Cognition and Emotion

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/pcem20

Duration of face mask exposure matters: evidence from Swiss and Brazilian kindergartners' ability to recognise emotions

Ebru Ger, Mirella Manfredi, Ana Alexandra Caldas Osório, Camila Fragoso Ribeiro, Alessandra Almeida, Annika Güdel, Marta Calbi & Moritz M. Daum

To cite this article: Ebru Ger, Mirella Manfredi, Ana Alexandra Caldas Osório, Camila Fragoso Ribeiro, Alessandra Almeida, Annika Güdel, Marta Calbi & Moritz M. Daum (05 Apr 2024): Duration of face mask exposure matters: evidence from Swiss and Brazilian kindergartners' ability to recognise emotions, Cognition and Emotion, DOI: 10.1080/02699931.2024.2331795

To link to this article: https://doi.org/10.1080/02699931.2024.2331795

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

View supplementary material

Published online: 05 Apr 2024.

Submit your article to this journal

View related articles

View Crossmark data

source: https://doi.org/10.48350/195699 | downloaded: 2.5.2024

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=pcem20

COGNITION AND EMOTION
https://doi.org/10.1080/02699931.2024.2331795

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Duration of face mask exposure matters: evidence from Swiss and Brazilian kindergartners' ability to recognise emotions

Ebru Ger [a,b*], Mirella Manfredi [b*], Ana Alexandra Caldas Osório [c,d], Camila Fragoso Ribeiro [c], Alessandra Almeida [e], Annika Güdel [b], Marta Calbi [f] and Moritz M. Daum [b,g]

[a]Department of Psychology, University of Bern, Bern, Switzerland; [b]Department of Psychology, University of Zurich, Zurich, Switzerland; [c]Developmental Disorders Program, Mackenzie Presbyterian University, São Paulo, Brazil; [d]Mackenzie Center for Research in Childhood and Adolescence, Mackenzie Presbyterian University, São Paulo, Brazil; [e]Department of Psychology, Mackenzie Presbyterian University, São Paulo, Brazil; [f]Department of Philosophy "Piero Martinetti", State University of Milan, Milan, Italy; [g]Jacobs Center for Productive Youth Development, University of Zurich, Zurich, Switzerland

ABSTRACT

Wearing facial masks became a common practice worldwide during the COVID-19 pandemic. This study investigated (1) whether facial masks that cover adult faces affect 4- to 6-year-old children's recognition of emotions in those faces and (2) whether the duration of children's exposure to masks is associated with emotion recognition. We tested children from Switzerland ($N = 38$) and Brazil ($N = 41$). Brazil represented longer mask exposure due to a stricter mandate during COVID-19. Children had to choose a face displaying a specific emotion (happy, angry, or sad) when the face wore either no cover, a facial mask, or sunglasses. The longer hours of mask exposure were associated with better emotion recognition. Controlling for the hours of exposure, children were less likely to recognise emotions in partially hideen faces. Moreover, Brazilian children were more accurate in recognising happy faces than Swiss children. Overall, facial masks may negatively impact children's emotion recognition. However, prolonged exposure appears to buffer the lack of facial cues from the nose and mouth. In conclusion, restricting facial cues due to masks may impair kindergarten children's emotion recognition in the short run. However, it may facilitate their broader reading of facial emotional cues in the long run.

ARTICLE HISTORY
Received 10 March 2023
Revised 7 March 2024
Accepted 9 March 2024

KEYWORDS
Emotion recognition; kindergarten children; facial masks; sunglasses; COVID-19

In the wake of the COVID-19 pandemic, many countries have mandated wearing facial masks in public places. Masks cover a substantial proportion of the face, namely the mouth and nose area, which play an important role in recognising different emotions (Boucher & Ekman, 1975; Wegrzyn et al., 2017). The lack of cues from parts of the face due to facial masks may impair emotion recognition, especially in young children, who are not yet entirely competent in recognising emotions (Widen & Russell, 2010). A growing body of research on COVID-19-related mask use suggests that this may indeed be the case (e.g. Carbon & Serrano, 2021; Gori et al., 2021).

However, different countries have adopted various mask policies, resulting in different extents of exposure to faces wearing masks. Therefore, the effect of covered faces on emotion recognition

CONTACT Mirella Manfredi m.manfredi@psychologie.uzh.ch Department of Psychology, University of Zurich, Binzmühlestrasse 14, Zurich 8050, Switzerland
*Ebru Ger and Mirella Manfredi share the first authorship.

Supplemental data for this article can be accessed online at https://doi.org/10.1080/02699931.2024.2331795.

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

might not be equal in all parts of the world. Although the duration of exposure to individuals wearing masks in the wake of the COVID-19 pandemic did not seem to influence the overall emotion recognition in adults (Carbon et al., 2022), they attended more to eye cues in recognising emotions than they had previously done after being exposed to masks for a prolonged time (Barrick et al., 2020). We still do not know the influence of the duration of exposure to individuals wearing masks on emotion recognition in young children, for whom facial input is even more crucial (Pollak et al., 2009). Hence, this study investigates how exposure and the duration of exposure to adults wearing facial masks impact 4- to 6-year-old children's recognition of emotions in those faces.

Emotions recognition: evidence pre-COVID-19 pandemic

Within the first half-year of life, children respond to the basic emotions of others expressed by non-verbal signals such as voice and facial expressions (Grosbras et al., 2018). There is limited research on how children recognise emotions from different parts of the face. Roberson et al. (2012) examined adults' and 3- to 10-year-old children's recognition of emotions (happiness, surprise, anger, fear, and sadness) in pictures of faces wearing either sunglasses, mask-like occlusions (i.e. a dark gray oval shape covering the mouth area), or no cover at all. Until 9 years of age, emotion recognition was not disrupted by sunglasses or mask-like occlusions. Surprisingly, sunglasses even improved recognition in 3- to 4-year-olds. The authors interpreted this as evidence that young children primarily focus on the eye region, which may impair the processing of other available cues in the face. Thus, when the eye region is covered, children can attend better to other cues. Gagnon et al. (2014) investigated how 5- and 10-year-olds recognised emotions (fear, anger, surprise, and disgust) in images of complete faces and partial faces displaying only the eye region, only the mouth region, or the middle part of the face. Children of both ages recognised fear, anger, and surprise in partial faces. However, they recognised fear more accurately in the eye than in the mouth region, whereas they recognised surprise better in the mouth region. Guarnera et al. (2015) examined 6- to 7-year-old children's recognition of emotions (happiness, sadness, anger, disgust, surprise, fear, and neutral) in the whole face, the eye region, or the mouth region. Children recognised all emotions better in the whole face except (1) anger, which was as well recognised from the eye region, (2) sadness, which was recognised better from the eye region, and (3) neutral, which was recognised better from the mouth region. These results suggest that directing attention to these isolated cues on the parts most informative to identify the specific emotions would facilitate emotion recognition. Different facial regions play different roles depending on the sensorimotor correlates associated with these emotions. As Guarnera et al. (2015) suggest, the eye region is more relevant in the case of anger because it is associated with the typical frowning and eyebrow arching movements. However, it is important to note that in the case of anger recognition, lower facial diagnostic regions are also considered highly informative (Kohler et al., 2004). In sum, research findings on how covering faces impacts young children's emotion recognition appear far from conclusive, with substantial variation in age ranges and emotion recognition methodology.

Emotion recognition during the COVID-19 pandemic

In the wake of the COVID-19 pandemic, and following the advice of the World Health Organization, wearing masks daily has been the norm during the COVID-19 pandemic in most countries. National policies regarding mask use have nevertheless been very different around the world. For example, between July 2020 and February 2022, the Swiss government mandated the use of masks in public transport , whereas the Brazilian government required citizens to wear masks in all public places between July 2020 and March 2022. However, masks became mandatory even before this date in several Brazilian states, namely São Paulo (the most populous state in Brazil), where the mandate was issued from May 2020 to March 2022.

There has been growing concern among researchers and experts on how masks may negatively impact interpersonal communication in adults and children (Mheidly et al., 2020). Recently, studies have examined the influence of masks on emotion recognition (e.g. Barrick et al., 2020; Calbi et al., 2021; Carbon, 2020; Galusca et al., 2023; Marini et al., 2021; Pazhoohi et al., 2021; Ruba & Pollak, 2020; Wermelinger, Moersdorf, Daum, et al., 2022; Wermelinger, Moersdorf, Ammann, et al., 2022).

Calbi et al. (2021) showed that adults correctly recognised emotions in faces with masks, and they did not attribute more negative valence to faces with masks compared to faces wearing scarfs that similarly covered the mouth. Nonetheless, other studies compared adults' emotion recognition in faces with and without covering and found an impairment by the covering of the mouth and the eye region (Carbon, 2020; Carbon et al., 2022; Gori et al., 2021; Marini et al., 2021; Pazhoohi et al., 2021; Ruba & Pollak, 2020).

In children, a study with 7- to 13-year-olds found that although they were better at recognising emotions (i.e. identifying fear, anger, and sadness by choosing one from a set of emotion labels) in faces without a mask or sunglasses, they nevertheless recognised emotions in faces with a mask at a level above chance (Ruba & Pollak, 2020). Moreover, there was no significant difference in recognising emotions between faces with masks and faces with sunglasses. The researchers, therefore, concluded that school-aged children's emotional recognition might not be significantly affected by the pandemic-related mask use. In parallel, a recent study reported that we found no statistically significant differences in emotion labelling in faces between children with and without exposure to the use of COVID-19-related masks, with the exception of fearful faces (Wermelinger, Moersdorf, Ammann, et al., 2022). These results suggest that although the children were exposed to facial input to a different degree and variability due to the pandemic, the input from visible faces they received must have been sufficient for the successful recognition and labelling of emotions. On the contrary, 9- to 10-year-old school children's emotion reading was significantly impaired by the mask coverage for the emotions of disgust, fear, and sadness and mildly impaired for happiness (Carbon & Serrano, 2021). Surprisingly, mask coverage enhanced emotion reading for angry and neutral faces.

In another study conducted at the beginning of the COVID-19 pandemic with 3- to 5-year-olds, 6- to 8-year-olds, and adults, the participants selected in a forced choice task the emotional label for pictures of people either wearing sanitary masks or not wearing any covering (Gori et al., 2021). Results showed that although the 3- to 5-year-old children selected the correct emotional label above chance in both conditions, their correct choices were significantly lower for the faces wearing masks than faces wearing no covering. However, the authors did not report the influence of masks on distinct emotions. We do not know whether masks disproportionally hinder the recognition of different emotions, compared to other facial coverings, such as sunglasses.

The current study

The impact of COVID-19 pandemic-related mask use on emotion recognition in younger children needs to be better understood. To our knowledge, no previous study examined how younger children, namely kindergarteners of 4–5 years of age, recognise different emotions in faces wearing standard sanitary masks compared to faces wearing sunglasses or faces with no covering. The existing previous research with kindergarten children either did not compare the emotion recognition in uncovered faces to that in covered faces (Wermelinger, Moersdorf, Daum et al., 2022), or did not distinguish between different emotions in comparing emotion recognition in covered versus uncovered faces (Gori et al., 2021). To reveal the role of covering faces on children's emotion recognition is particularly important to address, given that at the ages 4–5 important developmental advances occur in children's emotion processing (Widen & Russell, 2010). A deduction in the normal input of emotional facial expressions may substantially impact how children process faces for recognising emotions (Pollak et al., 2009). For instance, an increased exposure to faces covered with a mask may force children to process emotions by relying more on the remaining visible parts of the face in the absence of cues from the mouth and nose area. Therefore, in our study, we first asked whether facial masks influence kindergarteners' emotion recognition. We have focused only on three basic emotions, happiness, sadness, and anger, leaving out fear and disgust because children between 4 and 5 years of age can correctly label the latter two emotions at a low percentage (Widen, 2013). In particular, correct labelling was only at 40% for fear and at 10% for disgust. In light of the previous research during the pandemic reviewed above, we expected that children recognise happiness and anger better in uncovered faces than in faces wearing masks or sunglasses and recognise sadness better in uncovered faces than in faces wearing masks.

Second, we investigated whether the duration of exposure to masks modulates the influence of masks on children's emotion recognition ability. The

duration of exposure to individuals wearing masks may be a crucial component of the nature of the impact of masks on children's facial emotion recognition. At the beginning of a period where a change is imposed in the form of widespread mask use, it may come as surprising and may impair children's emotion recognition as masks eliminate some crucial emotional cues in the face. However, the longer the duration of the exposure gets, the more compensatory mechanisms may begin to develop, as adaptation will be necessary to the "new normal" of seeing faces covered in masks. Because countries adopted face mask policies at different rates and either mandated the public to wear masks everywhere outside the home nationwide or only in certain places (e.g. public transportation), children were exposed to adults wearing face masks to a different extent at the time of our data collection (September 2021–January 2022). Specifically, in Switzerland, kindergarten teachers were mandated to wear masks from October 2020 (Personal communication, Office of Education Canton of Zürich, March 23, 2021), while kindergarten children had never worn masks while attending kindergarten. In addition, there was never a mandate to wear masks in outdoor public places except at outdoor events. In comparison, in Brazil, mask use was mandatory in all public places from May 2020 in the São Paulo state and July 2020 nationally. Once schools began reopening in September 2021, kindergarten teachers had to wear masks at all times (e.g. both outdoors and indoors) and children older than 2 were encouraged to wear them as well while attending kindergarten (for specific information on anti-COVID-19 measures in the two countries, see Appendix A).

We expected children exposed to masks in kindergarten for a longer time would be better at recognising emotions in faces wearing masks. Therefore, we expected kindergartners from Brazil, who have been exposed to masks longer than their Swiss counterparts, to recognise emotions in faces wearing masks more accurately. Relying on the universality of facial emotion recognition in children (Yang & Wang, 2019), we reasoned that one of the potential origins of any difference between the two countries in the recognition of emotions in masked faces could be attributed to the difference in the exposure to masks. Furthermore, we additionally analysed the emotion recognition in uncovered faces where no difference between the countries in this baseline would strengthen this attribution.

In addition, independent of country of residence, we investigated whether the duration of exposure to adults wearing masks (in hours per week) influenced children's ability to recognise emotions in masked faces. We hypothesised that kindergartners with a longer exposure to adults wearing masks would recognise emotions better than those with a shorter exposure, only in faces wearing masks.

Method

Participants

The final sample consisted of $N = 79$ kindergartners (see Table 1 for sample characteristics). Children from Switzerland and Brazil did not differ in mean age ($p = .369$) or gender ($X^2(1) = 0.393$, $p = .531$). The Brazilian sample was composed mainly of children residing in the state of São Paulo ($n = 38$; 93%). Additionally, 13 children in Switzerland and 11 from Brazil were tested but excluded from the analyses because they were outside the target age range (3 Brazilian) or could not pass the Exclusion Task (13 Swiss, 8 Brazilian). Preliminary Wilcoxon rank sum tests did not show a statistically significant difference between the excluded and included children in terms of the weekly hours of mask exposure, $M(SD)_{\text{included}} = 26.7(15.5)$, $M(SD)_{\text{excluded}} = 26.7(20.4)$, $p = .689$, but excluded children performed significantly lower in the emotion recognition task ($M = 81\%$, $SD = 14\%$) compared to included children ($M = 92\%$, $SD = 8\%$), $p < .001$. Among the 98 children (after the exclusion based on target age), we did not find a statistically significant difference in age (in months) between the children excluded or included due to the performance on the exclusion task, $M(SD)_{\text{included}} = 57.5(5.4)$, $M(SD)_{\text{excluded}} = 57.3(5.3)$, $p = .946$.

The parents accompanying the child and filling out the questionnaire were 79% mothers and 21% fathers in Switzerland, 76% mothers, 22% fathers, and 2% legal guardians in Brazil. The education status of the caregiver who filled out the questionnaire is presented in Table 2 for both samples.

The participants from Switzerland were recruited via e-mail, using the participant database of the

Table 1. Sample characteristics.

Country	*N*	Percent girls	Mean age in months (*SD*)	Age range	Have sibling(s)
Switzerland	38	63%	58.1 (5.0)	50–64	82%
Brazil	41	54%	56.9 (5.8)	49–65	82%

Table 2. Education status of caregivers.

Completed Education	Switzerland	Brazil
Primary education dropout	0%	2%
Primary education	0%	17%
Secondary education (High-school equivalent)	13%	34%
Secondary education dropout	0%	7%
Tertiary education (University equivalent)	87%	39%

Research Unit at the University of Zurich. After completing the task, participants received a certificate and a small present worth approximately 5 Swiss Francs. The participants from Brazil were recruited at Mackenzie Presbyterian University in São Paulo, Brazil, through social media platforms. Participation was on a voluntary basis and not compensated, because according to Brazilian research regulations, it is not allowed to pay humans for research activities. All procedures in both countries were approved by the local ethics committees and performed following the ethical standards of the 1964 Helsinki Declaration and its later amendments. All parents gave informed consent before data collection. The exclusion criteria for participating in the study were developmental disorders and impaired sight.

Materials and stimuli

The service provider Gorilla Experiment Builder (www.gorilla.sc) was used to create and host our experiment online (Anwyl-Irvine et al., 2020). We also collected children's gaze data for the percentage of looks to the target using the webcam-based eye-tracking functionality (webgazer.js embedded in Gorilla). Face stimuli with emotional expressions (2 females, 2 males) were taken from the Karolinska Directed Emotional Faces – KDEF (Lundqvist et al., 2015) and were edited for facial masks and sunglasses using Photoshop software (cc2019). These face stimuli have been validated and used in previous research (Calbi et al., 2021). A self-prepared questionnaire was used to obtain information on demographics and mask exposure (see Appendix B for the questions).

Procedure

This study was conducted online with the child and one parent between September 2021 and January 2022. To obtain children's behavioural responses, children were asked to point to a particular picture on the screen, and parents were asked to click on that picture without intervening in their child's response. First, parents gave consent to participate by checking a box on the first page of an online demographic questionnaire. Afterward, they filled out the questionnaire, where they answered questions about their socioeconomic status, their children's kindergarten attendance/nanny care, and exposure to masks. Parents were then instructed to seat their children in front of the computer. Children first did a brief forced-choice task, developed by us, to test their knowledge of basic emotion labels. This task was used as an exclusion task, whereby only the children we ensured knew the emotion labels were included in the analyses of the subsequent emotion recognition task. Parents received instructions about the tasks through a pre-recorded video clip before both the exclusion and the emotion recognition tasks.

Mask exposure

Mask exposure was operationalised in two ways. First, data was collected from children in two representative countries with different official policies on mask mandates in schools and public places, namely Switzerland and Brazil. In Brazil, children were exposed to adults wearing masks for a longer duration than in Switzerland (for more details about the mask mandate in each country, see Appendix A). Hence, the country of residence was used as a binary measure of mask exposure, with Brazil representing longer exposure and Switzerland representing shorter exposure.

Second, we collected data from parents of individual children concerning children's mask exposure via a questionnaire. In that questionnaire, we asked parents how many hours during an average week their children have been exposed to people wearing masks, considering the past month (adding up the total hours of exposure per week in kindergarten, childcare, club/extracurricular activities, public places, leisure time, and visits). This served as a continuous measure of mask exposure (referred to as the weekly hours of mask exposure).

Exclusion task

Children saw three pictures of a panda, displaying one of three emotions (from left to right on the screen: happiness, sadness, and anger). In each of the three trials, a pre-recorded auditory prompt asked "Which panda is [sad/angry/happy]? Point to the [sad/angry/

Audio: Which panda is happy? Point to the happy panda.

Figure 1. An example trial in the exclusion task.

happy] panda." in the given fixed emotion order for every child. The children were asked to choose one of the three pictures, and the parents were asked to click on that picture (see Figure 1). All children were tested further with the emotion recognition task in any case. However, only the data of those who chose the correct panda picture for all three emotion labels were included in the final analyses.

Emotion recognition task

This task consisted of 36 trials. In each trial, children saw a picture of four different actors/actresses on a 2×2 grid on the screen, each displaying a different emotion: happiness, sadness, anger, or neutral (see Figure 2). The same four actors/actresses appeared in all 36 trials. Based on the condition, all four faces wore masks, sunglasses, or no cover. A pre-recorded auditory prompt asked children "Which person is [happy/angry/sad]? Please point it out". We only asked the child to point to either of the three emotions but not to the neutral face, which was only used as a distractor picture. A trial ended when the parent clicked on a picture and the children heard the cheer "Super!" regardless of their answer. The next trial began after a fixation cross was presented for 500 ms in the centre of the screen. Every 12 trials, children received an attention-grabber video clip in the centre of the screen for 1300 ms. Children saw all possible stimuli combinations of the actor's gender, emotion prompt, and condition. These combinations were pseudo-randomly presented and counterbalanced. Namely, all of the four actors represented all four emotions (including neutral) at least once in all of the three conditions. Each of the four actors/actresses represented the correct answer in nine trials. The same emotion was not consecutively the correct answer in more than two trials. For each trial, children were given a score of one if they pointed to the correct picture, and zero otherwise.

Eye tracking

In the Emotion Recognition task, we also collected children's gaze data to calculate the percentage of looks to the target. Because many participants had difficulty calibrating, valid eye-tracking data could only be collected from 11 Brazilian and seven Swiss children. Because these results may not be reliable enough, we do not interpret them. Nevertheless, we report the details of the procedure and results as Supplemental material to draw attention to the difficulties of collecting online eye-tracking data from children and to make this existing data available, although it is small.

Results

We pre-registered the study on the Open Science Framework (OSF; https://osf.io/e42m9). Based on the feedback we received during peer review, we decided to deviate from our pre-registered analysis plan in that we report mixed models in the main document, which are better suited for complex designs like ours. However, the results of our pre-registered ANOVA analyses are presented in Appendix C. The anonymized data and the analysis script can be found at: https://osf.io/ja2×9/. Data were analysed using R [version 4.1.3] (R Core Team, 2020) and the packages "rstatix" (Alboukadel Kassambara, 2021) and "emmeans" (Lenth, 2022).

The 79 children completed all 36 trials and were included in the analyses. The mean and standard deviations of children's total score on the Emotion

Figure 2. An example trial of the emotion recognition task (mask condition).

Recognition task are provided in Table 3. A one-sided t-test confirmed that children from Brazil had more hours of mask exposure ($M = 31.0$, $SD = 15.7$) than children from Switzerland ($M = 20.7$, $SD = 11.8$; $t(74) = 3.30$, $p < .001$). To answer our first research question of whether face covering and the duration of exposure to individuals wearing masks affect children's emotion recognition, we conducted a mixed logistic regression. Because there was no significant correlation between age and emotion recognition ($r = .17$, $p = .135$), we did not add age into further regression analyses. We included the correctness of children's response as a binary outcome variable, emotion (sad, happy, angry), cover condition (no cover, mask, sunglasses), participants' residence country (Switzerland, Brazil), their 3-way interaction and all 2-way interactions, and the weekly hours of mask exposure per week as fixed effects, and participants as random intercepts. Results revealed a significant effect of the weekly hours of mask exposure, no significant 3-way interaction, but significant 2-way

Table 3. The mean and SD of children's total score on the emotion recognition task.

		Brazil		Switzerland	
Condition	Emotion	*M*	*SD*	*M*	*SD*
No cover	Angry	98.17	6.59	96.71	10.35
	Happy	97.56	7.51	93.42	16.11
	Sad	96.34	10.55	94.74	10.33
Mask	Angry	92.68	12.80	89.47	13.79
	Happy	88.41	18.62	73.03	22.04
	Sad	83.54	21.37	83.55	20.37
Sunglasses	Angry	96.34	10.55	88.16	17.18
	Happy	96.95	9.99	92.76	16.34
	Sad	92.68	16.05	91.45	15.68

Table 4. Summary of the logistic regression predicting emotion recognition.

	Chisq	Df	Pr(>Chisq)
Condition	72.71	2	<. 001***
Emotion	8.63	2	.013**
Country	2.72	1	.099
Mask exposure	13.31	1	<.001***
Condition × Emotion	10.63	4	0.031*
Condition × Country	0.54	2	.763
Emotion × Country	7.98	2	.018*
Condition × Emotion × Country	2.32	4	.677

interactions between condition and emotion and between country and emotion (Table 4). Note that a model comparison with a model where the hours of mask exposure is integrated into the 3-way interaction (making it a 4-way interaction term) showed that it did not improve the model ($\chi^2(17) = 25.68$, $p = .081$), indicating that the hours of mask exposure have an effect on the emotion recognition independent of any of the remaining fixed effects. We also ran a simulation-based power analysis with 1000 iterations to estimate the observed power for our significant effects. The power for the interaction between condition and emotion was 72%, the interaction between country and emotion was 69%, the main effect of condition was 100%, emotion was 78%, and the weekly hours of mask exposure was 100%.

There was no significant 2-way interaction between the country and the condition. Yet, given that it is crucial for the whole interpretation of the findings that the two countries do not differ on the baseline (no cover) condition, we did a further mixed linear regression only in the no cover condition with the hours of mask exposure as a continuous fixed effect, and emotion, country, and their interaction as binary fixed effects. Here, we also did not find a statistically significant interaction ($\chi^2(2) = 0.71$, $p = .701$) or effect of the country (Unstandardised Estimate = −0.26, $p = .745$), supporting the same pattern.

Contrast analyses for the interaction between condition and emotion with Bonferroni correction showed that for anger, children performed better in the no-cover condition compared to both the sunglasses and mask conditions (Figure 3a). For sadness and happiness, children performed better in the sunglasses and the no cover conditions than in the mask condition (Figure 3a). Moreover, emotion had an effect only in the mask condition. Anger was recognised better than both happy and sad in masked faces (Figure 3b). Contrast analyses for the interaction between country and emotion with Bonferroni correction showed that only for happiness, Brazilian children performed more accurately than Swiss children (Figure 3c). Moreover, Brazilian children recognised anger better than sadness (Figure 3d).

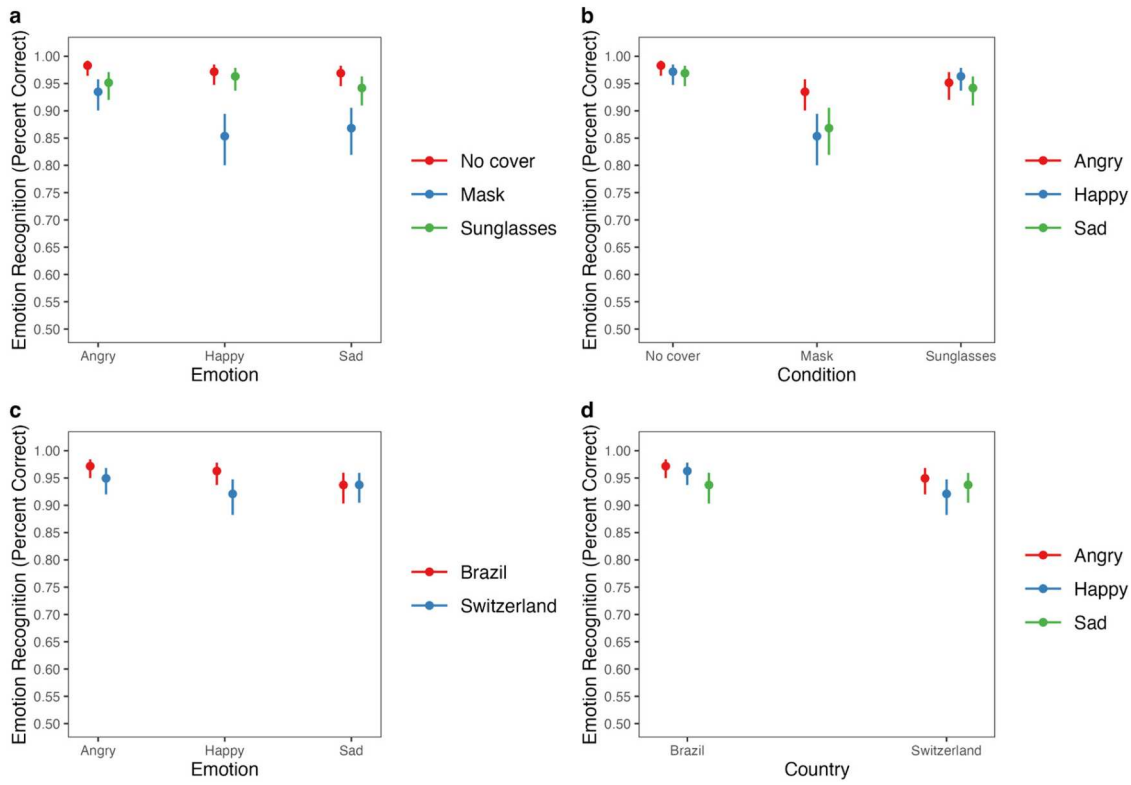

Figure 3 .#Emotion recognition score as a function of emotion, condition and country.

Note. Error bars indicate 95% CI.

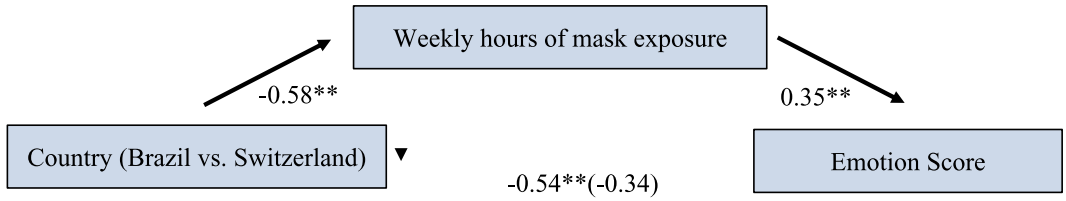

Figure 4. The relationship between country and emotion recognition mediated by the hours of mask exposure.

Because we determined by our individual mask exposure measure that Brazilian children were exposed to longer weekly hours of mask exposure, we additionally ran an exploratory simple mediation analysis using the "mediation" package (Tingley et al., 2014) to elucidate whether the country effect on emotion recognition was mediated by this mask exposure duration. The effect of country on emotion recognition was fully mediated by the weekly hours of mask exposure. As Figure 4 illustrates, the regression coefficient between country and emotion recognition and the regression coefficient between weekly hours of mask exposure and emotion recognition was significant. The indirect effect was (−.58)* (.35) = −.20. Bootstrapping procedures were used to test the significance of these unstandardised indirect effects for each of 1000 bootstrapped samples, and determined the indirect effects at the 2.5th and 97.5th percentiles to compute 95% confidence intervals. The bootstrapped unstandardised indirect effect was −.34, and the 95% confidence interval ranged from −.52 to −.01. Thus, the indirect effect was statistically significant ($p = .024$).

We conducted a one-sample Wilcoxon test (non-parametric due to non-normal distribution of emotion recognition score), separately for children from Switzerland and Brazil to see whether the overall performance in emotion recognition (i.e. Emotion Recognition Score averaged over emotion and condition) was above chance (i.e. 25%). Results revealed that children recognise emotions well above chance in both Switzerland ($p < .0001$, effect size $r = 0.87$) and Brazil ($p < .0001$, effect size $r = 0.88$).

Discussion

In this study, we investigated the effects of different mask exposure on children living in Brazil and Switzerland on their emotion recognition. Two questions guided this research: First, we examined how kindergarten children recognise emotions in adult faces wearing standard sanitary masks compared to faces wearing sunglasses or with no covering. In an online emotion recognition task, children were asked to recognise the facial emotion expressions in actors wearing a face mask, sunglasses, or no cover. Second, we investigated whether children's parent-reported weekly hours of exposure to individuals wearing masks modulates the influence of masks on children's emotion recognition ability. For this purpose, we tested children from Switzerland and Brazil. These countries were subject to different regulations, and therefore different mask exposure durations regarding the use of face masks during the COVID-19 pandemic. We also measured the average number of hours children were exposed to faces wearing masks in a standard week.

Emotion recognition in Swiss and Brazilian children

Children from both countries recognised emotions in both cover conditions above the chance level. However, recognition of happiness and sadness was less accurate in the mask condition than sunglasses or no cover, where we did not find a statistically significant difference between the latter two. Further, the recognition of anger was less accurate in the mask and sunglasses compared to no cover, where we did not find a statistically significant difference between the former two. Hence, masks impaired the recognition of all three emotions we tested, while sunglasses impaired the recognition of anger. Moreover, anger was recognised better than both happiness and sadness in masked faces. These results are in line with the fact that cues in the mouth region of the face seem crucial for the recognition of happiness (Boucher & Ekman, 1975; Eisenbarth & Alpers, 2011; Guarnera et al., 2015; Wegrzyn et al., 2017), while cues in the eye region seem crucial for the recognition of anger (Eisenbarth & Alpers, 2011; Gagnon et al., 2014; Guarnera et al., 2015; Kestenbaum, 1992).

For recognising sadness, the findings are less coherent, with studies on adults finding the eye region to be essential (Boucher & Ekman, 1975; Eisenbarth & Alpers, 2011; Wegrzyn et al., 2017), whereas for children the mouth region may be more essential (Guarnera et al., 2015). Recent studies examining the impact of face masks on adults' emotion recognition have also consistently shown that anger is the least impaired emotion by masks (Proverbio & Cerri, 2022; Rinck et al., 2022; Tsantani et al., 2022), and even facilitated in adult (Grenville & Dwyer, 2022) and child faces (Kastendieck et al., 2023).

These results are also in line with the previous research that similarly showed that, despite inferring emotions in faces with or without a mask at a level above chance, emotion inference was less accurate in faces wearing masks compared to wearing no cover in 3- to 5-year-old children, 6- to 8-year-old children, and adults (Gori et al., 2021;). The most pronounced impairment was revealed in the youngest group, which encompasses the age range we tested in the current study (but see Ruba & Pollak, 2020 for no significant effect of face masks in 7- to 13-year-old children).

Moreover, we found that Brazilian children recognised anger better than sadness, regardless of the covering condition. Previous studies suggest that only around the age of 4 years, children can efficiently discriminate facial expressions of anger and sadness (Widen, 2013). The expression of anger is detected before the expression of sadness, around the age of 3. Thus, it is possible that in our sample, some children had not yet acquired the ability to fully differentiate the two emotions, leading to this difference in performance. However, since we only found this difference in the sample of Brazilian children, this result deserves to be further explored through specific studies investigating the development of facial expression recognition in different cultures and countries.

Effect of duration of mask exposure on emotion recognition

Our second research question asked whether the duration of mask exposure influences children's recognition of emotions in masked faces. We found that the number of hours per week children were exposed to faces wearing masks positively predicted their accuracy in recognising emotions, regardless of covering condition and type of emotion. That is, the longer children saw people wearing masks, the better they recognised emotions. This implies that children may be not only developing ways to compensate for the lack of cues in the mouth and nose area, which is covered by masks, but also getting better in processing facial emotional cues in general.

We also found that, controlling for the weekly hours of mask exposure, Brazilian children recognised the emotion of happiness more accurately than Swiss children averaged over all covering conditions. For one, this could indicate a potential cultural difference in recognising happiness. Yet, although we lack previous research on a comparison, particularly between Brazilian and Swiss people, there is evidence that Brazilian adults did not differ from French adults in facial emotion recognition (De Souza et al., 2018). Considering that we did not find a statistically significant difference in emotion recognition between Brazilian and Swiss children in the no cover (baseline) condition, it is still likely that the more accurate recognition of happiness in Brazilian children over and above the hours of mask exposure is driven by the more widespread and longer period of exposure to masks due to the stricter COVID-19-related measures taken in Brazil compared to Switzerland. The reason why the difference emerged only for happiness may be because happiness is likely the most strongly affected emotion by mask covering as its recognition heavily relies on the cues around the mouth area. Nonetheless, it is important to highlight that this difference between the two countries might have occurred independent of mask exposure, as many other factors differ between these countries.

Implications

The COVID-19 pandemic has raised many concerns about its impact on child development. In particular, a significant body of existing literature has recently analysed the effects of sanitary masks on emotion recognition skills in children. This study focused on responses in kindergarten children between the ages of 4 and 6, a critical age group for social development (Johnson et al., 1999). Furthermore, the main objective of this work was to shed light on the effects of the sanitary mask on children's emotion recognition in countries where the regulations concerning its use differed significantly. This approach made it possible to analyse and partially control for the effect of some external factors, such as time of exposure to the mask and cultural context, on

children's ability to recognise emotions at the time of COVID-19.

The main implication of our study is that sanitary masks impair 4- to 6-year-old children's ability to recognise emotions in faces. Importantly, however, it seems that whereas a shorter-term exposure to faces wearing masks might be impairing, a longer-term exposure may drive children to compensate for the lack of cues covered by masks and improve their emotion recognition more broadly, possibly by learning to holistically attend to all possible facial cues in the face to detect emotions. Because masks eliminate important facial cues to emotions, parents and teachers may be encouraged to provide children with additional cues that support emotion recognition, such as verbalisations and body gestures.

Limitations and future directions

Our study has several limitations. First, although having samples from two different cultural settings helps us provide evidence for the generalisability of the impact of face masks on emotion recognition, we are still limited to the two particular countries we conducted our study. Relatedly, we cannot rule out all potential cultural factors that may have contributed to the results. Second, as parents registered the responses of their children, we cannot entirely rule out the possibility that they intervened, although they were asked to honestly register the true response of their child. Third, we interpret that the longer mask exposure may help children compensate for the lack of cues in the lower part of the face. Yet we do not know the mechanism by which children may be doing so, that is, what other cues children may orient their attention to with a prolonged duration of mask exposure. Future studies may focus on potential cues parents and teachers may provide while wearing masks, whether children can pick up on these cues, and if so, whether the ability to pick up on these cues improves with a longer duration of mask exposure. Fourth, we assessed children's emotion recognition only on static images of human faces. An informative future direction is to investigate how children's ability to detect emotions in an actual context, presumably providing additional contextual cues for the emotions, would be affected by the covering of faces. Fifth, we studied children in kindergarten age, who recognised the emotions in all of the covering conditions at a level above chance in our study. Future research can focus on a younger age group, who have not yet fully acquired the ability to detect emotion, to examine how they might be affected by the covering of faces. Finally, a minor limitation is that the children in the Swiss sample received a small present, whereas the children in the Brazilian sample did not. However, since the children in the Swiss sample only received the reward after the task (and were unaware of it beforehand), we do not think this could have caused a difference in motivation in the two groups of children.

Conclusion

Our findings suggest that facial masks negatively impact kindergartners' (i.e. 4- to 6-year-old children) emotion recognition of faces. They also suggest that kindergartners with a longer exposure to adults wearing masks recognise emotions better than those with a shorter exposure. This indicates that with prolonged exposure to the masks, children might adapt to and compensate for the lack of facial cues in the nose and mouth areas, especially concerning the emotion of happiness. Thus, restriction of facial cues due to masks may impair kindergarten children's emotion recognition in the short run but may facilitate their broader reading of facial emotional cues in the long run.

Acknowledgments

We are grateful to the parents and children who participated in our study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

Ana Osório received financial support from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior [grant number 0426/2021], process no. 23038.006837/2021-73, CAPES/PrInt [grant number 88887.310343/2018-00]. This work was supported by the Jacobs Foundation.

Ethical approval

The study has been approved by the local ethics committee. The anonymized data and analysis scripts are available at: https://osf.io/ja2×9/.

ORCID

Ebru Ger http://orcid.org/0000-0002-6140-1807
Mirella Manfredi http://orcid.org/0000-0002-6549-1993
Ana Alexandra Caldas Osório http://orcid.org/0000-0002-1692-4609
Camila Fragoso Ribeiro http://orcid.org/0000-0002-4504-5742
Alessandra Almeida http://orcid.org/0000-0002-1940-0501
Annika Güdel http://orcid.org/0000-0002-7441-157X
Marta Calbi http://orcid.org/0000-0001-7555-0611
Moritz M. Daum http://orcid.org/0000-0002-4032-4574

References

Alboukadel Kassambara. (2021). rstatix: Pipe-Friendly framework for basic statistical tests. R package (Version 0.7.0). https://CRAN.R-project.org/package=rstatix

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, *52*(1), 388–407. https://doi.org/10.3758/s13428-019-01237-x

Barrick, E. M., Thornton, M. A., & Tamir, D. (2020). *Mask exposure during COVID-19 changes emotional face processing* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/yjfg3

Boucher, J. D., & Ekman, P. (1975). Facial areas and emotional information. *Journal of Communication*, *25*(2), 21–29. https://doi.org/10.1111/j.1460-2466.1975.tb00577.x

Calbi, M., Langiulli, N., Ferroni, F., Montalti, M., Kolesnikov, A., Gallese, V., & Umiltà, M. A. (2021). The consequences of COVID-19 on social interactions: An online study on face covering. *Scientific Reports*, *11*(1), Art. 1. https://doi.org/10.1038/s41598-021-81780-w

Carbon, C.-C. (2020). Wearing face masks strongly confuses counterparts in reading emotions. *Frontiers in Psychology*, *11*, 566886. https://doi.org/10.3389/fpsyg.2020.566886

Carbon, C.-C., Held, M. J., & Schütz, A. (2022). Reading emotions in faces with and without masks is relatively independent of extended exposure and individual difference variables. *Frontiers in Psychology*, *13*, 856971. https://doi.org/10.3389/fpsyg.2022.856971

Carbon, C.-C., & Serrano, M. (2021). The impact of face masks on the emotional reading abilities of children—a lesson from a joint school–university project. *I-Perception*, *12*(4), 204166952110382. https://doi.org/10.1177/20416695211038265

De Souza, L., Bertoux, M., De Faria, Â., Corgosinho, L., Prado, A., Barbosa, I., Caramelli, P., Colosimo, E., & Teixeira, A. (2018). The effects of gender, age, schooling, and cultural background on the identification of facial emotions: A transcultural study. *International Psychogeriatrics*, *30*(12), 1861–1870. https://doi.org/10.1017/S1041610218000443

Eisenbarth, H., & Alpers, G. W. (2011). Happy mouth and sad eyes: Scanning emotional facial expressions. *Emotion*, *11*(4), 860–865. https://doi.org/10.1037/a0022758

Gagnon, M., Gosselin, P., & Maassarani, R. (2014). Children's ability to recognize emotions from partial and complete facial expressions. *The Journal of Genetic Psychology*, *175*(5), 416–430. https://doi.org/10.1080/00221325.2014.941322

Galusca, C. I., Clerc, O., Chevallier, M., Bertrand, C., Audeou, F., Pascalis, O., & Fort, M. (2023). The effect of masks on the visual preference for faces in the first year of life. *Infancy*, *28*(1), 92–105. https://doi.org/10.1111/infa.12518

Gori, M., Schiatti, L., & Amadeo, M. B. (2021). Masking emotions: Face masks impair how we read emotions. *Frontiers in Psychology*, *12*, 669432. https://doi.org/10.3389/fpsyg.2021.669432

Grenville, E., & Dwyer, D. M. (2022). Face masks have emotion-dependent dissociable effects on accuracy and confidence in identifying facial expressions of emotion. *Cognitive Research: Principles and Implications*, *7*(1), 15. https://doi.org/10.1186/s41235-022-00366-w

Grosbras, M.-H., Ross, P. D., & Belin, P. (2018). Categorical emotion recognition from voice improves during childhood and adolescence. *Scientific Reports*, *8*(1), 14791. https://doi.org/10.1038/s41598-018-32868-3

Guarnera, M., Hichy, Z., Cascio, M. I., & Carrubba, S. (2015). Facial expressions and ability to recognize emotions from eyes or mouth in children. *Europe's Journal of Psychology*, *11*(2), 183–196. https://doi.org/10.5964/ejop.v11i2.890

Johnson, C., Ironsmith, M., Snow, C. W., & Poteat, G. M. (1999). Peer acceptance and social adjustment in preschool and kindergarten. *Early Childhood Education Journal*, *27*(4), 207–212. https://doi.org/10.1023/B:ECEJ.0000003356.30481.7a

Kastendieck, T., Dippel, N., Asbrand, J., & Hess, U. (2023). Influence of child and adult faces with face masks on emotion perception and facial mimicry. *Scientific Reports*, *13*(1), 14848. https://doi.org/10.1038/s41598-023-40007-w

Kestenbaum, R. (1992). Feeling happy versus feeling good: The processing of discrete and global categories of emotional expressions by children and adults. *Developmental Psychology*, *28*(6), 1132–1142. https://doi.org/10.1037/0012-1649.28.6.1132

Kohler, C. G., Turner, T., Stolar, N. M., Bilker, W. B., Brensinger, C. M., Gur, R. E., & Gur, R. C. (2004). Differences in facial expressions of four universal emotions. *Psychiatry Research*, *128*(3), 235–244. https://doi.org/10.1016/j.psychres.2004.07.003

Lenth, R. (2022). *emmeans: Estimated marginal means, aka least-squares means*. R package version 1.7. 2.

Lundqvist, D., Flykt, A., & Öhman, A. (2015). *Karolinska directed emotional faces [data set]*. American Psychological Association. https://doi.org/10.1037/t27732-000

Marini, M., Ansani, A., Paglieri, F., Caruana, F., & Viola, M. (2021). The impact of facemasks on emotion recognition, trust attribution and re-identification. *Scientific Reports*, *11*(1), 5577. https://doi.org/10.1038/s41598-021-84806-5

Mheidly, N., Fares, M. Y., Zalzale, H., & Fares, J. (2020). Effect of face masks on interpersonal communication during the covid-19 pandemic. *Frontiers in Public Health*, *8*, 582191. https://doi.org/10.3389/fpubh.2020.582191

Pazhoohi, F., Forby, L., & Kingstone, A. (2021). Facial masks affect emotion recognition in the general population and individuals with autistic traits. *PLoS One*, *16*(9), e0257740. https://doi.org/10.1371/journal.pone.0257740

Pollak, S. D., Messner, M., Kistler, D. J., & Cohn, J. F. (2009). Development of perceptual expertise in emotion recognition. *Cognition*, *110*(2), 242–247. https://doi.org/10.1016/j.cognition.2008.10.010

Proverbio, A. M., & Cerri, A. (2022). The recognition of facial expressions under surgical masks: The primacy of anger.

Frontiers in Neuroscience, *16*. https://www.frontiersin.org/journals/neuroscience/articles/10.3389fnins.2022.864490

R Core Team. (2020). *R: A language and environment for statistical computing*. R foundation for statistical computing [Computer Software]. https://www.R-project.org/

Rinck, M., Primbs, M. A., Verpaalen, I. A. M., & Bijlstra, G. (2022). Face masks impair facial emotion recognition and induce specific emotion confusions. *Cognitive Research: Principles and Implications*, *7*(1), 83. https://doi.org/10.1186/s41235-022-00430-5

Roberson, D., Kikutani, M., Döge, P., Whitaker, L., & Majid, A. (2012). Shades of emotion: What the addition of sunglasses or masks to faces reveals about the development of facial expression processing. *Cognition*, *125*(2), 195–206. https://doi.org/10.1016/j.cognition.2012.06.018

Ruba, A. L., & Pollak, S. D. (2020). Children's emotion inferences from masked faces: Implications for social interactions during COVID-19. *PLoS One*, *15*, e0243708. https://doi.org/10.1371/journal.pone.0243708

Tingley, D., Yamamoto, T., Hirose, K., Keele, L., & Imai, K. (2014). Mediation: R package for causal mediation analysis. *Journal of Statistical Software*, *59*(5), 1–38. http://www.jstatsoft.org/v59/i05/

Tsantani, M., Podgajecka, V., Gray, K. L. H., & Cook, R. (2022). How does the presence of a surgical face mask impair the perceived intensity of facial emotions? *PLoS One*, *17*(1), e0262344. https://doi.org/10.1371/journal.pone.0262344

Wegrzyn, M., Vogt, M., Kireclioglu, B., Schneider, J., & Kissler, J. (2017). Mapping the emotional face. How individual face parts contribute to successful emotion recognition. *PLoS One*, *12*(5), e0177239. https://doi.org/10.1371/journal.pone.0177239

Wermelinger, S., Moersdorf, L., Ammann, S., & Daum, M. M. (2022). Exploring the role of COVID-19 pandemic-related changes in social interactions on preschoolers' emotion labeling. *Frontiers in Psychology*, *13*, 942535. https://doi.org/10.3389/fpsyg.2022.942535

Wermelinger, S., Moersdorf, L., & Daum, M. M. (2022). How experience shapes infants' communicative behaviour: Comparing gaze following in infants with and without pandemic experience. *Infancy*, *27*(5), 937–962. https://doi.org/10.1111/infa.12488

Widen, S. C. (2013). Children's interpretation of facial expressions: The long path from valence-based to specific discrete categories. *Emotion Review*, *5*(1), 72–77. https://doi.org/10.1177/1754073912451492

Widen, S. C., & Russell, J. A. (2010). Children's scripts for social emotions: Causes and consequences are more central than are facial expressions. *British Journal of Developmental Psychology*, *28*(3), 565–581. https://doi.org/10.1348/026151009X457550d

Yang, Y., & Wang, Q. (2019). *Culture in emotional development. Handbook of emotional development*. Springer.

Appendices

Appendix A

Event	Description	Date
	Switzerland	
School closing	School closed	13 March 2020
School opening	Mandatory schools opening again	11 May 2020
Mask mandates	Mask mandates in public transportation	06 July 2020
	Mask mandates in enclosed public spaces (including public schools) for adults from 16 years.	19 October 2020
	Mandatory mask only on public transportation and in healthcare institutions	17 February 2021
	Mandatory mask on public transportation and in healthcare institutions lifted	17 February 2022
	Brazil	
School closing	School closed	From 13 March 2020 to 22 March 2020
School opening	Mandatory gradual opening of schools	From 13 July 2020 to 30 November 2021
Mask mandates	Mask mandate in outdoor and indoor public places.	04 May 2020
	Mask mandate lifted in outdoor public places.	09 March 2022
	Mask mandate lifted in indoor public places (including public and private schools). Exceptions: public transport and health care facilities.	17 March 2022

Appendix B. Official Mask Wearing Policies in Switzerland (based on Bundesratbeschluss) and Brazil (based on Secretaria da Educação do Estado de São Paulo, Diário oficial do Estado de São Paulo and Diário Oficial da União) in Public Places and Schools. *Brazil represents the São Paulo state where the majority of our participants come from. Resources:

https://www.bag.admin.ch/bag/de/home.html
https://www.in.gov.br/servicos/diario-oficial-da-uniao
http://www.imprensaoficial.com.br

Appendix B

Questionnaire Items on Demographics and Mask Exposure

1. When did your child start attending Kindergarten?
2. How many hours a week does your child attend kindergarten? Please indicate in hours.
3. Did your child attend Kindergarten in the last two weeks?
4. If not, when did your child last attend Kindergarten?
5. Do the adults (e.g. teachers) in the kindergarten wear masks?
6. Do the children in the kindergarten wear masks?
7. Does your child receive care outside of the immediate family? (as example after school programme, in-home daycare or Nanny care)
8. How many hours a week does your child receive care outside of the immediate family? Please indicate in hours.
9. Do the people when taking care of your child outside of the immediate family wear face masks?
10. Does your child regularly attend classes such as dance or piano lessons?
11. How many hours a week does your child attend classes? Please indicate in hours.
12. Do adults instructing in the classes wear face masks?
13. Please think back to last month. In an average week, at which activity does your child see you or someone else wearing a mask? Please tell us the average hours a week in.

    public places: Shopping, going to the doctor, going to any public offices, in public transport, outdoor public places, restaurants or coffee shops.

    leisure time: Playground, leisure activity, sport- or culture event or outdoor playdates with other children.

    visitations: Visiting other people or receiving visitors.

Appendix C

Results of the Pre-registered ANOVAs

Our pre-registered $3 \times 3 \times 2$ mixed ANOVA with emotion recognition score (percentage of correct answers) as the dependent variable, emotion (sad, happy, angry), and condition (no cover, mask, sunglasses), as within-subjects independent variables, and participants' residence country (Switzerland, Brazil) as a between-subjects independent variable revealed a significant 3-way interaction and a significant 2-way interaction between emotion and condition (Table 3). We broke down the 3-way interaction into a Bonferroni-corrected simple 2-way interaction between emotion and condition at each level of participant's residence country. As we computed two simple 2-way interaction, one for Brazil and one for Switzerland, we applied a Bonferroni-adjusted alpha level of 0.025 for statistical significance. This analysis revealed a significant 2-way interaction between condition and emotion only in Switzerland ($F(4, 333) = 4.16$, $p = .003$, $\eta_p^2 = 0.048$), while it revealed no significant 2-way interaction ($F(4, 360) = 0.93$, $p = .449$, $\eta_p^2 = 0.01$) but a significant main effect of condition ($F(2, 360) = 15.5$, $p < .001$, $\eta_p^2 = 0.079$) and emotion in Brazil ($F(2, 360) = 4.23$, $p = .015$, $\eta_p^2 = 0.023$). The simple 2-way interaction in Switzerland was further broken down into simple simple main effects. Specifically, we examined both (1) the effect of condition as a function of emotion and (2) the effect of emotion as a function of condition. For the first analysis, as we computed 3 simple simple main effects, for each of three emotions, we applied a Bonferroni-adjusted alpha level of 0.017 for statistical significance. There was a significant effect of condition on happy ($F(2, 111) = 15.12$, $p < .001$, $\eta_p^2 = 0.214$) and sad ($F(2, 111) = 4.91$, $p = .009$, $\eta_p^2 = 0.081$), but not angry ($F(2, 111) = 4.08$, $p = .020$, $\eta_p^2 = 0.068$). Holm-corrected pairwise comparisons revealed that mask was less accurate than sunglasses ($t(37) = 5.12$, $p < .001$) and no cover ($t(37) = 5.77$, $p < .001$) for happy, and mask was less accurate than no cover ($t(37) = 3.63$, $p = .003$) for sad. For the second analysis, as we computed 3 simple simple main effects, for each of three conditions, we applied a Bonferroni-adjusted alpha level of 0.017 for statistical significance. There was a significant effect of emotion only in the mask condition ($F(2, 111) = 7.25$, $p = 0.001$, $\eta_p^2 = 0.116$). Holm-corrected pairwise comparison revealed that in masked faces, happy was recognised less accurately than angry ($t(37) = 4.20$, $p < .001$) and sad ($t(37) = 2.59$, $p = .028$).