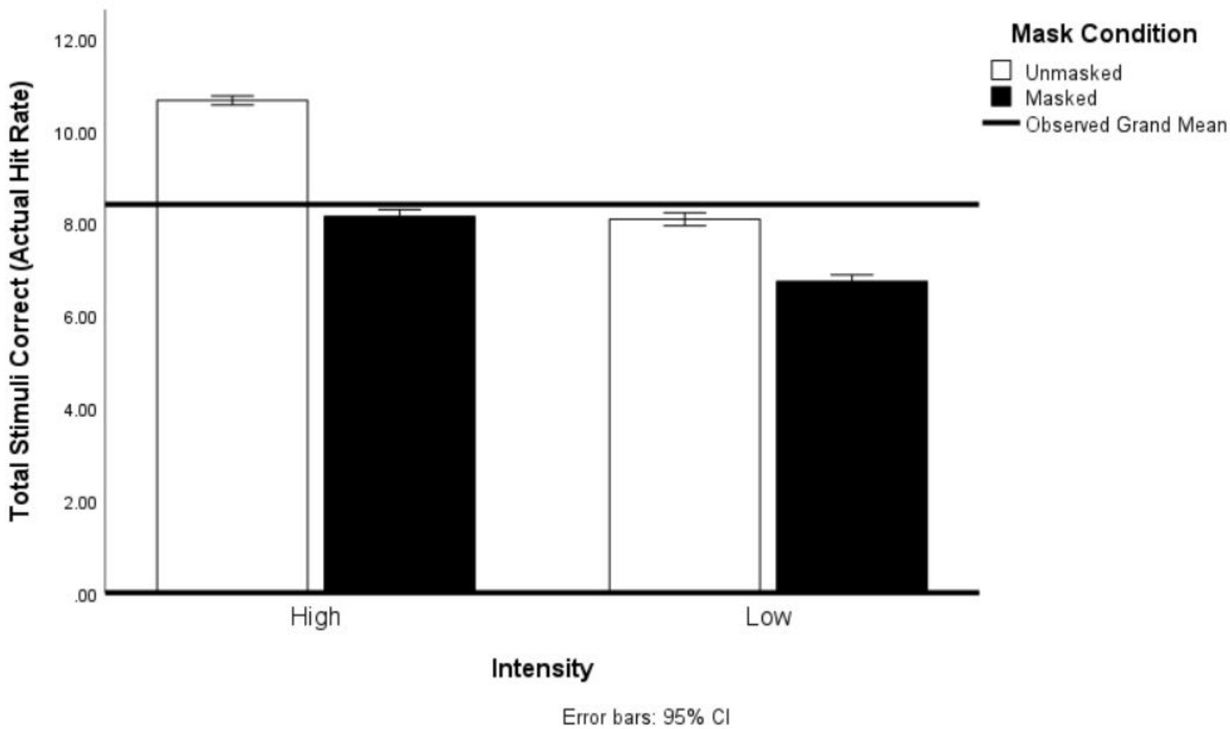
Figure 2

Facial Emotion Accuracy Rate by Stimuli Condition (Unmasked or Masked) and Intensity



Note. Study 1: 2 (Masking Condition) X 2 (Intensity) Repeated Measures MANOVA, college sample.

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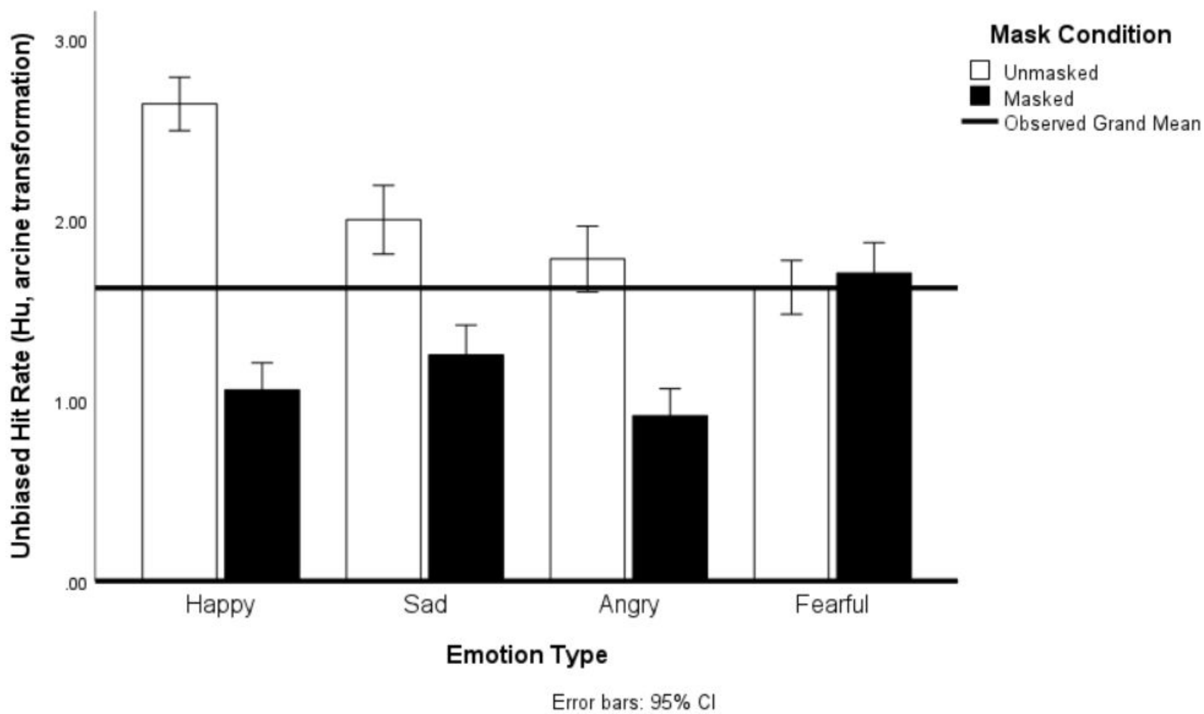
Figure 3

Facial Emotion Accuracy Rate by Stimuli Condition (Unmasked or Masked) and Emotion Type



Note. Study 2: 4 (Emotion Type) X 2 (Masking Condition) MANOVA, MTurk sample.

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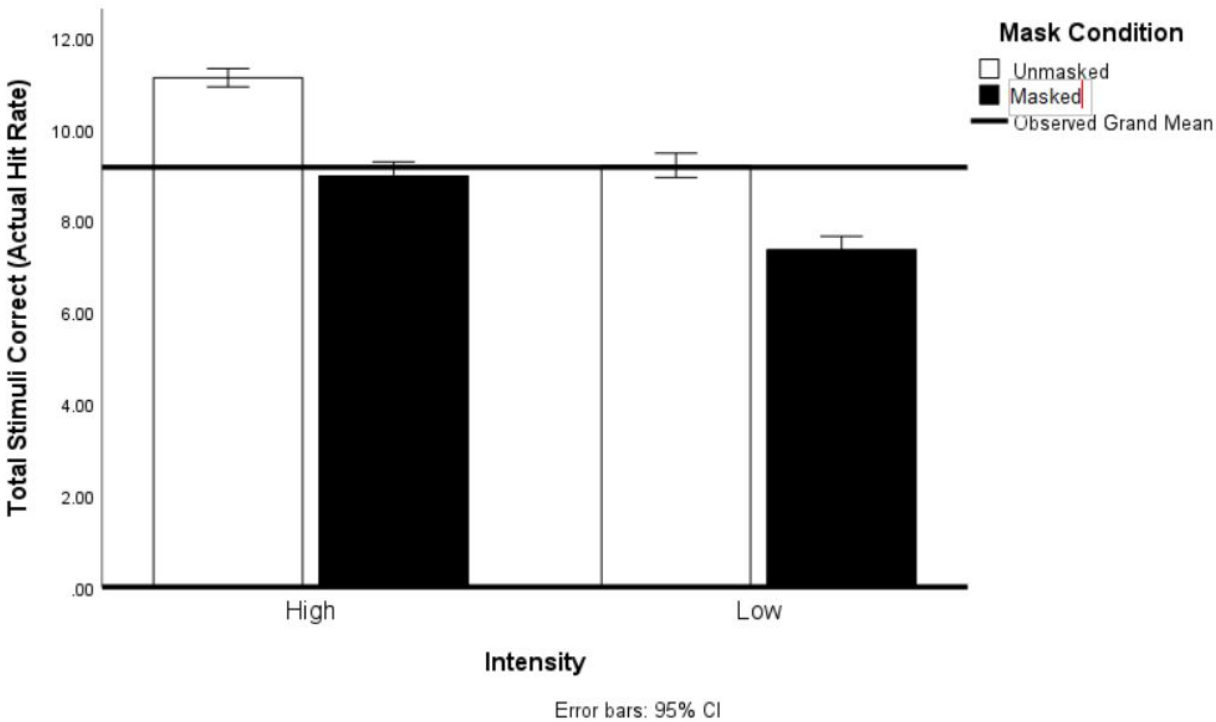
Figure 4

Facial Emotion Accuracy by Stimuli Condition (Unmasked or Masked) and Intensity



Note. Study 2: 2 (Masking Condition) X 2 (Intensity) MANOVA, MTurk sample.

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