Title: The role of facemasks in the recognition of emotions by preschool children

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Introduction: Since the beginning of the COVID-19 pandemic, health policy requires staff working in preschool education to wear facemasks. This has prompted worries about the ability of young children to recognize emotions, and the possible impact on their development. Without facemasks, pre-schoolers aged 36- 72 months had correct responses rate between 11.8 % and 13.1%[1]. Recent studies using photos with digitally added facemasks showed worse recognition with facemasks, the first tested pre-schoolers on a smartphone at home [2] and the second tested 7- 13- year old children [3] . We therefore aimed to study the role of actual facemasks on the recognition of joy, anger and sadness in younger preschool children.

Methods: The primary outcome of this cross-sectional experimental study was the rate of correct responses using pictures of adults displaying joy, anger or sadness. With 15 actors with and without a surgical facemask, we created a dataset of 90 pictures displaying joy, anger or sadness (10 women, 5 men, based on demographic information of childminders in local public day-care centres) (Figure 1). We built the experiment with E-Prime® [4]. The ethics committee for human research of the Canton Vaud approved the study (study number: 2020-02687) and accepted that with the pandemic situation consent could be waived. Parents of children attending public day-care centres received written, oral and filmed information, with the possibility to opt out. Children aged 36 to 72 months without treated neurodevelopmental impairment were eligible to participate. They sat in front of a computer, with a known caretaker if they wanted, and a trained paediatrician showed randomly the 90 pictures. Children

could either name the emotion, point on a card showing emoticons of these three emotions, or choose the response options "I don't know" or "quit the experiment". The statistical analysis included a comparison of the correct response rate in the different conditions with χ^2 tests and bias corrected Cramer's V to calculate effect sizes.

Results: Data was collected in nine public day-care centres. The sample consisted of 276 children (girls: 48.9%, mean age=52.4 months, SD=9.6). The test lasted a median of 6.74 min per child (IQR 4.22-9.26). The rate of "I don't know" responses was 3.1 % and 2.2 % children stopped the experiment prematurely but their responses were included. The global correct response rate was 68.8%, 70.6% without facemask *vs* 66.9% with facemask ($\chi^2(1) = 37.783$, $p < .001$, $V = 0.0385$, 95%CI [0.0266, 0.0515]), with a difference for joy (94.8 *vs* 87.3%, $\chi^2(1) = 140.260$, $p < .001$, $V = 0.1301$, 95%CI [0.1090, 0.1521]), sadness (54.1 *vs* 48.9, $\chi^2(1) = 21.937$, $p < .001$, $V = 0.0505$, 95%CI [0.0266, 0.0515]), but not anger (62.2 *vs* 64.6%, $\chi^2(1) = 2.7094$, $p = .0997$, $V = 0.0147$, 95%CI [0.0000, 0.0399]). There was no difference between boys and girls. The rate of correct responses increased with age ($\chi^2(2) = 136.680$, $p < .001$, $V = 0.07363$, 95%CI [0.0615, 0.0864]) (Figure 2A). Finally, the analysis of the mistakes showed that up to 25 % pre-schoolers confused anger and sadness and up to 21% answered joy for anger or sadness (Figure 2B).

Discussion: Actual facemasks, depicted on static pictures, were significantly associated with emotion recognition of healthy preschool children, although differences were small and effects sizes were weak (Cramer's $V \leq 0.2$). Joy was more recognised and mistakenly chosen for anger or sadness, probably due to a positivity bias in children[6]. Overall, participants of our study, who had been exposed to facemasks for nearly a year, recognized emotions on pictures better than reported in previous research, even with facemasks [1, 6]. This study has several limitations including the generalizability of its findings using static pictures instead of live actors, and the validity of the outcomes. Investigating the role of facemasks in relation to other aspects of development and for children with developmental issues remains important, particularly in the wake of a fourth wave of the COVID-19 pandemic.

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Figure 1. Examples of pictures of the same actor showing (A) joy, (B), sadness, and (C) anger without and with facemasks.

A B C

Figure 2B Responses for joy, anger and sadness, without and with facemasks (*n*= 276)

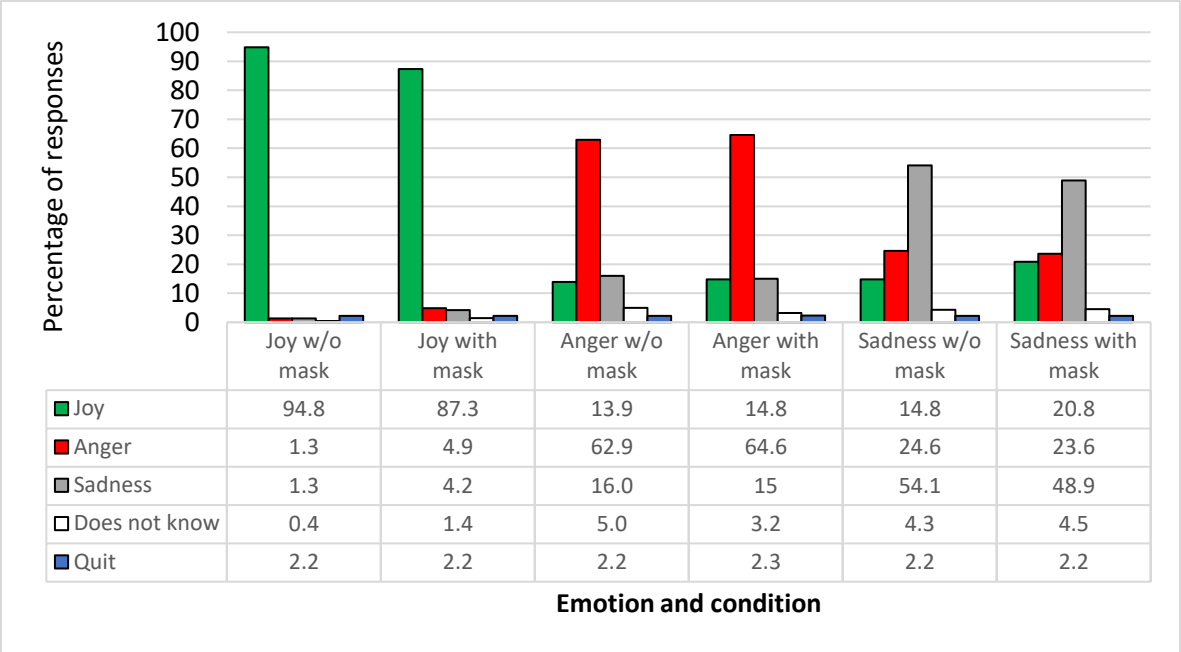

Figure 2A Rate of emotion recognition by age, emotion, and presence of facemask (*n* = 276)