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Children's Interpretation of Others' Faces Covered with Medical Masks

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CHILDREN'S INTERPRETATION OF OTHERS' FACES COVERED WITH MEDICAL MASKS

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Abstract

How we recognize and regulate emotions is fundamental to overall health and wellbeing. Emotional recognition and understanding are key to proper communication and emotion regulation. Barriers, such as masks, might have an impact on the way children recognize and interpret others' emotions, and therefore the way they learn, communicate, and regulate their own. The COVID-19 pandemic necessitated widespread mask-wearing, raising questions about its impact on children's emotional development. Using a sample of children with varying levels of exposure to mask wearing adults (N = 13, ages 4 to 6), we investigated how prolonged mask wearing predicts emotion recognition, particularly for masked and unmasked faces, and emotion regulation skills of children. Children were given a series of short vignettes and asked to match masked and unmasked facial expressions of emotions that portray the emotion described in the vignette. The Transparent Box Task was used to observe children's ability to regulate their emotions during a frustrating situation. Caregivers responded to a set of surveys to confirm mask exposure during mask mandates (2020/2021), as well as their child's emotion regulation skills. Correlation analyses were run to explore associations between mask exposure, emotion recognition, and emotion regulation. Independent Samples T-Tests were used to investigate biological sex differences. Despite the small sample size, several trends emerged that, while mostly not statistically significant, still offer important insights. Older children, who had higher mask exposure, showed poorer emotion recognition. Biological sex differences were noted in emotion regulation, with males displaying higher levels of lability/negativity. Increased mask exposure was found to be associated with a diminished ability to recognize emotions on masked, unmasked, and angry faces. These findings support our hypotheses and highlight the need for

targeted educational and psychological interventions, especially in contexts where mask wearing is prevalent.

Keywords: emotion, emotion recognition, emotion regulation, socioemotional learning, COVID-19, mask, children

Children's Interpretation of Others' Faces Covered with Medical Masks

Emotions are embedded into the fabric of our human existence. How we understand and regulate emotions is fundamental to our overall health and wellbeing (Becker et al., 2014). While the emphasis on health education has primarily been on physical health, the importance of mental health and wellbeing for both adults and children cannot be underestimated (Weare, 2000). Importantly, our capacity to accurately recognize others' emotions has long term implications for our social and cognitive wellbeing (Kang et al., 2017). Indeed, accurately recognizing others' emotions helps to build and strengthen relationships (Koizumi et al., 2011). In this vein, how and to what extent children can accurately recognize facial expressions of emotions is important for their own emotional understanding, regulation, and communication (Sappok et al., 2016).

Existing research indicates that by ages four to five, children become particularly accurate at recognizing facial expressions when it comes to the emotions of happiness, sadness, and anger (Felleman et al., 1983). Children may use various cues including content, voices, and facial expressions to read others' emotions (Yow & Markman, 2011; Stoop et al., 2020; Frank et al., 2009). During the COVID-19 pandemic, children experienced a range of emotions because of the widespread impact of the virus and the related restrictions (Idoiaga et al., 2020). Starting June 2020, mask mandates were introduced across Canada to slow the spread of COVID-19 cases (Karaivanov et al., 2021). The masking requirements in Ontario were not lifted until June 2022, mandating citizens to wear masks in most indoor spaces, including public transit, stores, and healthcare settings. While the impact of the COVID-19 pandemic and its restrictions on children's emotional wellbeing has been a subject of research (Idoiaga et al., 2020), children's recognition of others' emotions behind medical masks is an area that is understudied; thus, is the

purpose of this study. Specifically, this work sought to examine the extent to which children can recognize emotional expressions when others' faces are wearing medical masks and how this predicts their ability to regulate their own emotions.

Literature Review

In this literature review, I will first define the concept of 'emotion' and explore the development and significance of emotions in children. Next, I will delve into the concept of emotion recognition, focusing on its meaning and development in children. Following this, I will address the process of recognizing emotions when faces are partially covered (by masks), and the implications this has. Finally, I will discuss the relationship between emotion recognition and emotion regulation, highlighting how the ability to accurately perceive emotions influences emotional self-regulation.

Children and Emotions

The definition of 'emotion' varies according to the context and field of study (Mulligan & Scherer, 2012). While one study derived 11 categories (affective, cognitive, external stimuli, physiological, emotional/expressive behaviour, disruptive, adaptive, multi aspect, restrictive, motivational, and skeptical statements) to try to categorize 92 definitions and nine skeptical statements of definitions of the word 'emotion' (Kleinginna & Kleinginna, 1981), Ekman & Cordaro (2011) define the word emotion as "Discrete, automatic responses to universally shared, culture-specific, and individual-specific events." which will be the definition this study adopts as it accounts for the universality of emotions. While consensus on a precise definition has not been achieved, there is ample evidence that emotions are a fundamental component of being human that has implications for overall development from infancy to older adulthood (Becker et al., 2014; Ekman & Cordaro, 2011; Viana et al., 2020).

According to extensive research by Ekman and colleagues (Ekman, 1992; Ekman, 1992; Ekman, 1993; Ekman & Friesen, 1971; Levenson, 2011; Loderer et al., 2020; Oatley & Johnson-Laird, 2011), six emotions are considered 'basic', meaning they are universal, involuntary, and automatic. Ekman (1992) identifies these basic emotions as *happiness*, *sadness*, *anger*, *disgust*, *surprise*, and *fear*. This study follows suit and examines children's ability to recognize three of these six emotions (happiness, sadness, and anger) when they are presented on faces with and without medical masks. To minimize the risk of fatigue and/or frustration associated with younger children's shorter attention span, limited capacity to persevere through longer tasks, and potential participant fatigue that could be associated with testing all six emotions (Yang et al., 2018), this study focused on happiness, sadness, and anger as they are typically recognized at an earlier age compared to fear, surprise, and disgust (Gagnon et al., 2014; Guarnera et al., 2015). Focusing on these three emotions allowed us to minimize the noise that may occur if less identifiable emotions were presented.

Emotion Recognition

Emotion recognition is critical for understanding, empathizing, and interpreting others' actions and feelings (Bänziger et al., 2009). Emotion recognition plays an essential role when it comes to building and keeping healthy relationships with others (Bänziger et al., 2009; Cole & Deater-Deckard, 2009; Denham, 1998; Saarni, 1999; Denham & Kochanoff, 2002; Fonagy & Target, 1997; Laible & Thompson, 1998; de Rosnay & Harris, 2002) because how we interpret others' emotions has impact on our mental and social wellbeing (Everaert & Joormann, 2020). Research indicates that enhanced emotional understanding is associated with increased proficiency in recognizing, controlling, and regulating emotions (Sprung et al., 2015; Harris, 2008). Hence, it is crucial for children to interpret their own and others' emotions accurately to

develop and foster strong physical, social, and mental health outcomes while building relationships with others.

Extant research has found that virtually all human beings are born with primary (i.e., basic) emotions (anger, sadness, fear, happiness, surprise, and disgust) that are essential for survival (Ekman, 1992; Ekman & Cordaro, 2011; Levenson, 2011; Loderer et al., 2020; Oatley & Johnson-Laird, 2011). Children begin to show understanding of others' emotions by discriminating faces and recognizing facial expressions as early as three-four months of age when the faces they see are steady (Zieber et al., 2013; Maurer & Barrera, 1981; LaBarbera et al., 1976; Schwartz et al., 1985; Young-Browne et al., 1977), and by seven months of age on dynamic presentations (Soken & Pick, 1992; Rump et al., 2009). Furthermore, humans are able to read others' emotions from faces and voices during their first year of life based on their ability to match vocal emotional cues with the body representation of that specific emotion (Zieber et al., 2013). Existing literature shows that children start to talk about emotions and demonstrate ability to label certain emotions by the age of two (Wellman et al., 1995). Moreover, three-year olds can observe emotions of puppets and respond by displaying prosocial behaviours (Denham, 1986).

While children's understanding of emotions continue to develop and improve throughout their lifetime, the ages of three and four years seems to be especially important (Cole & Deater-Deckard, 2009). Furthermore, variations exist across the recognition of different emotions (Durand et al., 2007; Kujawa et al., 2014). For instance, one study looked at 5-, 7-, 9-, and 11-year-old children and adults' abilities to read facial expressions of emotions by conducting a series of tasks where participants identified emotions in both upright and upside-down faces (Durand et al., 2007). They found that our capacity for facial emotion recognition evolves over

time, following a developmental trajectory that varies depending on the specific emotion being recognized (Durand et al., 2007). Specifically, the study found that at age 5, children demonstrated adult-level accuracy in recognizing happy and sad facial expressions, while their ability to recognize anger, fear, disgust, and neutral expressions developed more gradually, as younger children showed lower accuracy in those emotions when compared to older children and adults (Durand et al., 2007; Kujawa et al., 2014). As well, many early and recent studies support the relatively early development of recognizing happy faces accurately (Ale et al., 2010; Broeren et al., 2011; MacDonald, Kirkpatrick, & Sullivan, 1996). By the age of 11, facial emotion recognition has developed to match adult-like levels, with high accuracy, such as 99.1% for happy expressions and approximately 90% for anger and sadness (Chronaki et al., 2015).

Since emotional development advances over a lifetime and that those who are between the ages of three and four show significant improvements in emotional understanding (Cole & Deater-Deckard, 2009), this study looked at children between the ages of four and six to ensure that a) all participants have, more or less, completed their developmental and sensitive periods (i.e., ages three to four) in this regard, and b) that this developmental period overlapped with the mask mandates that were put in place in Ontario, Canada. Having considered such developmental milestones, and accounting for individual differences among children, we find that it is reasonable to look at children as young as four to observe their emotion recognition abilities in different contexts.

Emotion Recognition of Covered Faces

Facial expressions are a key component of social communication, and existing literature provides various explanations. For example, the Still Face Experiment conducted by Tronick and colleagues (1978) led researchers to hypothesize that infants experience distress when their

mother is unresponsive and presenting a still face, as this creates a situation where the infants are confronted with contradictory emotional signals, leading to confusion and emotional discomfort. According to Morray and Trevarthen's (1985) work, infants feel more distressed when their parent puts on a still face compared to when the parent turns away from the infant to communicate with someone else. In another study, infants displayed "negative affect" (i.e., facial expressions such as anger, sadness, fear, and/or negative sounds such as crying, whining, and complaining) when their mothers put on a still face, but did not display the same signs of distress when the mother put on a mask and continued to engage with eye contact and conversation with the infant (Weinberg et al., 2012, Legerstee & Markova, 2007). These studies indicate that the absence of interconnection between the child and the parent might not be the main cause of distress, but the absence of emotional expression (Mesman et al., 2009). With this in mind, and the possible distress associated with the absence of facial expressions, whether children can recognize emotions behind medical masks is of primary concern since those wearing medical masks can often appear to have a still face if they are not overly expressive with their eyes.

There is no doubt that mask wearing is a significant disruption when it comes to processing others' faces (Fischer et al., 2012; Schurgin et al., 2014). Wearing medical masks impacts one's ability to process faces by obstructing the lower half of the face, which influences the recognition of faces and the emotional expressions displayed (Freud et al., 2021; Carragher & Hancock, 2020; Dhamecha et al., 2014; Freud et al., 2020; Gosselin & Schyns, 2001; Kret & De Gelder, 2012; Stajduhar et al., 2021; Grundmann et al., 2021). Various facial characteristics are observed and utilized when reading the facial expressions of emotions in others (Saito, Motoki, & Takano, 2023). For instance, the mouth region provides important cues for identifying expressions of happiness, while the eye region is considered informative when recognizing fear

(Bombari et al., 2013; Saito, Motoki, & Takano, 2023). Additionally, studies found that the accuracy of facial emotion recognition, particularly for happy and disgusted expressions, decreases due to the reduced visibility from the lower part of the face (Bombari et al., 2013; Fischer et al., 2012; Saito, Motoki, & Takano, 2023; Schurgin et al., 2014).

When considering children's ability to read others' facial expressions behind masks, a body of literature have reported that, as observed with adults, children also show differences when processing masked versus unmasked faces (Bourke et al., 2023; Chester et al., 2022; Stajduhar et al., 2022). That is, children's ability to recognize emotions was worse when faces were covered with masks, and the negative influence of masking on emotion recognition were more pronounced for happy, sad, and fearful expressions as compared to angry or neutral faces (Bourke et al., 2023; Chester et al., 2022). In addition, Chester et al. (2022) reported that children who experienced higher levels of social disruption (e.g., greater degrees of social distancing and virtual interactions), as reported by their parents, showed significantly poorer ability to recognize emotions on masked faces compared to unmasked faces. Conversely, another study looked at children's (ages 3-5) ability to identify emotions on masked and unmasked faces, and reported that older children, who had more exposure to mask wearers, demonstrated greater ability to accurately recognize emotions in masked faces (Giordano et al., 2022). Giordano et al. (2022) attributed this to the potential that increased exposure to mask wearers might improve children's ability to read faces more accurately. Given the discrepancies among these studies, the impact of mask exposure on children's emotion recognition abilities is not fully understood. Thus, this study intends to provide additional insight on the relationship between mask exposure and emotion recognition among young children by assessing their accuracy in identifying emotions on faces with and without masks.

Emotion Recognition and its Relationship to Emotion Regulation

Emotion regulation is defined as the ability to shift, manage, and alter emotional states (Cicchetti, Ganiban, & Barnett, 1991), and is key to health and wellbeing as well as success in life (Keltner & Haidt, 1999; Côté et al., 2010). Specifically, emotion regulation strategies have an impact on one's emotional environment and therefore their relationships with others (Pisani et al., 2012). Indeed, healthy relationships depend on one's capacity to accurately understand, express, and regulate emotions as well as engage in social behaviours. Distinctively, emotion self-regulation strategies describe methods individuals can develop to manage their own emotions (Supplee et al., 2011). Children start to use emotion regulation strategies when they are as young as infants (Supplee et al., 2011). Head turning, self-soothing, reaching out for social support, and active distraction are only some examples of how a child may self-regulate (Supplee et al., 2011). Current studies have found that emotion regulation plays a vital role for children's health and development, and more specifically, their socioemotional wellbeing (Breaux et al., 2017). Surely, a child's ability to regulate his/her emotions and demonstrate social emotional skills can say a lot about their mental health later on in life (Brumariu et al., 2011). In fact, children who struggle with emotion regulation seem to later suffer from mental health issues (Pisani et al., 2012). For example, children who have poor emotion regulation skills experience higher levels of mood and anxiety disorders (Barlow, Allen, & Choate, 2016; Kovacs & Lopez-Duran, 2012; Loevaas et al., 2018; Weems, 2008). To properly regulate emotion, however, accurate emotion recognition and interpretation is required (Greenberg et al., 2017; Mauss et al., 2005; Mayer & Salovey, 1997; Zarotti et al., 2018). For instance, Mayer & Salovey (1997) describe in their four-branch model that perceiving emotions, using emotions to facilitate thinking, understanding emotions, and managing emotions are components of emotional

intelligence that build on each other progressively. Similarly, Greenberg et al. (2017) highlight in their social-emotional learning (SEL) model that emotional awareness is a foundational skill for emotional regulation.

Table 1

The four-branch model of emotional intelligence

Emotional Intelligence	
Branch name	Brief description of skills involved
Perception of emotion (Branch 1)	The ability to perceive emotions in oneself and others, as well as in objects, art, stories, music, and other stimuli
Use of emotion to facilitate thinking (Branch 2)	The ability to generate, use, and feel emotion as necessary to communicate feelings, or employ them in other cognitive processes
Understanding of emotion (Branch 3)	The ability to understand emotional information, how emotions combine and progress through relationship transitions and to appreciate such emotional meanings
Management of emotion (Branch 4)	The ability to be open to feelings, to modulate them in oneself and others so as to promote personal understanding and growth

Note. Reprinted from "Measuring emotional intelligence with the Mayer-Salovery-Caruso Emotional Intelligence Test (MSCEIT)" by M. A. Brackett and P. Salovey, 2006, *Psicothema*, 18, p. 35.

While emotions are fairly universal in humans, the degree to which people recognize, understand, and regulate them varies. For instance, research suggests that women are often better at understanding nonverbal cues in communication compared to men (Bertsch, Pilot & Koudjoji, 2020). When it comes to children's ability to regulate and interpret emotions, a number of factors including the sex and the age of the child, and the type of emotion being presented seem to play a

significant role (López-Pérez & Pacella, 2021). For example, López-Pérez & Pacella (2021) conducted a study where 8-10-year-old children were asked to identify the emotions the characters were feeling in a simulation game and respond with four possible regulation strategies (adaptive or maladaptive). Results indicated that 8-year-olds chose less adaptive strategies to respond to sadness than 10-year-olds (López-Pérez & Pacella, 2021). As well, they reported that boys chose less adaptive regulation strategies when responding to fear, as compared to girls (López-Pérez & Pacella, 2021). This said, whether or not children's ability to interpret mask wearing faces will vary based on their sex, age, or the type of emotion presented is another matter that this study will investigate.

Children's understanding of emotion, through their ability to recognize facial expressions, has important implications for their social well-being, mental health, and cognitive development (Denham, 2007; Parker & Gottman, 1989; Knitzer, 1993; Blair, 2002). However, during the COVID-19 pandemic, children were exposed to more masked faces and fewer full facial expressions. Additionally, even beyond the context of the pandemic, investigating children's ability to read facial expressions when others are wearing masks could have long term implications that are key for developing effective emotion regulation for children in various settings, making it important for this study to examine both high and low mask exposed children and compare their social emotional outcomes. Thus, the subject of how accurate children are when it comes to interpreting others' emotions and how this impacts their emotion regulation remains unclear; thus, is the purpose of this study.

The following research questions and hypotheses guide this work:

Research Question 1: To what degree are children who were more highly exposed to mask wearers able to recognize emotions compared to children who had lower exposure to mask wearers?

H1: Children who had higher exposure to mask wearers will demonstrate decreased ability to recognize emotions, as compared to children who had lower mask exposure.

Research Question 2: How does children's levels of exposure to mask wearers predict their ability to regulate their own emotions?

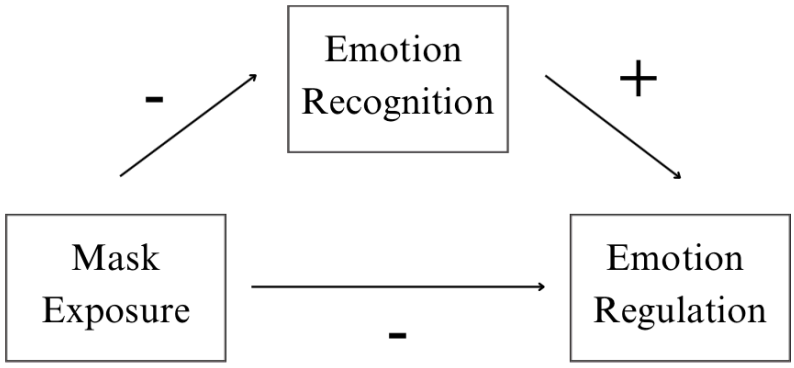
H2: Children who had higher exposure to mask wearers will demonstrate decreased ability to regulate their own emotions, as compared to children who had lower mask exposure.

Research Question 3: Does emotion recognition mediate the relationship between mask exposure and emotion regulation?

H3: Emotion recognition will mediate the relationship between mask exposure and emotion regulation. Mediation analyses explore how an intermediary variable (the mediator) explains the process through which an independent variable influences a dependent variable (Baron & Kenny, 1986). A simple mediation analysis involves three variables and encompasses two causal pathways to the outcome variable: the direct effect of the independent variable, and the effect of the mediator (Baron & Kenny, 1986). As well, a third pathway establishes a sequential link from the independent variable to the mediator (Baron & Kenny, 1986). In this study, it is hypothesized that emotion recognition will mediate the relationship between mask exposure and emotion regulation (see Figure 1), as mask exposure may decrease children's emotion recognition, thereby negatively impacting the way they regulate their own emotions.

Figure 1

Mediation Model



Method

Participants

Data for this study were collected from both caregivers and children using both parent- and child-report methods to ensure a more robust understanding of children's emotion regulation abilities where parental insights complement children's self-reports, especially since young children have limited insight into their past experiences (Conjin, Smits, & Hartman, 2020; Hourigan, Goodman, & Southam-Gerow, 2011). While effort was exercised to obtain a target of 80 participants to achieve 80% power and a medium effect size of .5 for mediation analysis (Fritz and Mackinnon, 2007), we were only able to recruit 13 children between the ages of 4 and 6 (N=13; 53.8% female, 46.2% male; M_{age} = 4.92 years) and their caregiver. 10 of the participants (76.9%) were White, while the ethnicity of the remaining 3 (23.1%) is unknown. Due to the absence of one participant's video footage, they were excluded from the analyses involving the Transparent Box Task and associated emotion regulation coding.

Following approval from the Wilfrid Laurier University Research Ethics Board (#6941), efforts began to recruit parent and child dyads through parent groups on social media platforms.

The intended number of participants was not achieved due to the in-person nature of the study, as well as its restriction to the Brantford area (i.e., the specific lab set-up necessary for the study's structure). Data was, therefore, collected from 13 parent-child pairs in 2023 and 2024. Following participation, children were awarded a "Junior Scientist Certificate", playdough, and stickers as a token of appreciation. All participants were accompanied by their guardians.

Measures

Parent Report

Demographic Information. The guardians of the participants were requested to provide several demographics details concerning their children (i.e., date of birth and biological sex) through a questionnaire administered electronically via Qualtrics. Guardians completed the questionnaires independently, while they were in the lab.

Mask Exposure. Participants' degree of mask exposure in years 2020/21 was verified through a short questionnaire presented to each participant's guardian. To do so, the guardians were asked about: 1) their child's regular attendance (at least once a week) at a specific location (e.g., school, daycare, childcare program) during 2020/21, 2) if masks were mandated for adults at that location throughout their child's presence, and 3) the frequency of their child's attendance (i.e., months per year, days per week, hours per day). This data was then analyzed using SPSS to compute the total regular exposure to mask wearing adults, expressed in both hours and days per year. The cohort included children with both higher and lower levels of mask exposure.

Emotion Regulation. A modified version of the Emotion Regulation Checklist (ERC) (Shields & Cicchetti, 1997) was used to measure emotion regulation in participants. The ERC is a 24-item caregiver-report that measures several aspects of emotion regulation in children including "affective lability, intensity, valence, flexibility, and situational appropriateness"

(Shields & Cicchetti, 1997, p.910). Caregivers responded using a 4-point Likert scale that ranged from '*1- Rarely/Never*', to '*4- Almost Always*', and a total score was achieved for each subscale by summing the items and subtracting the reverse coded items from the overall sum. The assessment comprised two subscales intended to gauge (a) Lability/Negativity, which refers to emotional instability or rapid changes in mood, (15-items) (e.g., '*Transitions well from one activity to another; doesn't become angry, anxious, distressed, or overly excited when moving from one activity to another'*) and (b) Emotion Regulation (8-items) (e.g., *'Can say when he/she is feeling sad, angry, mad, fearful, or afraid'*). Reliability for both subscales was strong (α= .83 and .77, respectively) (Silverman et al., 2022). The language used in the original scale was modified for several items to enhance comprehensibility for caregivers (e.g., '*Can modulate excitement*' was modified to '*Can control his/her excitement*'). This adaptation was deemed necessary to ensure accurate and meaningful responses, acknowledging the diverse linguistic backgrounds and educational levels among caregivers, thereby optimizing the reliability and validity of the collected data in the context of this study. Our study revealed strong internal consistency across the Lability/Negativity subscale (α= .95, scores ranging from -4 to 28), and sufficient internal consistency for the Emotion Regulation subscale (α= .64, scores ranging from 11 to 21).

Child Report

Recognition of Facial Expressions. Two versions of the Face Recognition Task (FRT; Version A and Version B) were developed using PowerPoint. For the test items, four adults (split by gender, not including the model used for baseline items) were used as models for conveying the three emotions examined in this study (happiness, sadness, and anger). Each adult was photographed making the facial expression for each of the three basic emotions without a mask.

The models were instructed to follow Ekman's guidelines while producing the facial expressions (Ekman, 1970; Ekman, Friesen, & Tomkins, 1971; Ekman & Friesen, 1971; Ekman, 1972). The same photos were used to digitally create the faces with masks by photoshopping a 'realistic' looking mask on each photo using the Adobe Photoshop software. This was done to ensure that the facial expressions of masked and unmasked faces remained identical. In total, each model represented each emotion twice, once with the mask and once without. Four vignettes were created for each category: unmasked happy, unmasked angry, unmasked sad, masked happy, masked angry, and masked sad, producing a total of 24 vignettes (see Appendix A). Each of the 24 scenarios were recorded by the same voice actor using a neutral tone of voice. Each version of the FRT counterbalanced the order of vignettes, as well as the emotional expressions in each vignette. The voice recordings were then incorporated into each slide of the PowerPoint presentations. Pilot testing was conducted with two children, aged 4 and 6, to ensure that the photos accurately represented the intended emotions. The pilot test provided valuable insights into the optimal positioning of cameras and the use of a Chromebook for recording responses. The results confirmed that the photos accurately represented the intended emotions, necessitating no changes to the photos, scenarios, or voice recordings.

Model photographs were combined using the Qualtrics software, wherein each model's unmasked photographs were displayed as various alternatives within one question (see Figure 2), while their masked faces were presented as alternatives in a separate question (see Figure 3). One question was removed from the FRT due to the majority of participants answering that question incorrectly ('*Emily told her mom that she is not doing well in school. Emily's mom was sad to hear that Emily was struggling. Which one is her sad face?*').

Figure 2

Sample Response Options, Unmasked Faces

Figure 3

Sample Response Options, Masked Faces

Participants and an RA were seated in front of a computer with their assigned version of the FRT presentation (A or B) on. To verify basic recognition of emotion on faces, three baseline questions where participants were asked to point (without a vignette) to the happy/sad/angry unmasked faces were used (i.e., "Which one is the happy/sad/angry face?"). To do so, one adult

was used as a 'model' for conveying three basic emotions. Participants' performance on the baseline questions were not included in their overall scores. Once it was verified that participants could recognize the basic emotions, they were asked to respond to a series of questions that included short vignettes/scenarios that helped create context for participants by telling them how the character was feeling (e.g., *'Emily helped her mom clean their messy kitchen which made her mom very happy. Which one is her happy face?'*). The research assistant recorded participants' answers on a Qualtrics survey, using a Chromebook, as they responded. Participants' total correct responses, as well as their performance on questions depicting each emotion (i.e., happiness, sadness, and anger) were recorded and summed (see Table 2).

Table 2

Minimum and Maximum Scores on the Face Recognition Task

		Minimum Score	Maximum Score
Happy			
	Unmasked	4	4
	Masked	4	4
Sad			
	Unmasked	3	4
	Masked	3	3
Angry			
	Unmasked	3	4
	Masked	2	4
Total			
	Unmasked	11	12
	Masked	9	11

Emotion Regulation. The Transparent Box Task (TBT) was designed to observe children's temperament and emotion regulation when provided with a frustrating task (Laboratory Temperament Assessment Battery; Goldsmith & Rothbart, 1996). In this task, children were given a transparent box that housed a desired item (i.e., squishy balls), along with a set of keys

that, unbeknownst to them, would not open the box (Ramsook et al., 2019). After they were provided with the transparent box and the wrong set of keys, the participants were given 3 minutes alone to try and open the box (Dennis et al., 2009; Ramsook et al., 2019). Participants were video recorded using two webcams (one recording their face and the other recording the room). After 3 minutes, the experimenter returned to the room, said they mistakenly provided the wrong keys, and gave the correct keys to the child (Dennis et al., 2009; Ramsook et al., 2019). The child then opened the box with the correct keys and was permitted to play with the squishy balls for a few minutes (Dennis et al., 2009; Ramsook et al., 2019). A team of five coders then independently coded the footage for seven actions: problem solving, behavioural distraction, attention distraction, focus on desired object, soothing, disruptive behaviours, and distress (Dennis et al., 2009; Ramsook et al., 2019):

Problem solving was defined as statements, questions, and behaviours made by the child that indicate attempts at understanding the situation, its constraints, and solutions (e.g., enacting possible solutions to the task such as trying different ways to open the box, asking to self, "How does this lock work?", or talking to self about the task "Maybe I should try…").

Behavioural distraction was defined as the child doing something other than focusing on the task at hand such as engaging in play, dancing, or singing.

Attentional distraction was defined as the child turning attention away from the task at hand, without engaging in a different activity (e.g., shifting gaze, staring into space, laying head on the table).

Focus on desired object was defined as the child looking at the desired toy locked inside the box without touching or manipulating the box (e.g., staring at the toys without touching the box).

Soothing was defined as the child self-soothing and/or comfort seeking rather than seeking information about how to open the box independently. Examples include, but are not limited to, thumb sucking, hugging self, nail biting, cuticle picking, rocking, head banging, sucking on clothing, lip licking, tongue sticking, face rubbing/touching, humming/singing, mumbling, indistinct vocalizations/words, encouraging self-talk (e.g., "Nobody can do this") or asking for help (e.g., "Help me, the box won't open", "Help, I can't do it", "These keys don't work").

Disruptive behaviour was defined as the child exercising behaviours or words directed toward the experimenter or objects in the room in a defiant or aggressive way (e.g., throwing keys on the floor, trying to break the box, banging at the door/walls, throwing chairs, hitting the computer) or speech (e.g., saying, "I want the toy now, stupid!", or "I hate this!").

Distress was defined as behaviours that suggest the child is in a state of emotional discomfort but is not defiant or aggressive, such as sadness (e.g., hiding, running away, crying, clinging to caregiver, fidgeting, frowning) and irritability (e.g., grunting, protesting, complaining, furrowing brows, tensing shoulders, making fists, tightly shutting mouth into a straight line).

Footage was segmented into 10 second intervals and coders determined the frequency of occurrence of any of the seven actions within that time frame until the session was ended. Interrater reliability among coders were high for Problem Solving (ICC = .937, 95% CI [.86, .98]), Behavioural Distraction (ICC = .949, 95% CI [.89, 0.98]), Attentional Distraction (ICC = .964, 95% CI [.92, .99]), Disruptive Behaviour (ICC = .992, 95% CI [.98, .997]), and Distress (ICC = .928, 95% CI [.83, .98]). Poor to moderate levels of agreement were observed for the Focus on Desired Object (ICC = .666, 95% CI [.23, .89]) and Soothing (ICC = .588, 95% CI [.06, .87]) categories. Discrepancies across raters were addressed through a comprehensive

review process where definitions of each category were revisited, and raters were provided with an opportunity to review their individual scores based on refined definitions.

Analysis and Results

Correlations between age, biological sex, and other key variables such as emotion recognition and emotion regulation were run before addressing the primary research questions. As mentioned, participants were between the ages of 4 and 6 (N=13; 53.8% female, 46.2% male; M_{age} = 4.92 years). 10 of the participants (76.9%) were White, while the ethnicity of the remaining 3 (23.1%) is unknown. Importantly, it is acknowledged that the small sample size inherently limits the generalizability and robustness of the analysis and findings. As such, the results and interpretations presented should be interpreted with caution and as an initial step toward responding to the research questions.

Preliminary Analyses

Table 3

Participant Demographics and Face Recognition Task Correct Scores

Age (in Years)	Mask Exposure per Year (in Days)	Face Recognition Task Scores								
		Unmasked Happy (out of 4)	Unmasked Angry (out of 4)	Unmasked Sad (out of 4)	Masked Happy (out of 4)	Masked Angry (out of 4)	Masked Sad (out of 3)	Unmasked Total (out of 12)	Masked Total (out of 11)	Total (out of 23)
4.8	86.67	4	4	4	4	4	3	12	11	23
4.8	26.00	4	4	4	4	4	3	12	11	23
4.2	1.63	4	4	4	4	4	3	12	11	23
4.3	0.54	4	4	4	4	4	3	12	11	23
5.8	58.50	4	4	4	4	4	3	12	11	23
5.5	7.58	4	4	4	4	4	3	12	11	23
6.5	2.17	4	4	4	4	4	3	12	11	23
4.3	2.71	4	4	4	4	4	3	12	11	23
6.1	54.17	4	4	3	4	2	3	11	9	20
5.9	57.42	4	3	4	4	4	3	11	11	22
5.8	54.17	4	4	4	4	4	3	12	11	23
6.3	104.00	4	4	4	4	3	3	12	10	22

6.3	60.67	4	4	4	4	4	3	12	11	23

Table 3 indicates that participants consistently performed well in recognizing emotions, with little variance in correctly identifying masked and unmasked faces. However, there were slight difficulties in recognizing masked angry faces, as reflected by several participants not reaching the maximum score of four. Despite this, participants were largely able to accurately identify masked happy, masked sad, and unmasked emotions, demonstrating strong emotion recognition skills across the board.

Age, Biological Sex, and Emotion Recognition

Bivariate correlations using both Spearman and Pearson's *r* were run to explore age differences in emotion *recognition*. As differences between the two were not significant, only Pearson's *r* will be reported here. Although none of the correlations reached statistical significance ($p > 0.05$), inverse relationships between age and emotions recognized on masked ($r = -.36$) and unmasked faces ($r = -.30$), as well as the overall face recognition score ($r = -.38$) were seen. Findings, if significant, would have indicated that, as age increases, children's ability to identify emotions on masked and unmasked faces decreases. A similar trend was seen between age and the ability to recognize anger behind masked faces, where as age increased, children's ability to recognize angry faces behind a mask decreased ($r = -.36$, $p > 0.05$).

To examine the relationship between biological sex and emotion recognition, Independent Samples T-Tests were conducted to look at biological sex differences in emotion recognition. Results revealed no significant difference between males' ($M = 22.83$, $SD = 0.41$) and females' ($M = 22.43$, $SD = 1.13$) recognition of emotions, $t(11) = 0.83$, $p = 0.43$. Similarly, no significant differences in biological sex were found when looking at recognition among masked, unmasked, or angry faces. Recognition of happy or sad faces across males versus

females could not be assessed due to the absence of variability across scores. In summary, while not statistically significant, trends suggest that as children age, their ability to recognize emotions, and anger behind masked faces, decreases. No biological sex differences were observed in emotion recognition.

Age, Biological Sex, and Emotion Regulation

Bivariate correlations using both Spearman and Pearson's *r* were run to explore age differences in emotion *regulation*. As differences between the two were not significant, only Pearson's *r* will be reported here. While all of the analyses were found to be not statistically significant ($p > 0.05$), we observed a positive correlation between age and the emotion regulation score reported in the parent-report (ERC) ($r = .38$). As well, positive correlations between age and lability/negativity reported in the ERC ($r = .20$), as well as age and disruptive behaviours seen during the TBT ($r = .38$) were noted, suggesting that an increase in age is associated with an increase in lability/negativity and disruptive behaviours. Moreover, we found a weak negative correlation (also not statistically significant, $p > 0.05$) between age and problem-solving behaviours coded during the TBT ($r = -.08$), where an increase in age was associated with a decrease in problem solving behaviours.

Independent Samples T-Tests were conducted to look at biological sex differences in emotion regulation skills reported by parents and observed through the TBT. Results suggested that males ($M = 17.17$, $SD = 7.91$) had significantly higher levels of reported lability/negativity in the ERC compared to females ($M = 3.60$, $SD = 5.94$), $t(9) = 3.24$, $p = 0.01$. The same trend was not seen when looking at the emotion regulation scores reported in the ERC, where there was no significant difference between males ($M = 17.33$, $SD = 2.33$) and females ($M = 15.80$, $SD = 4.44$), $t(9) = 0.74$, $p = 0.48$. When examining emotion regulation during the TBT (i.e., problem

solving, behavioural distraction, attentional distraction, focus on desired object, soothing, disruptive behaviour, and distress), there were no significant differences across the two groups (see Table 2). In summary, findings suggest positive correlations between age and parent reported emotion regulation scores, parent reported lability/negativity scores, and disruptive behaviours observed. Males displayed significantly higher levels of lability/negativity than females, based on parent report. No significant differences in overall emotion regulation scores were found between sexes.

Table 4

Biological Sex Differences Across Transparent Box Task Codable Actions

	Male ($N = 5$)		Female ($N = 7$)					
	M	*SD*	*M*	*SD*	*df*	*t*	*p*	Cohen's d
Problem Solving	16.36	1.54	17.06	.67	5.10	-.95	.39	-.63
Behavioural Distraction	1.08	.95	.31	.50	5.59	1.64	.16	1.07
Attentional Distraction	5.56	1.96	4.46	1.70	7.94	1.01	.34	.61
Focus on Desired Object	.12	.18	.29	.36	9.19	-1.04	.32	-.55
Soothing	12.04	12.98	3.03	1.39	4.07	1.55	.20	1.09
Disruptive Behaviour	.84	1.88	.00	.00	4.00	1.00	.37	.71
Distress	7.96	2.21	9.43	2.76	9.79	-1.02	.33	-.58

Associations Between Emotion Recognition and Emotion Regulation

We explored the associations between emotion recognition and emotion regulation scores to provide a more comprehensive understanding of their relationship. The correlation between the ERC scores and child performance on the FRT revealed several trends, although none of these correlations reached statistical significance ($p > 0.05$). First, there was a positive correlation between the ERC – Lability/Negativity scores and the recognition of unmasked faces ($r = .34$), suggesting that higher lability/negativity is associated with better recognition of unmasked faces. Additionally, the relationship between ERC – Lability/Negativity scores and the recognition of masked faces was negative ($r = -.31$), where increases in lability/negativity were associated with decreases in recognition of masked faces. Moreover, the ERC – Emotion Regulation scores were negatively correlated with the recognition of unmasked faces ($r = -.33$) and the overall face recognition score ($r = -.20$).

Pearson's correlation was also used to study the associations between the actions coded from the TBT and the FRT scores. Again, none of the correlations reached significance ($p > 0.05$), but the direction and strength of the linear relationships were examined. Firstly, disruptive behaviours coded during the TBT and participants' recognition of masked faces were negatively correlated, where increased number of disruptive behaviours were associated with a decrease in recognition of masked faces ($r = -.38$). Next, higher levels of distress coded during the TBT were associated with increases in recognition of unmasked faces ($r = .35$) and an overall face recognition score ($r = .34$), revealing positive correlations.

Bivariate correlations to investigate emotion-specific trends in face recognition among ERC and TBT scores were also conducted. Due to the lack of variability in scores (i.e., participants responded correctly to all vignettes presenting the emotions happiness (masked and unmasked) and sadness (masked)), we were only able to explore differences in the recognition of

anger, but not happiness or sadness. Results between ERC - Lability/Negativity scores and anger recognition showed a negative correlation for masked faces (r = -.31), and a positive correlation for unmasked faces (r = .34) meaning that an increased lability/negativity score was associated with a decrease in the recognition of masked angry faces, and an increase in the recognition of unmasked angry faces. When looking at the relationship between ERC – Emotion Regulation scores and the recognition of anger, negative associations were found for unmasked faces (r = -.33) and the overall anger recognition score (r = -.20), demonstrating that an increased parent reported emotion regulation score was associated with decreases in recognition of unmasked angry faces, and the recognition of angry faces overall. When the actions coded during the TBT and the face recognition scores for anger were explored, negative correlations between disruptive behaviours and recognition of anger in masked faces (r = -.38) and the overall anger recognition score (r = -.32) were seen, suggesting that an increase in disruptive behaviours coded were associated with a decrease in ability to recognize anger overall, as well as in masked faces. Conversely, positive correlations were seen between distress coded during the TBT and recognition of anger in masked faces (r = .28) and the overall anger recognition score (r = .32), where more distress coded during the TBT was associated with a better ability to recognize anger overall, as well as in masked faces. In summary, higher lability/negativity scores were related to better recognition of unmasked faces and lower recognition of masked faces. Lower emotion regulation (ERC) scores were associated with reduced recognition of unmasked faces, while increased disruptive behaviours were linked to reduced recognition of masked faces, particularly for anger.

Research Question 1: Mask Exposure and Emotion Recognition

To respond to research question one, "*To what degree are children who were more highly exposed to mask wearers able to recognize emotions compared to children who had lower exposure to mask wearers?*", linear regression analyses were planned based on the expectation of a larger sample size. The analysis would have included age and gender as covariates, with emotion recognition variables assessed initially. Subsequently, the impact of mask exposure on emotion recognition would have been examined, controlling for the effects of age and gender. This approach aimed to evaluate how mask exposure predicts emotion recognition while accounting for these covariates. Given the small sample size, bivariate correlations were conducted to examine whether statistically significant linear relationships emerged between mask exposure and emotion recognition scores. While not statistically significant ($p > 0.05$), mask exposure was found to be negatively correlated with emotion recognition in unmasked faces ($r = -.20$), emotion recognition in masked faces ($r = -.37$), and overall emotion recognition ($r = -.34$), suggesting that an increase in mask exposure was associated with a decreased ability to recognize emotions in both masked and unmasked faces. When examining emotion specific relationships, we looked at the association between mask exposure and participants' ability to recognize anger in masked and unmasked faces. While not significant statistically ($p > 0.05$), results indicated that mask exposure is negatively correlated with anger recognition in unmasked faces ($r = -.15$), anger recognition in masked faces ($r = -.37$), and overall ability to recognize anger ($r = -.42$). This suggests that increased mask exposure is associated with decreased ability to recognize anger in both masked and unmasked faces. In summary, mask exposure was related to lower emotion recognition in both masked and unmasked faces, as well as overall emotion recognition. Similarly, mask exposure was associated with lower anger recognition in both

masked and unmasked faces, suggesting that greater mask exposure may be linked to a reduced ability to recognize emotions, particularly anger.

Research Question 2: Mask Exposure and Emotion Regulation

Research question 2 asked, "*How does children's levels of exposure to mask wearers predict their ability to regulate their own emotions?*". As with research question one, and our hope for a larger sample size, a linear regression analysis was initially planned. Age and gender would have been included as covariates, with emotion regulation variables examined first. Next, the effect of mask exposure on emotion regulation would have been analyzed while accounting for covariates. This method aimed to understand how mask exposure predicts emotion regulation, considering the influence of age and gender. With the small sample size, Pearson's correlation analyses were used instead to explore the relationship between mask exposure and emotion regulation. While none of the analyses were statistically significant, several trends emerged from the results. First, we found that mask exposure was negatively correlated with emotion regulation scores reported in the ERC (r = -.27), and positively correlated with lability/negativity scores reported in the ERC (r = .01). While examining the associations between mask exposure and the actions coded during the TBT, we found that mask exposure was positively correlated with disruptive behaviours, and the relationship was moderately strong and approached significance (r = .55, p = 0.06). In addition, mask exposure was found to be negatively correlated with attentional distraction (r = -.43) and soothing (r = -.38), suggesting that an increase in mask exposure is associated with a decrease in attentional distraction and soothing behaviours. To conclude, mask exposure was related to lower emotion regulation scores reported in the ERC and showed a slight positive association with lability/negativity scores.

Additionally, mask exposure was associated with higher levels of disruptive behaviours, with a moderately strong relationship that approached significance.

Due to constraints in sample size, it was not feasible to perform the planned mediation analysis. A minimum of 350 participants (80% power) were required to achieve adequate statistical power to run this analysis. The sample size available for this study did not meet this requirement, necessitating a focus on simple correlation techniques instead.

Discussion

The primary objective of this study was to explore the impact of mask exposure on children's emotion recognition and regulation. The study aimed to examine the relationship between levels of mask exposure during the COVID-19 pandemic predicted these emotional processes, considering age and biological sex as additional factors. As has been noted previously, it is important to acknowledge that the small sample size of this study limits the generalizability, accuracy, and statistical power. Consequently, while the reported correlations and trends are discussed as if they were statistically significant, it should be recognized that results from this study may not fully reflect broader patterns or effects. The interpretations provided should therefore be considered as preliminary, with the understanding that more robust conclusions would require validation through larger, more representative samples.

Mask Exposure & Emotion Recognition

Previous research has produced limited literature on the impact of mask exposure on children's emotion recognition. Our results suggest a negative relationship between mask exposure and emotion recognition, where children with higher exposure to mask wearing adults had greater difficulty recognizing emotions, both on masked and unmasked faces overall, as well as when looking at angry faces specifically. This finding aligns with our hypothesis (*H1:*

Children who had higher exposure to mask wearers will demonstrate decreased ability to recognize emotions, as compared to children who had lower mask exposure) given that prolonged mask-wearing is likely to hinder the development of emotion recognition skills due to the obstruction of key facial features such as the mouth and the lower part of the face, which are essential for understanding emotional cues. Furthermore, children highly exposed to masked faces may struggle to generalize their understanding of emotions to unmasked contexts. Indeed, this study found that children with higher levels of mask exposure not only struggled to recognize masked faces, but unmasked faces as well, providing some evidence that higher levels of mask exposure may negatively influence children's ability to recognize emotions. It is possible that one might expect children who had higher levels of mask exposure to develop stronger skills in recognizing emotions due to the need to rely more on uncovered facial features/cues, such as the eyes, and other contextual information. However, this study suggests otherwise, finding that greater mask exposure correlates with poorer emotion recognition. Rather than improving interpretative skills, the prolonged lack of access to comprehensive facial expressions seemed to hinder overall emotion recognition abilities, as children were deprived of crucial visual cues needed to fully understand and differentiate emotional states. Although the results were not statistically significant, the observed correlations align with our first hypothesis, highlighting a negative relationship between mask exposure on children's perception and recognition of emotions.

Interestingly, the facial features that help in identifying facial expressions differ depending on the emotion. For example, recognizing happy and disgusted expressions depend highly on cues from the lower part of the face, particularly the mouth (e.g., smile) (McCrackin et al., 2023; Smith et al., 2005). On the other hand, identifying fearful and sad expressions

primarily relies on information from the upper part of the face, such as the eyes (Bombari et al., 2013; McCrackin et al., 2023; Smith et al., 2005; Sullivan et al., 2007). The findings regarding anger are inconsistent: some studies show reduced anger recognition when the lower face is obscured (Kotsia et al., 2008), while many others emphasize the eye region as the key feature for identifying anger (Bassili, 1979; Ciccarelli et al., 2022; Guarnera et al., 2015; Smith et al., 2005, Williams et al., 2023).

The present study observed that participants were able to recognize happy expressions despite the lower part of the face being obscured, a finding that contrasts with existing literature (McCrackin et al., 2023; Smith et al., 2005). On the other hand, we observed that children with higher levels of mask exposure showed greater difficulty recognizing angry faces (both masked and unmasked). This is particularly interesting because, as mentioned, many studies suggest that anger is primarily recognized through cues from the upper part of the face, such as furrowed brows and intense eye expressions (Bassili, 1979; Ciccarelli et al., 2022; Guarnera et al., 2015; Smith et al., 2005, Williams et al., 2023). Despite this, children with higher levels of mask exposure showed difficulty recognizing anger. One possible explanation is that children in this study were exposed to masked faces during sensitive developmental periods (i.e., ages three to four, when mask mandates were in place), which could potentially have an impact on their ability to process emotions from partial visual information. The consistent absence of lower-face cues, such as mouth tightening, may have limited their ability to associate upper-face cues with anger, given that anger could typically be recognized from the upper face alone. Without seeing these additional cues, children might struggle to fully interpret the emotional context, leading to less accurate recognition (Grundmann et al., 2020). In other words, their ability to interpret anger may have been compromised due to a lack of exposure to full facial expressions during these

formative years. This means that while some specific facial expressions can signal emotions, the absence of a complete facial context due to mask wearing could impair a child's ability to integrate these cues effectively (Carbon, 2020; Grundmann et al., 2020; Roberson et al., 2012). Hence, children might not develop a comprehensive understanding of certain emotional expressions, which could influence their overall ability to recognize and respond to emotions in various social situations. This impairment could have contributed to the observed difficulties in recognizing angry faces, even though children had no trouble recognizing happy or sad faces. This might not have been the case for recognizing happiness or sadness as children typically master the recognition of happiness and sadness around age five, while their ability to recognize other emotions such as anger does not reach adult-like levels until ages 11 or 12 (Durand et al., 2007). Therefore, it is possible that prior to the impact of mask wearing on their development, they had already acquired the skills to recognize happy and sad faces but had not yet fully developed the ability to recognize anger.

Another possible explanation for these discrepancies may lie in the expressiveness of the actors' eye regions in the stimuli used in this study. For instance, the actors in this study may have conveyed stronger expressions through their eyes when expressing happiness, while their eye region may have been less expressive for anger than those from other studies. Differences in the expressiveness of actors across studies could account for the variation in findings, a hypothesis that can be further investigated using eye-tracking devices to pinpoint the specific facial regions participants focus on.

Mask Exposure & Emotion Regulation

This work also looked at the relationship between mask exposure and emotion regulation in children, as reported by their parents, through the ERC and observed through the TBT. We

found a negative correlation between mask exposure and parent-reported emotion regulation skills, suggesting that increased mask exposure was associated with poorer emotional regulation. Children's understanding and recognition of emotions are known to be critical for their social well-being, mental health, and cognitive development (Denham, 2007; Parker & Gottman, 1989; Knitzer, 1993; Blair, 2002). More specifically, accurate emotion recognition is key for children as they learn to regulate their own emotions (Greenberg et al., 2017; Mauss et al., 2005; Mayer & Salovey, 1997; Zarotti et al., 2018). Thus, our findings indicating that prolonged mask exposure may be associated with poorer emotion regulation skills is not surprising. When children, in our study, were exposed to masked faces, it seems that their ability to observe and learn from full facial expressions did not evolve as rapidly; thus, impeding effective emotion regulation strategies, as children might not fully grasp how to modulate their own emotions based on incomplete or inaccurate interpretations of others' emotional states (Izard, 2001; Lane, 2000; Mayer et al., 2001; Yoo et al., 2006). Indeed, emotion recognition has been found to be a more foundational concept than emotion regulation, as emotion recognition must take place before emotion regulation can occur (Izard, 2001; Lane, 2000; Mayer et al., 2001; Yoo et al., 2006). Additionally, consistent exposure to masked faces may disrupt typical social interactions and feedback processes that are essential for learning and practicing emotion regulation skills (McCrackin et al., 2023).

A (very small) positive correlation between mask exposure and parent-reported lability/negativity scores, as well as a strong positive correlation (that approached significance) between mask exposure and disruptive behaviours were observed during the TBT. These disruptive behaviours further reflect challenges in emotion regulation, particularly as exposure to masked faces increased. These findings provide more evidence of the possibility that obstructed

facial cues could lead to more frequent misinterpretations of others' emotions, resulting in a decreased emotion regulation and increased number of disruptive behaviours. In other words, as children struggle to understand and predict emotional responses due to incomplete visual information, they might experience greater difficulty regulating their own emotions, leading to more frequent and intense emotional fluctuations. This hypothesis is supported by previous work that has found emotion knowledge to predict behavioral outcomes later in life (Izard, 2001). Indeed, when children do not have the skills to accurately understand and interpret others' emotional expressions, they are more likely to misinterpret these expressions which can influence their ability to perceive emotions in a way that does not align with social expectations, resulting in social difficulties and miscommunications (Eisenberg & Fabes, 1998; Izard, 2001). The lack of clear emotional feedback from others could contribute to heightened lability and negativity, as children may have less confidence in their emotional understanding and responses (Eisenberg & Fabes, 1998; Izard, 2001).

In addition, several noteworthy trends emerged from the behaviours observed during the TBT. First, when looking at the relationship between mask exposure and attentional distraction, we found a negative correlation suggesting that lower mask exposure is associated with an increase in attentional distraction. While attentional distraction might seem counterproductive when the immediate goal is to open a locked box, it can be a useful and positive strategy for regulating emotions, particularly when a child is trying to manage anger or frustration (Dennis et al., 2009; Calkins & Johnson, 1998; Grolnick et al., 1996; Shoda et al., 1990). By shifting their attention from the source of their distress, a child can prevent these strong feelings from escalating into disruptive behaviours. This technique may allow them to calm down and approach the situation more rationally, demonstrating an effective way to cope with difficult

emotions without resorting to negative actions. For example, Cole & Deater-Deckard (2009) reported that cognitive self-distraction is an important and effective emotion regulation strategy helping young children deal with frustrating situations. Similarly, a negative correlation was found between mask exposure and soothing behaviours observed during the TBT, proposing that lower mask exposure is associated with increases in soothing behaviours. This is not surprising, given that soothing behaviours, such as self-comforting actions, are considered elementary responses that children naturally engage in to regulate their emotions (Dennis et al., 2009; Gilliom et al., 2002; Kopp, 1989), and lower mask exposure was expected to be associated with an increase in emotion regulation ability. That said, children are expected to use self-soothing less frequently as they develop more sophisticated and useful emotion regulation strategies, such as problem solving (Dennis et al., 2009). It is however notable that no strong correlation was found between mask exposure and problem solving. The absence of a strong correlation might suggest that children with higher mask exposure might be experiencing delays in their emotional development, leading them to rely on more elementary responses like self-soothing, rather than advancing to more complex strategies (Dennis et al., 2009). The restricted opportunities to observe and learn more nuanced emotional cues due to masked faces could contribute to these developmental delays, resulting in a continued dependence on basic soothing behaviours instead of advanced emotion regulation techniques.

All this being said, we observed these relationships two to three years after mask mandates were removed. Could prolonged exposure to masks have long-lasting impact on children's emotional development, and more specifically, their emotion regulation skills? These potential impacts could include delays in social-emotional development, habitual responding, and cumulative social stress. First, those children who were in their critical periods (i.e., ages

three to four) in their emotional development during the mask mandates (2020/2021) and consistently had minimal exposure to full facial expressions could experience delays in their emotional development, disrupting their ability to learn and understand social cues. For example, Cole & Deater-Deckard (2009) suggested that disruptions to emotional development (e.g., inappropriate parent strategies) during sensitive periods (i.e., ages 3-4) may result in difficulties coping with emotions effectively. Furthermore, during mask mandates, children had fewer opportunities to practice recognizing and responding to emotions accurately, thus potentially leading to challenges in social communication. Bourke et al. (2023) suggested that older children who had experience learning about emotions prior to the COVID-19 pandemic showed better emotion recognition compared to those who may not have developed those skills during the pandemic. Similarly, for over a year during the mask mandates, children missed out on important peer interactions and the opportunity to form and maintain relationships. The absence of consistent reinforcement of these skills might suggest that they are still experiencing delays even years later (Cole & Deater-Deckard, 2009).

Next, children may have developed habitual emotional responses during mask mandates. During the time masks were required, children might have become accustomed to certain ways of handling their emotions when they experienced difficulties in their emotional understanding. For instance, if a child frequently felt confused or anxious because they could not recognize someone's facial expression behind a mask, they might have developed a habit of reacting with frustration or fear (which can manifest as anger) (Senkal et al., 2022). Even after masks were no longer required, these habits might become part of their default mode network, resulting in habitually reacting with frustration in uncertain situations (Senkal et al., 2022; Wang et al., 2020). These habitual responses might become a part of how they cope with emotions, and it can

take time and effort to learn new, healthier ways to respond (Senkal et al., 2022; Wang et al., 2020).

Lastly, cumulative social stress and effects of social isolation may help explain the observed relationship between mask exposure and weaknesses in emotion regulation (i.e., lability/negativity, disruptive behaviours). As in the scenario above, if a child frequently felt confused or anxious due to the unpredictability of others' facial expressions, they might withdraw socially (Wang et al., 2020). The difficulties with social interactions associated with prolonged mask wearing may then lead to social stress and/or anxiety. This extended period of social strain might have long-lasting effects on children's overall emotional health and their ability to regulate their emotions effectively (Wang et al., 2020). Together, the observed relationships between mask exposure and both lability/negativity and disruptive behaviours provide support for our second hypothesis, which posits that children with higher exposure to mask wearers will demonstrate decreased ability to regulate their own emotions.

Strengths and Limitations

There are several strengths to this work, including the use of multiple measures to assess emotion regulation, the development of a mask exposure measure and an emotion recognition task, and the exploration of specific emotions. However, various limitations to this work need to be highlighted. Of course, the small sample size is a significant limitation, impacting the statistical power of the analyses, the interpretation of the results, and the generalizability of findings. Further, the small sample did not allow us to analyse the data in a more nuanced way and we relied heavily on simple correlations. A larger sample size would allow for more robust statistical techniques, such as regression, mediation, and moderation analyses, and provide a more accurate representation of the population. The small sample size also restricts the ability to

detect subtle differences and relationships among variables, potentially overlooking important trends or associations. Next, the lack of variability in responses restricts the ability to conduct comprehensive analyses and draw meaningful conclusions about several emotions included in the study (i.e., happiness and sadness). This also raises concern for the emotion recognition measure employed, as well as its ability to capture the full range of emotion recognition abilities. In addition, while we aimed to control for age and biological sex differences, the current analyses did not allow us to control for confounding variables. Plus, there may even be other confounders such as socioeconomic status, parental involvement or attachment, previous exposure to social emotional learning problems, and neurodiversity (e.g., Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder) that this study did not account for. These factors could interact with the variables of this study (e.g., mask exposure, emotion recognition and regulation abilities) and impact the outcomes, leading to biased or incomplete interpretations of the data. While also closely tied to the small sample size, other factors such as sensitivity of measures, limited variability in data, and uncontrolled confounding variables could play a role in the lack of statistical significance in this study's findings.

Implications and Future Directions

The findings of this study could have implications for educational and psychological support and interventions, particularly in contexts where mask wearing was prevalent. It is important for educators, mental health professionals, and others working with children to recognize the potential impact of prolonged mask exposure on children's ability to recognize and regulate emotions. Given the observed correlations between mask exposure and emotion recognition, tailored interventions may be necessary to support children in developing these critical social-emotional skills. Schools and counselling services should implement programs that

focus on enhancing children's emotional literacy and adaptive emotion regulation strategies, especially in the context of a post-pandemic world. These programs should include activities that teach children to identify and understand emotions through facial expressions, as well as alternative cues, such as body language and tone of voice.

The study's findings highlight several avenues for future research, particularly the need for larger sample sizes. Increasing the sample size will not only enhance the statistical power of the analyses but also help address the issue of lack of variability in the data. Larger, more diverse samples would allow us to capture a wider range of experiences and emotional responses, providing a more comprehensive understanding of how mask exposure affects children's emotional development. Future studies should aim to recruit participants from various socioeconomic, cultural, and geographical backgrounds to ensure the findings are generalizable and reflective of the broader population. Moreover, longitudinal studies are essential to understanding the long-term effects of mask exposure on children's emotion recognition and regulation abilities. Future research could focus on following children over extended periods and observing how their emotion recognition and regulation skills develop and change as they grow, given their exposure to masks during their critical development periods. As well, future studies could benefit from including a control group of children who were in regions without mask mandates compared to a group of children with high mask exposure. This comparison could provide a clearer understanding of the direct effects of mask-wearing on emotional development by controlling for other variables. Besides, incorporating eye tracking technology into this study could provide valuable insights by precisely identifying where children focus their gaze when interpreting emotions. Such information could clarify the specific visual strategies employed in emotion recognition, particularly under conditions where facial cues are partially obscured.

Lastly, future research should also include mediation and moderation analyses to explore the underlying mechanisms and contextual factors influencing the relationship between mask exposure, emotion recognition, and emotion regulation. Mediation analyses could explore if emotion recognition is the root of the relationship between mask exposure and emotion regulation, while moderation analyses could help identify the impact of mask exposure on the relationship between emotion recognition and emotion regulation.

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Appendix A

Scenarios

Actor 1 Unmasked Happy

Jason's dad asked if Jason could help him in the backyard, and Jason said, "Yes, I would love to help you, dad!". Jason's dad was happy to hear that. Can you point out to the happy face?

Actor 1 Unmasked Sad

Jason's dad lost his wallet. He was sad because he had very important things in his wallet. Can you point out to the sad face?

Actor 1 Unmasked Angry

Jason's dad told Jason to finish his food before leaving the table. Jason did not listen to and left the table. Jason's dad was angry. Which one is his angry face?

Actor 1 Masked Happy

Jason and his dad exercised together. Jason's dad was so happy to exercise with Jason. Which one is his happy face?

Actor 1 Masked Sad

When Jason came back from school, he saw his dad sitting on the couch all by himself. Jason asked if he was okay, and his dad said, "I am sad because my best friend is moving far away.". Point out the sad face.

Actor 1 Masked Angry

When Jason and his dad were walking home, a car went by and splashed water on them! Jason's dad was angry at the driver for not being careful. Which one is his angry face?

Actor 2 Unmasked Happy

Justin saved some money and bought his mom a gift for her birthday. Justin's mom was so happy when Justin gave her the gift. Point out the happy face.

Actor 2 Unmasked Sad

Justin's mom spent all day cooking Justin's favourite meal. When it was dinner time, Justin took a bite and said, "Eww! This food tastes bad!". Justin's mom was very sad to hear that. Which one is her sad face?

Actor 2 Unmasked Angry

When Justin and his mom were walking on the street, Justin's mom warned him that he should not run because he could fall. Justin started running which made his mom angry. Which one is her angry face?

Actor 2 Masked Happy

Justin and his mom played soccer. Justin's mom was so happy that they got to spend time together. Can you point out to her happy face?

Actor 2 Masked Sad

Justin's mom found out that her car broke down. Now, she is very sad because she has to spend a lot of money to get it fixed. Point out to her sad face.

Actor 2 Masked Angry

When Justin and his mom were having a serious talk, Justin stopped listening. Justin's mom got angry at him. Which one is her angry face?

Actor 3 Unmasked Happy

Today, Jo did a great job at school and received a well-done sticker from her teacher! When Jo mentioned this to her dad, he was so happy. Point out the happy face.

Actor 3 Unmasked Sad

When Jo and her dad were walking this morning, Jo stumbled on a rock and fell down. Jo started crying, and her dad was sad to see Jo hurt. Which one is his sad face?

Actor 3 Unmasked Angry

Jo promised her dad that she would water the plants this morning. When Jo's dad asked if she had watered the plants, Jo said, "I did not water the plants because it is a boring thing to do.". Jo's dad felt angry because Jo didn't keep her promise. Which one is his angry face?

Actor 3 Masked Happy

Jo and her dad visited some relatives. Everyone had a great time together and ate very good food. Jo's dad was very happy. Which one is his happy face?

Actor 3 Masked Sad

Jo's dad had an argument with one of his friends at work. He was very sad that this happened. Which one is his sad face?

Actor 3 Masked Angry

When Jo and her dad were at the grocery store, someone was very rude to the cashier. Jo's dad got angry at this person for being so rude. Point out to the angry face.

Actor 4 Unmasked Happy

Emily helped her mom clean their messy kitchen which made her mom very happy. Which one is her happy face?

Actor 4 Unmasked Sad

Emily's mom told Emily to clean her room, but Emily said no and said, "I don't love you anymore mom!". This made her mom feel very sad. Which one is her sad face?

Actor 4 Unmasked Angry

Emily was playing with one of her toys. Suddenly, she threw it on the floor, and the toy broke. Emily's mom got very angry. Point out to the angry face.

Actor 4 Masked Happy

Emily suddenly walked up to her mom, hugged her, and said, "I love you so much mom!". Emily's mom was so happy to hear that. Which one is her happy face?

Actor 4 Masked Sad

Emily told her mom that she is not doing well in school. Emily's mom was sad to hear that Emily is struggling. Can you point out the sad face?

Actor 4 Masked Angry

Emily and her mom went swimming. Emily's mom warned her that she should not run around the pool since she could hurt herself. Emily did not listen and started running. Emily's mom got angry at Emily for not listening. Point out the angry face.

Appendix B

Table 5

Pearson's Correlations Between Emotion Regulation Measures

		Transparent Box Task Actions Coded						
		PS	BD	AD	FDO	S	DB	D
Emotion Regulation Checklist Scores	ERC (LN)	-.14	.18	-.002	-.29	.29	.30	-.60
	ERC (ER)	-.24	-.04	.57	.38	.25	-.02	.08

Appendix C

Table 6

Pearson's Correlations Between Mask Exposure and Transparent Box Task Actions Coded

		Mask Exposure (Hours Per Year)
Transparent Box Task Actions Coded	Problem Solving	.06
	Behavioural Distraction	-.05
	Attentional Distraction	-.43
	Focus on Desired Object	-.27
	Soothing	-.38
	Disruptive Behaviours	.55
	Distress	-.12