Mask-wearing and Facial Emotion Recognition: A Preliminary Analysis of the Relevance of Depressive Symptoms

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Depression is a psychiatric condition that impairs the life of millions of people around the globe. Previous research has shown that depressed individuals tend to present deficits in facial emotion perception. For instance, perception accuracy may be reduced and biases in perceived intensity may be enhanced. Mask-wearing practices initiated in response to the COVID-19 pandemic have become a new social norm often enforced by local mandates. Preliminary studies have shown that mask-wearing may impair facial emotion recognition. In this study, we aimed at understanding how facial emotion recognition impairment interacts with depressive symptoms in a sample of German adolescents and adults (N = 91, 56% female, mean age of 32.7 years) by utilizing a mixed-effects linear regression analysis. We found evidence that mask-wearing may be a limiting factor for facial emotion recognition, as well as for emotion intensity ratings. However, a significant association of depressive symptoms with these outcome variables was not detected. Still, larger sample sizes may have the potential to substantiate a trend toward an interaction of depressive symptoms and mask-wearing for the rating of happy faces. Future research should be committed to psychophysiological processes and to improving the quality of the stimulus material.

Theoretical Background

Depression and Facial Emotion Recognition

In 2017, the WHO issued a report estimating that, globally, over 300 million people suffer from depression, equivalent to 4.4% of the world's population (WHO, 2017). A review from 2014 shows that the average 12-month prevalence estimate of DSM-IV major depressive episodes varies from 5.5% to 5.9% in most countries (Kessler et al., 2014). In the U.S. alone, around 30 million adults have met the criteria for major depressive disorder at least once in their lifetime (Haro et al., 2006). The core symptoms of clinically relevant depression include first and foremost a persistently depressed mood and loss of interest or pleasure in almost all activities (APA, 2013). In addition, there are several other affective, cognitive, somatic, and motivational-behavioral features that play a role in depression, such as sleep disturbances, a sense of guilt, and impaired executive function (Berking & Rief, 2011). The presentation of each symptom can vary greatly in nature and intensity so the overall picture can differ considerably from case to case.

Early theories of depression, such as Beck's (1976) schema and Bower's (1981) network theory, proposed that, in depressive patients, cognitive biases operate throughout information processing, including perception, attention, and memory. Beck (1976) proposes that those with depression develop cognitive distortions and tend to overlook positive attributes of reality and selectively attend to the negative. The associative network theory of emotion and memory, outlined by Bower (1981), suggests that depressed mood leads to biases favoring the perception of mood-congruent information. Both models assume that affected individuals selectively process information related to sadness, loss, and failure. Furthermore, poor interpersonal relationships have been proposed as a critical aspect in both the etiology and maintenance of depression (Finch & Zautra, 1992; Platt et al. 2013). Impaired emotion recognition may contribute to the interpersonal difficulties and avoidance behavior seen in depressed patients (Persad & Polivy, 1993). Since deficits in emotion recognition could contribute to the maintenance of depressive symptoms, investigating the relationship between these two variables has important implications for both existing and the development of novel cognitive-behavioral interventions.

For a long time now, research has shown that people suffering from affective disorders have difficulties correctly interpreting human emotions from the perception of facial expressions. In adults, the facial emotion recognition (FER) impairments have been associated, for example, with bipolar disorder (Derntl et al. 2009) and also very commonly with depression (e.g., Demenescu et al., 2010; Bistricky et al 2011, Rubinow & Post, 1992). However, findings in this area seem to vary strongly based on symptom severity, psychiatric comorbidity, and the nature of stimuli (Bistricky et al., 2011). A meta-analysis conducted by Dalili et al. (2015) using 22 independent samples found significant recognition deficits in depressed participants in all basic emotions except sadness. But the main

feature of facial emotion recognition in depression is not a deficit in the ability to identify emotions per se, it is rather a bias in emotional valence rating. Many studies have reported a negative bias in depressed patients (e.g., Schmid & Schmid Mast, 2010; Milders et al., 2010, Kan et al., 2004), which means the affected populations sometimes perform better in recognizing sad faces, tend to interpret neutral or ambiguous faces as sad more often and label happy faces as less happy.

The literature presents similar evidence for adolescents and younger children. Nyquist & Luebbe, (2020) reviewed 26 studies and identified three trends for FER in youth that were either depressed or qualified as high-risk populations for depression: sensitivity to sadness (higher accuracy in recognizing sadness and biased rating towards sad faces), over-perception of anger (falsely recognizing ambiguous or neutral faces as angry), and under-perception of happiness (lower accuracy in recognizing happiness and biased rating towards happiness). Investigating features of depression in families, Lopez-Duran et al. (2013) observed sensitivity to sadness as a potential mechanism of risk among boys at familial risk for depression. In a similar vein, Kluczniok et al. (2015) found that children from mothers with remitted depression displayed depressive-like emotion recognition bias that correlated with their mothers' performance. As suggested by the literature, emotion recognition bias is a common correlate of depressive symptomatology in all age groups. It is, therefore, essential to investigate how these deficits can impair social functioning and contribute to the pathological behavior of clinically relevant populations.

Masks and Emotion Recognition

Since March of 2020, the COVID-19 pandemic has brought significant changes to the daily lives of everyday citizens. To help stop the spread of the virus, the wearing of a protective face mask, which has been shown to drastically reduce viral transmission (Cheng et al., 2020), has become a largely accepted norm (e.g., Cheng et al., 2020; Hong et al., 2020; Howard et al., 2020). Albeit necessary for keeping the virus under control, masks may have important psychological impacts on social interactions, for example, by muffling speech and other forms of communicative vocalization (Mheidly et al., 2020). Social distancing and mask-wearing can also impair interpersonal communication by limiting physical touch and body language, as well as by hindering visibility of the lower half of the face.

Regarding facial emotional recognition, recent studies have found that mask-wearing can make emotions less well recognized or interpreted (e.g., Carbon, 2020a; Carbon, 2020b), faces less well-remembered, or critically impair holistic processing (Freud et al., 2020). New data, nonetheless, shows that emotions can still be recognized both in adults (e.g., Calbi et al., 2021; Kastendieck, et al., 2021) and in children (e.g., Ruba & Pollak, 2020), even if the intensity of the emotion decreases (Kastendieck et al., 2021).

Studies also show that sad and angry faces cause more fixation on the eyes, while happy faces attract more fixation on the mouth, due to the way different emotions mobilize different facial musculature (Eisenbarth, 2011; Schurgin, 2014) - curiously, psychiatric patients seem to have less fixation overall (Eisenbarth, 2011). These facts may account for findings reporting that when only the upper part of the face is visible, participants perceive and recognize negative emotions, like anger and fear, better than positive ones (Marta et al., 2021; Fischer et al., 2012). In sum, it is possible that mask-wearing does not impair or even relatively increase the perception of negative facial expressions and, at the same time, diminishes the perception of positive ones (Spitzer, 2020). Therefore, it may have significant effects on day-to-day activities that rely on interpersonal communication and social interaction (Freud et al., 2020).

The factors that influence facial emotion recognition in laboratory settings remain unclear when individuals wear masks. The type of stimuli, for instance, is discussed as a possible moderator: so far, mainly adult faces have been used (e.g., Ruba & Pollak, 2020), whereas in real-life interactions children as well as adolescents and adults represent their counterpart. For this reason, emotional child and adult faces will be used in the current study. Moreover, static photos are mostly used (e.g., Carbon, 2020a, Carbon, 2020b; Ruba & Pollak, 2020), whereas closer proximity to reality can be assumed when videos are used (Rymarczyk et al., 2016). For that reason, this study is going to use video stimulus material.

Research Gap and Current Research Purpose

As to this point, we are unaware of any research projects trying to fill the newly created research gap of how mask-wearing interacts with psychopatholo

gy in impairing social function. Considering that the COVID-19 pandemic has introduced a new norm in face-to-face interactions (which now almost always include the wearing of face masks), research on FER must rise to the challenge of understanding how this phenomenon can impact the nature of social exchange, especially for populations that already suffer from social difficulties, like a significant amount of patients diagnosed with mental disorders (Lehmann et al., 2019) – since these people may be particularly challenged by the pandemic (Druss, 2020). This preliminary study was conducted as a part of the *Gesichter lesen*[1] project, an initiative seeking to investigate how mask-wearing differentially impacts social exchange in children, adolescents, and adults. Here, we aim to understand how depressive symptoms interact with the effects of mask-wearing in facial emotion recognition processes in adolescents and adults.

In the future, the *Gesichter lesen* project intends to analyze data from multiple psychopathological variables and attitudes in emotion recognition and facial mimicry in children and adolescents. Considering that children's and early adolescents' development are largely influenced by the social context within which they interact (Richards & Light, 1986), the impact of mask-wearing might be particularly significant for them, notably if they struggle with any form of psychopathology. For this first experiment, we selected a more accessible sample of adults recruited online and decided to focus on a single psychopathology-related construct (depressive symptoms, continuous) and mask-wearing (binary) as independent variables. We aim to examine how the wearing of face masks interacts with the biases in facial emotion reading found to be associated with depressive symptoms in adolescents and adults (see above). The dependent variables of interest are, therefore, emotion recognition and emotion intensity rating.

Hypotheses

The first outcome being examined is emotion recognition. We hypothesize that participants' emotion recognition of anger, sadness, and happiness is negatively affected by the presence of a face mask (H1.1). In addition, recognition of anger, sadness, and happiness are associated with the participant's depressive symp-

toms (H1.2). In line with the presented literature, we expect sadness and anger to be overperceived and happiness to be underperceived by participants with elevated depressive symptoms. Finally, there is an interaction effect between the presence of a face mask and the participant's depressive symptoms in emotion recognition for anger, sadness, and happiness (H1.3).

For the second outcome, emotion intensity rating, we hypothesize that all emotions (anger, sadness, and happiness) are rated as less intense in masked faces than emotions in unmasked faces (H2.1). Additionally, the intensity rating of all perceived emotions (anger, sadness, and happiness) is associated with the participant's depressive symptoms (H2.2). In line with the presented literature, we expect sadness and anger to be rated more intensively and happiness to be rated less intensively by participants with elevated depressive symptoms. Lastly, there is an interaction effect between the presence of a face mask and the participant's depressive symptoms in the rating of emotion intensity for all emotions (anger, sadness, and happiness) (H2.3).

Methods

Sample. Inclusion criteria for the online experiment consisted of currently living in Germany, speaking fluent German, and being at least 14 years old. Recruiting was conducted between January and June 2021 through multiple channels, including Prolific[2], different social media platforms (Facebook and Twitter), and student recruiting resources from the Institute of Psychology at the Humboldt University Berlin, which consist of mailing lists and flyer distribution. Participants received 5 EUR on average for their participation, which is classified as good payment in Prolific. Compensation was carried out either via Prolific, bank deposit, or as test person points for undergraduate credit. A total of 108 participants (adults and adolescents 14 years and over) completed the online experiment and gave their consent via Sosci Survey. After the exclusion of subjects that did not complete psychopathology measures or dropped out before the end of the experiment, the final sample consisted of data from 91 participants (51 women, 56%) with a mean age of 32.7 years (SD = 15.6, range 14-71), who reported having seen the video stimuli and for whom at least one video upload

was successful. We did not collect information on race, ethnicity, income level, or educational attainment.

Material. For the diagnostic material, we selected the PHQ-9 for the recording of depressive symptoms (Patient Health Questionnaire - 9; Richardson et al., 2010). The PHQ-9 is a versatile instrument for screening and measuring the severity of depression using only 9 items. It incorporates diagnostic criteria from the DSM-IV and other important major depressive symptoms into a short self-report tool (Kroenke et al., 2001). This instrument has been shown to have adequate internal consistency (>0.8; Kim & Lee, 2019; Titov et al., 2010), a one-factor replicable structure (Kim & Lee, 2019; Titov et al., 2010), and satisfactory convergent validity (Kim & Lee, 2019; Beard et al., 2016). In this study, the PHQ-9 had a Cronbach's alpha of 0.86. For a different set of analyses not relevant to the present study, the experiment materials also included the Inclusion of Other in the Self scale (IOS, Aron et al., 1992), the GAD-7 (Spitzer et al., 2006), and a short questionnaire on the participant's attitudes towards mask-wearing (An et al, 2021).

As video stimuli, we selected validated child and adult faces from the online Radbound Faces Database (Bijsterbosch et al., 2020), which were presented as videos through a morphing process created using FantaMorph5. Facial expressions ranged from neutral to emotional. Selected examples of the stimuli are presented in Figure 1. A surgical mask was added to half of the stimuli with the help of the video editing software Lens Studio by Snap Inc. The final videos were then composed with Adobe AfterEffects as follows: 1.5 seconds fixation cross, 5 seconds for the morph sequence, 1.5 seconds post-stimuli neutral background. For the sad videos, the morph sequence is 6 seconds long instead of 5 because research has shown that the onset and development of a sad facial expression take somewhat longer than happiness or anger (Fayolle & Droit-Volet, 2014). The pool of stimuli consists of 48 videos of 16 agents (8 adults, 8 children; 50% of all agents being female) showing three selected emotions (happiness, anger, and sadness). Half of all videos show agents wearing face masks. A superficial qualitative evaluation of how well a face mask would fit the morph was conducted to determine which videos would feature face masks. Each agent appears on 3 videos (one for each emotion), with either 1 out of

3 or 2 out of 3 videos being masked. The stimuli were randomized using a block design to prevent the same gender from being presented more than twice in a row.

Figure 1: On the left, a woman with a mask expressing happiness. On the right a child without a mask expressing anger.

Procedure. The study was conducted entirely online. For adolescents 14 years and over and adults, participation was completely self-sufficient, as approved by the Ethics Committee of the Humboldt University Berlin. Participants were informed that they would be required to watch 48 short videos, that the task would take about 40 minutes, and that participation in the experiment would only be possible if they had a webcam-enabled computer/laptop and agree to a webcam recording of their face during the experiment. Informed consent included standard details on compensation, confidentiality, and contact information. Participants who agreed to participate were instructed to set up their webcam to allow recording, to arrange sufficient lighting, and to refrain from eating or covering their face during the experiment.

The first set of questions asked for demographic information. Participants then watched the video stimuli while their facial activity was recorded. Following each video, using 7-point Likert-scales, participants rated the targets' emotion expressions using an emotion profile (happiness, sadness, fear, anger, disgust, and surprise) and were asked to indicate how close they felt to the person shown using the IOS Scale and how much they would like to meet the displayed agent. Following the video task, participants filled out

psychopathology measures (PHQ-9 and GAD-7) and were asked about their attitudes toward mask-wearing and questioned about how the pandemic had affected their lives with the scale adapted from An et al. (2021). Finally, participants were given the opportunity to opt-out by requiring their videos to be erased (no participant used this option), informed about the purpose of the experiment, thanked for their participation, and received the necessary instructions for payment.

Statistical Analysis. Hypothesis for both outcome variables (emotion recognition and emotion intensity rating) were analyzed with linear mixed models (LMMs) using the statistical programming language R and its packages lme4 and lmerTest. The main effect of mask, depression score and the interaction between the two were estimated by random intercept/ random slope models. Cohen's d effect sizes were computed for every significant coefficient. The data structure characterized a repeated measures design since we collected many observations on the same variables from every participant. Thus, participant identification (ID) was included in the model as a cluster variable. Hence, the full model was computed as follows: Outcome ~ Mask * Depression + (1+Mask+Depression | ID).

Results

Emotion intensity rating. The main effect of the mask factor on emotion intensity rating can be observed in the descriptive bar plot in Figure 2. The mask factor (after controlling for depression score) yielded significant beta coefficients for happiness (β = -1.57, p < 0.001, Cohen's d = -0.41, CI95% = [-0.47; -0.35]), and for sadness (β = -0.99, p < 0.001, Cohen's d = -0.24, CI95% = [-0.28; -0.19]), but not for anger. The main effect for happiness, however, was qualified by the interaction mask*depression score and thus was interpreted in this context. These effects were also tested via likelihood-ratio test model comparison of intercept-only models and the results were maintained. Depression scores did not yield significant main effect regression coefficients for any of the selected emotions in the LMMs. It is important to mention that, for sadness, a non-significant small positive effect of depressive symptoms was observed (β = 0.04, p < 0.1, Cohen's d = 0.11, CI95% = [-0.02; -0.24]).

As for the interaction effects, the mask*depression score interaction was significant at the 5% level for happiness (β = -0.05, p < 0.05, Cohen's d = -0.07, CI95% = [-0.13; -0.01]) but not for sadness or anger. The significant interaction coefficients were plotted to allow a better interpretation of the effect and can be seen in Figure 5. The model for happiness, including the mask, depression scores, and the interaction between the two produced a marginal R2 of 0.174 (calculated according to Nakagawa & Schielzeth, 2013). A moderation analysis of depressive score in the mask effect was conducted with the help of simple slopes (with the package interactions in R) at three different points of the depression scale (-1SD, mean, +1SD). The mask effect was significant throughout the spectrum of depressive symptoms (p < 0.001). However, the 95% confidence intervals of the coefficients did overlap, that is, the simple slopes were not significantly different from one another. Thus, the moderation effect could not be interpreted as significant. Estimates for the effect of mask at the three respective levels of depression were β = -1.31 with CI95% = [-1.62; -1.00] at -1SD, β = -1.57 with CI95% = [-1.79; -1.36] at the mean and β = -1.84 with CI95% = [-2.14; -1.53] at +1SD

Emotion recognition. The main effect of the mask factor for emotion recognition can be observed in the descriptive bar plot in Figure 3. A hit (=1) was registered when the intensity rating of the target emotion was higher than the intensity rating of all other emotions. A miss (=0) was registered when one of the distractor emotions was rated higher than or equal to the target emotion. The second outcome variable, emotion recognition, produced similar results to emotion intensity ratings. The main effect of mask (after controlling for depression scores) was present for happiness (β = -0.17, p < 0.001, Cohen's d = -0.27, CI95% = [-0.34; -0.20]) and sadness (β = -0.19, p < 0.001, Cohen's d = -0.21, CI95% = [-0.26; -0.16]) but not for anger. Model comparison tests were consistent with this significance pattern. The variable depressive symptoms did not significantly predict the emotion recognition of any of the emotions displayed in this study.
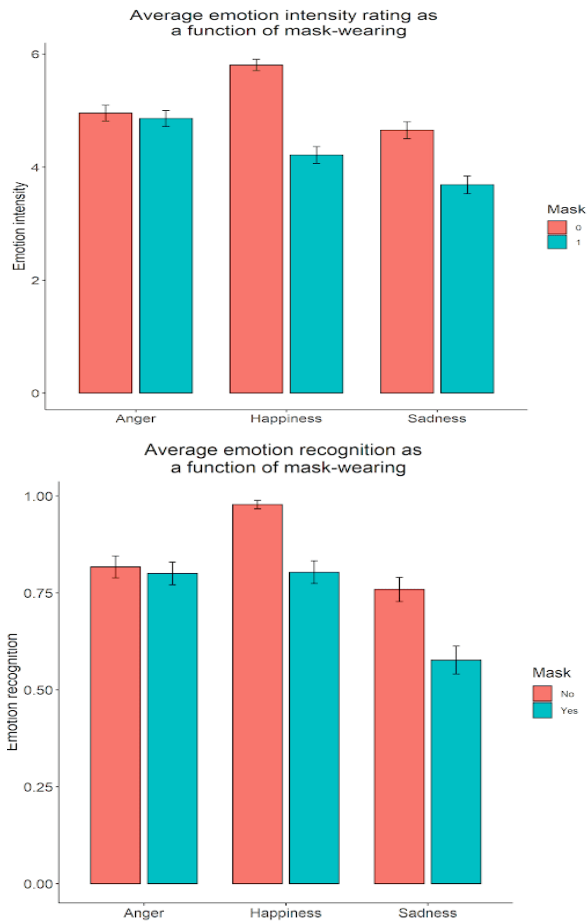
Figures 2 (top) and 3 (bottom): Emotion intensity rating and recognition for each emotion as a function of mask. Error bars are 95% confidence intervals.

Interactions between mask and depression scores also failed to yield significant results. Still, it is worth mentioning that, in the case of happiness, a non-significant interaction effect consistent with the one found in the emotion intensity rating variable was reported (β = -0.006, $p<0.1$, Cohen's d = -0.05, CI95% = [-0.12; 0.01]), which is plotted in Figure 5. The model for emotion recognition of happiness including the mask, depression scores, and the interaction between the two produced a marginal R^2 of 0.093 (calculated according to Nakagawa & Schielzeth, 2013). Moderation analysis through simple slopes was conducted for this outcome variable and showed similar results to the one of emotion intensity rating, meaning that the effect of the mask was significant throughout the depression scale and tended to increase as participants reported more symptoms, but 95% confidence intervals overlapped so that the difference between the simple slopes

could not be interpreted as significant. Coefficients at the three respective points were β = -0.13 with CI95% = [-0.19; -0.07] at -1SD, β = -0.17 with CI95% = [-0.21; -0.12] at the mean and β = -0.20 with CI95% = [-0.26; -0.14] at +1SD.
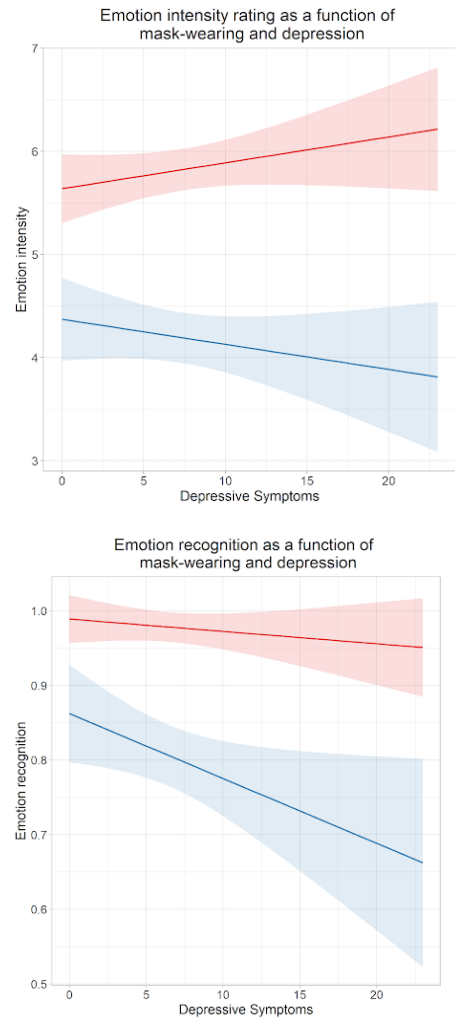
Figures 4 (top) and 5 (bottom): Regression slopes of emotion intensity rating and emotion recognition of **happiness** by depression score grouped by mask (0: without mask, 1: with mask). Error bars are SDs.

Within the framework of the *Gesichter lesen* project, this study utilized morphed face stimuli to assess the effect of face masks and depressive symptoms on emotion recognition and emotion intensity rating.

The Effect of Mask-Wearing

In partial accordance with H1.1 and H2.1, the results suggest that mask-wearing has, according to Cohen's standards (Cohen, 1988), small to medium

effects on both recognition and intensity rating of happy and sad faces, but no significant effects were found for angry faces. This pattern could, at least partially, be explained by the notion that, in comparison to happy and sad faces, the diagnostic face region of anger tends to be in the upper half of the observed face (Bassili, 1979). On a similar note, Calvo et al. (2018) evaluated eye movement patterns of participants looking at different facial emotions and found significantly more fixation on the eye region for angry faces. Thus, a face mask that covers only the lower region of the face may not impair the recognition of anger at all. However, it is important to point out that the fact that our study did not find a difference between the masked vs. unmasked condition for anger does not mean that this difference does not exist. In this sense, more research with larger samples is needed to further investigate the role of masks in the facial expression of anger.

Still, considering that the mask may, for example, also impair the understanding of speech (Mheidly et al., 2020), our findings for happiness and sadness may have important consequences for social interactions that include face masks. Social interaction partners may have to express their sadness or happiness in less ambiguous ways to avoid being misunderstood, for example, by speaking louder and incorporating gestures and body language when displaying these emotions. One type of interaction that could suffer considerably from these deficits is, for instance, a live psychotherapy session in which the client and the therapist are wearing face masks. Psychotherapists should pay attention to these impairments when trying to read the facial expression of patients and when expressing emotional reactions themselves. Failure in accounting for this shortfall may worsen interpersonal communication and hinder therapeutic progress.

The Relevance of Depressive Symptoms

The analysis of a possible main effect of depressive symptoms on emotion recognition and intensity rating as postulated by hypotheses H1.2 and H2.2 did not yield any significant results. This finding goes against some of the literature presented in the theoretical background of the present study. We could speculate in the following ways about the non-emergence of an effect. First, considering that we were expecting small effects, the study may have lacked the power to find it. However, a power analysis for linear mixed

models, which needs simulation studies, was beyond the scope of this article. Second, our study did not apply psychiatric diagnostic of participants, and the number of participants presenting moderately severe to severe (>15) PHQ-9 scores was relatively low (11 out of 91, 12%). It could be that the effect in question manifests itself in clinical depression cases, as observed for example by Bistricky et al. (2011) and Bourke et al. (2010) but disappears when evaluating the non-clinical spectrum of depressive symptoms. Furthermore, many studies that observed FER deficits in depressive patients utilized ambiguous or neutral facial stimuli (e.g., Beevers et al., 2009; Kan et al., 2004, Bourke et al., 2010) whereas this study focused solely on a less ambiguous positive (happy) or less unambiguous negative (angry and sad) facial expressions. At the same time, it is relevant to note that there is still a debate in the literature as to whether facial emotion recognition biases are indeed a characteristic of depressive disorders. Wu et al. (2012), for example, reported normal performance by highly depressive patients when testing for accuracy in recognizing emotions.

Interaction of Mask-Wearing and Depression

Concerning H1.3 and H2.3, the data produced mixed results. For happiness, sadness, and anger, no consistent significant interaction was observed between the mask factor and depressive scores for any of the dependent variables. If at all, the pattern of the results was most suggestive in the case of happiness. Given the simple slope pattern, there may be some indication to speculate that there could be a significant difference once the sample size was larger. By taking a closer look at Figures 4 and 5 and the interaction coefficients, it seems that the presence of a face mask triggers a depressive response to the evaluation of happiness. In other words, when happy faces are masked, depressive scores correlate negatively in a slightly stronger fashion with emotion recognition and emotion intensity ratings. However, it is imperative to note that moderation analysis with the help of simple slopes revealed that the 95% confidence intervals of these coefficients were not significantly different from one another. One could speculate that with increased power and more reliable measurement, this effect could be found significant in future studies or the ongoing project *Gesichter lesen*. Still, effects are expected to be small, and no conclusions can be drawn from the present sample.

Implications of Findings

If one detected a significant interaction effect, for example, with a larger dataset, it could be interpreted in a few different ways. First, it is possible that, as reported by Leyman et al. (2008), participants with higher rates of depressive symptoms have more trouble fixating their gaze on happy faces and therefore present more difficulty in recognizing this emotion when the mask is present. Duque & Vázquez (2015) also observed attentional bias in depressed patients, in the sense that positive emotions attracted less attention than negative ones. The eye-tracking methodology could be utilized with the presence of a mask in future studies to further investigate this rationale. Second, one could argue that the mask may act as a social signal that triggers pandemic-related psychological burdens, and therefore impacts emotion interpretation performance. It is noteworthy to mention that the second explanation does not clarify why the interaction effect would be missing for sadness and anger.

The finding of an interaction effect on happiness and other emotions would have especially important implications. Many recently published studies highlight how pandemic-related safety measures interact with the mental health of vulnerable populations. One study conducted in Germany by Benke et al. (2020), for example, found that higher restrictions due to lockdown measures, a greater reduction of social contacts, and greater perceived changes in life were associated with higher mental health impairments. In Italy, Fiorenzato et al. (2021) found subjective cognitive functioning and mental health were strongly associated with enforcing social distancing measures. In China, Lai et al. (2020) reported particularly bad mental health outcomes for front-line professions such as doctors and nurses, people that consistently use face masks and protective equipment in their daily tasks. In this context, this preliminary study is a further account of how the impairments in facial emotion recognition brought about by the wearing of face masks can have a distinctive impact on people with a disposition to depressive symptoms.

The present investigation sheds light on one specific phenomenon that can exist in the universe of interactions between psychopathology and the burdens produced by the current pandemic, namely, that mask-wearing may significantly impair people's ability to interpret happy and sad facial expressions and that

this impairment may present itself more strongly for individuals scoring higher on a depressive symptoms scale. Following the studies cited in this paragraph, the present data provides some evidence that the pandemic and the safety measures related to it do impact psychological functioning and may do so differently in dependence on people's mental health. Governments and responsible authorities should take these findings into consideration when dealing with the spread of the Coronavirus and planning future restrictions.

Limitations and Outlook

Although one should consider the time and accessibility constraints under which this study was conducted and evaluated, there are a few strengths worth mentioning. First, we built a time-effective online study that could be completed by anyone that spoke German and had a tablet or computer with up-to-date software and a webcam. Second, considering the complexity and time limitation usually associated with this investigation, this study conducted fairly sophisticated data analysis with the help of LMMs and its possibilities within the statistical software R, which help prevent false-positive associations due to population or relatedness structure and increase power by applying a correction that is specific to this structure. In addition, the preliminary character of this investigation allows for further scientific inquiry of the psychological processes addressed in this paper, both within and outside of the *Gesichter lesen* project.

Nonetheless, the present study contains several limitations worthy of critical evaluation. Because of the short period of time within which the data had to be collected for this thesis, we conducted the analysis on a relatively small and homogeneous sample. Having expected small effect sizes, a larger and more heterogeneous sample could account for more reliable results and possibly find effects that remained undisclosed in the present sample.

Dealing with the phenomenon of emotion perception and processing, the fact that this study was based solely upon psychological rating data is also a limitation. Including other forms of measurement to assess response to stimuli, such as psychophysiological data, can increase validity and further contribute to the understanding of the psychological response to emotions. The *Gesichter lesen* project is already in the process of collecting and analyzing this type of data. In a relat

ed online experiment, Kastendieck et al. (2021) have found that facial mimicry - the perceiver's imitation of the other's emotional display - was reduced or absent in response to happy but preserved for sad mask-covered expressions. In the future, it would be interesting to see how mimicry and other physiological processes such as skin conductance and heart rate relate to psychopathology in emotion processing. For that, a study set up in laboratory settings would be the better approach.

Because of the COVID-19 pandemic, university facilities and therefore laboratories had their access restricted and did not allow studies to take place. In order to increase standardization (for example, using electromyography instead of OpenFace[3] video analysis), future studies should utilize superior methods for mimicry assessment and, if possible, go back to being conducted in laboratory environments.

As a last point, one could argue that there is still room for improvement in the quality of the stimuli. Here, we utilized morphed videos composed of static photos from neutral faces to faces displaying full emotions and added a face mask to it. To increase ecological validity, future stimuli should consist of recorded videos of people wearing face masks and expressing their respective emotions.

Conclusion

In summary, the present study found evidence that masks impair facial emotion recognition and bias the intensity rating of happy and sad faces but have no effect on angry faces. Depression scores were not associated with the outcomes in this sample. An interaction effect between mask-wearing and depressive symptoms may exist for happy facial expressions. The findings implicate that social interaction partners wearing face masks should pay additional attention to facial expressions to avoid misinterpreting emotions. In light of the results of this preliminary study and the relevance of precaution measures to contain the spread of COVID-19 at the current moment, authorities should consider the suggested deficits in emotion recognition and, in particular, how they associate with psychopathology when planning future pandemic-related public policy.

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