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Children's recognition of facial expressions

Children's recognition of emotional facial expressions through photographs and drawings

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Abstract

The purpose of the present study was to examine children's recognition of emotional facial expressions, by comparing two types of stimulus: photographs and drawings. We aimed to investigate whether drawings could be considered as a more evocative material than photographs, as a function of age and emotion. Five and 7-years-old children were presented with photographs and drawings displaying facial expressions of four basic emotions (i.e., happiness, sadness, anger and fear) and they were asked to perform a matching task by pointing to the face corresponding to the target emotion labelled by the experimenter. The photographs we used were selected from the Radboud Faces Database and the drawings were designed on the basis of both the facial components involved in the expression of these emotions and the graphic cues children tend to use when asked to depict these emotions in their own drawings. Our results show that drawings are better recognized than photographs, for sadness, anger and fear (with no difference for happiness, due to a ceiling effect). And that the difference between the two types of stimulus tends to be more important for 5-year-olds compared to 7-year-olds. These results are discussed in view of their implications, both for future research and for practical application.

Keywords: Children; Emotion; Facial expression; Stimulus

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Studies examining emotion recognition in children have used various tasks of increasing difficulty (Markham & Adams, 1992). In matching tasks, children are asked to choose among a set of facial expressions the one that matches an emotional situation, or another facial expression, or an emotion label. In forced choice labeling tasks, children need to choose among a set of emotional labels the one best describing a target facial expression. In free labeling tasks, children are expected to freely produce the emotional label corresponding to a target facial expression. Within matching tasks, there is a clear hierarchy when considering the task difficulty. For instance, because it provides children with contextual cues and does not rely on children's knowledge of emotional labels, matching a facial expression with an emotional situation has been proved to be an easier task for children than matching a facial expression with an emotional label. However, contrary to labeling tasks, matching tasks do not require children to give a verbal response, therefore minimizing the demands relative to children's linguistic abilities and emotional vocabulary. Regarding age differences, studies consistently report a general increase with age in children's ability to recognize facial expressions along with differences according to emotion (Chronaki, Hadwin, Garner, Maurage & Sonuga-Barke, 2015; Gao & Maurer, 2010; Gross & Ballif, 1991; Herba & Phillips, 2004; Saarni, Campos, Camras & Witherington, 2006). However, the age-improvements depend on the type of task that is used. For instance, when using a matching task, the improvement is expected to appear at an earlier stage (i.e., between the age of 3 and 7) than when using a free labelling task (i.e., between 5 and 11). Whatever the type of task, happiness is generally recognized more easily and earlier than the other basic expressions, sadness usually comes next, followed by anger and then by fear, surprise and disgust. This developmental pattern for basic emotions can be attributed to the progressive differentiation in children's categories for emotion (Widen, 2013; Widen & Russell, 2010) and to the improvement of perceptual discriminability in the facial expressions associated with these emotions (Gibson & Spelke, 1987; Gosselin & Larocque, 2000).

When researchers and psychologists aim to examine children's comprehension, interpretation and perception of emotional faces, they can use validated databases of photographs consisting in controlled stimulus sets of adults and/or children posing basic facial expressions (e.g., CAFE: LoBue &

Thrasher, 2015; JACFEE: Matsumoto & Ekman, 1988; NimStim: Tottenham et al., 2009; Pictures of Facial Affect: Ekman & Friesen, 1976; Radboud Faces Database: Langner et al., 2010). Some researchers also report using other kinds of materials such as pictorial representations of emotional faces. Indeed, line drawings are often used as emotional stimulus or as response cards in research with children (e.g., Da Fonseca, Segquier, Santos, Poinso & Deruelle, 2009; Lobue, 2009; van Beek & Dubas, 2008; Walden & Field, 1990). In these studies, schematic drawings are usually used “in order to use the simplest possible stimulus while still preserving the information necessary for emotion expression” understanding (Palermo, Pasqualetti, Barbati, Intelligente & Rossini, 2006, pp. 356). This seems to be reasonable assumption, particularly when considering the findings from studies investigating children's depiction of emotions in their own expressive drawings of faces (Brechet, Baldy & Picard, 2009; Cox, 2005; Golomb, 1992; Jolley, 2010; Sayil, 2001). Indeed, these studies consistently report that children are able to depict facial expression of emotions in their drawings from a very young age: children are able to depict happiness from the age of 4, sadness from the age of 5 and anger and fear from the age of 7. So as to depict these emotions, children use facial cues consisting in highlighting or exaggerating the key facial features involved in the facial expression of each emotion. For instance, sadness is commonly depicted through a downturned mouth, half-closed eyes and outward eyebrows; whereas fear is depicted through an opened and wavy mouth, wide-opened eyes and curved eyebrows. Furthermore, Missaghi-Lakshman and Whissell (1991) showed that when children were presented with their own drawings a few weeks after the expressive drawing task, they were better than adults at recognizing the target emotions that were depicted in the drawings. These results reinforce the idea that children are particularly familiar with and sensitive to drawings of emotional faces.

However, the use of schematic faces over photographs as stimuli in emotion recognition studies raises two main concerns. First, as there is no available database providing with controlled drawings of emotional faces, the drawings which are used as emotional stimulus are usually specifically created by the authors for their research, without clear precisions about how these drawings were designed and validated. As a result, when studies report contrasting results, the differences may be simply due to the

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use of different materials. Moreover, the use of stimuli which have not been previously controlled can raise some questions about the validity of the findings. Second, the use of drawings in these studies is motivated by the idea that this type of stimulus is more evocative than photographs and more suitable to children. Yet this assumption is mainly based on intuition and lacks empirical evidence. Indeed, to our knowledge, there is only one study which aim was to examine the relevance of using drawings compared to photographs with children (MacDonald, Kirkpatrick & Sullivan, 1996). Although the results of this study suggest that drawings could be more easily recognized than photographs by children, it was not clearly reported on what basis the drawings were designed and even the older children of the sample (i.e., 5-year-olds) still had difficulties recognizing the target emotions, except for happiness. Thus, it may be interesting using more controlled line drawings of facial expressions and examining their recognition in older children as well. Furthermore, this study did not include statistical analyses relative to the potential interaction between type of stimulus and age and emotion. Yet, recognizing emotional facial expressions has been shown to be more complex for young children compared to older ones and for facial expressions that involve complex combinations of facial features (e.g., anger) compared to more simple combinations (e.g., happiness). Consequently, if schematic faces are a more evocative stimulus than photographs, this difference might be more important for younger children and for the emotions which display the more complex facial expressions. But, this assumption needs to be empirically tested.

The purpose of the present study was to examine children's recognition of emotional facial expressions, by comparing their interpretation of two different types of stimulus: photographs and drawings, as a function of age and emotion. We aimed to address the two concerns cited above about the use of drawings as stimuli in emotion recognition studies, (1) by designing and presenting more controlled line drawings that could be used in future studies and (2) by examining whether these drawings could be a more evocative material than photographs when investigating children's recognition of basic emotions, as a function of age and emotion. To this end, we used the same matching task as MacDonald et al. (1996), so as to minimize the demands relative to children's linguistic abilities and

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emotional vocabulary (compared to tasks involving free labelling), but without giving children too much cues (compared to tasks involving matching facial expressions with emotional situations) (Markham & Adams, 1992). Children aged 5 and 7 were asked to recognize facial expressions of happiness, sadness, anger and fear. Based on developmental literature, we chose not to examine children under the age of 5 because of motivational issues and possible lack of understanding of task requirements and we chose to limit our investigations to 7-year-olds because a ceiling effect is very likely to occur from the age of 8 in this kind of task (e.g., Harrigan, 1984; Kirouac, Doré, & Gosselin, 1985). Children were presented two kinds of stimulus. Photographs were taken from the Radboud Faces Database (RaFD; Langner et al., 2010); whereas drawings were thoroughly designed on the basis of both the facial components involved in the expression of these emotions (Ekman, Friesen & Hager, 2002) and the graphic cues children tend to use when asked to depict these emotions in their drawings (Brechet et al., 2009).

In line with previous studies, we expect children's accuracy to depend on age and emotion (Chronaki et al., 2015; Gross & Ballif, 1991; Herba & Phillips, 2004; Saarni et al., 2006). More precisely, the number of correct responses should be higher at 7 than at 5 and happiness should be better recognized, followed by sadness, then by anger and by fear. According to MacDonald et al.'s findings (1996), drawings should be better recognized than photographs. However, this expected effect of the type of stimulus is very likely to depend on age and emotion. Indeed, the difference between photographs and drawings might be more important for young children and for emotions involving complex combinations of facial features (e.g., anger and fear).

Method

Participants

Three hundred and forty-three children participated: one hundred and sixty 5-year-olds ($M = 5;7$, range = 5;0-5;11, $SD = 5$ months, 83 boys and 87 girls) and one hundred and eighty-three 7-year-olds ($M = 7;6$, range = 7;1-7;11, $SD = 4$ months, 92 boys and 91 girls). Children were attending elementary schools in France. The 5-year-olds were in kindergarten and the 7-year-olds were in 2nd grade. They were of average socio-economic background, and in their normal school year. These children were

recruited randomly from local schools that expressed interest in participating in the study. This study was conducted in accordance with the Declaration of Helsinki (WHO, 2008) and approved by the local Ethics Committee Review Board (University Montpellier III, France). Written parental consent was obtained for each participant and children's assent was obtained prior to beginning the experiment.

Material

Photographs. Two models were selected from the Radboud Faces Database (RaFD; Langner et al., 2010) on the basis of how well their emotional expressions of four basic emotions (happiness, sadness, anger and fear) were recognized in the validation study, resulting in a total of 8 photographs. Note that these facial expressions were based on prototypes from the Facial Action Coding System (FACS; Ekman et al., 2002) and that the percentage of agreement on emotion categorization for these photographs ranged from 91 to 100%, according to the validation data. There was a specific combination of action units (AU) for each emotional expression, consisting in prototypical facial components relative mainly to the shape of the eyes, the eyebrows and the mouth, as documented in the FACS (Ekman et al., 2002). Happiness was expressed through AU 6 (cheek raise), 12 (lip corner puller) and 25 (lips part). Sadness was expressed through AU 1 (inner brow raise), 4 (brow lower), 15 lip corner depress and 17 (chin raise). The expression of anger corresponded to the following combination: AU 4 (brow lower), 5 (upper lid raise), 7 (lid tighten), 17 (chin raise), 23 (lip tighten) and 24 (lip press). Finally, fear was expressed through AU 1 (inner brow raise), 2 (outer brow raise), 4 (brow lower), 5 (upper lid raise), 20 (lip stretch) and 25 (lips part). Figure 1 shows the four photographs corresponding to the first model we selected.

Drawings. As the main goal of the study was to compare the evocative power of drawings versus photographs, we designed drawings of emotional faces that involved the same action units as those displayed in each photograph (see the detailed description above). Consequently, our drawings differed in terms of the shape of the eyes, the eyebrows and the mouth, as a function of emotion. The shape of these facial features was designed so as to be as close as possible to the facial cues usually depicted by children in their expressive drawings of faces (Brechet et al., 2009; Cox, 2005; Golomb, 1992; Jolley,

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2010; Missaghi-Lakshman & Whissell, 1991; Sayil, 2001). We also added in these drawings expressive facial details such as wrinkles and expression lines, so as to fit to more subtle action units as AU 17 (chin raise) for example. In order to be sure that these drawings were conveying the intended emotional content, a pretest was conducted with a group of 24 graduate students. The percentage of agreement on emotion categorization for these drawings ranged from 95 to 100%. These drawings are presented in Figure 1.

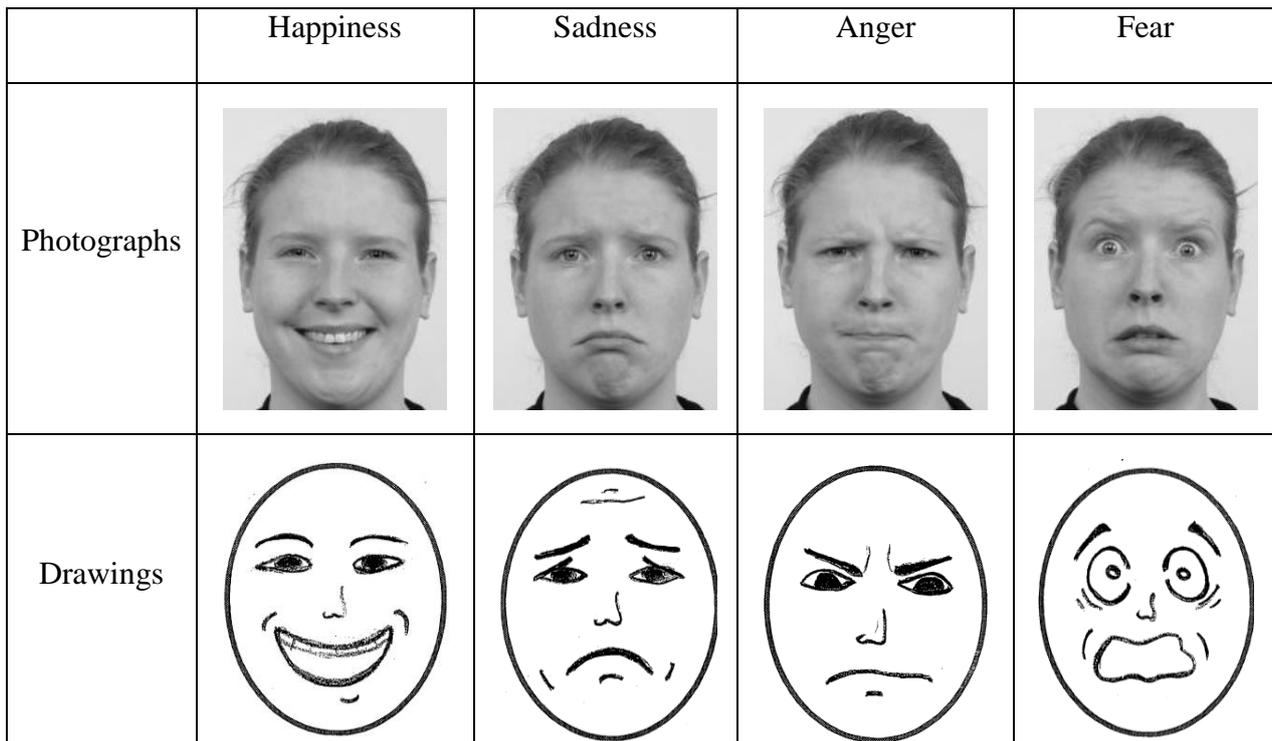


Figure 1. Photographs and drawings used for each emotion

Procedure

Participants were observed individually, in a quiet room in their school. Children were told that they were going to be shown some pictures of faces that displayed different emotions and that the experimenter was going to give them an emotional label and ask them to point to the face displaying this target emotion. Once children felt comfortable with the experimenter, they were shown the first test block. They were presented with two test blocks (photographs and drawings) in a counterbalanced order, each containing 8 trials (2 trials per emotion), for a total of 16 trials. The order of the target emotions within each block was randomized. For each trial, children were presented with a set of four faces

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depicting each of the four emotions tested, either through photographs or through drawings (depending on the test block). The placement of the four faces was randomized for each trial. The experimenter labelled the target emotion (i.e., happy, sad, angry and afraid) and asked the child to point to the corresponding face. The test took up to 10 minutes per child. Each response was scored as correct if the child pointed to the face corresponding to the target emotion. When children pointed to another face than the one expressing the target emotion or when they answered "I don't know", their response was recorded as incorrect. Children were thanked for their participation and were invited to ask any question they wanted. Most of them reported that they enjoyed the experiment. Given that this is a categorical judgement study, emotion recognition accuracy was computed through Wagner's (1993) formula for unbiased hit rates, so as to correct for guessing (Rosenthal, 1987; Wagner, 1993). The resulting corrected scores (ranging from 0 to 1) were then normalized with an arcsine transformation. The final scores could range from 0 to 1.57 (i.e., arcsine of 1).

Results

First, so as to make sure that there was no difference between the two models we selected for the photographs, we conducted an analysis of variance with age (5-, 7-year-olds) as between-subject factor and with emotion (happiness, sadness, anger and fear) and model (model 1, model 2) as within-subject factors. We used an alpha level of .05. This analysis revealed no main effect of the model and no interaction of this factor with age and emotion. Thus, we collapsed data from both models in the subsequent analysis.

Data were then subject to an analysis of variance with age (5-, 7-year-olds) and gender (boys, girls) as between-subject factors and with emotion (happiness, sadness, anger and fear) and type of stimulus (photographs, drawings) as within-subject factors. We used an alpha level of .05. Table 1 presents the mean scores as a function of age, emotion and type of stimulus.

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Table 1. Mean scores (and standard deviations) as a function of age, emotion, and type of stimulus

	5-year-olds		7-year-olds	
	Photographs	Drawings	Photographs	Drawings
Happiness	1.48 (0.02)	1.48 (0.02)	1.54 (0.02)	1.54 (0.02)
Sadness	1.06 (0.04)	1.18 (0.03)	1.32 (0.03)	1.37 (0.03)
Anger	0.75 (0.05)	1.06 (0.04)	1.07 (0.05)	1.27 (0.04)
Fear	0.71 (0.05)	0.89 (0.05)	1.02 (0.04)	1.15 (0.04)
Grand mean	0.99 (0.02)	1.15 (0.02)	1.24 (0.02)	1.33 (0.02)

Note. The mean scores could range from 0 to 1.57

Results showed a significant main effect of age, $F(1, 339) = 66.61, p < .001, \eta^2_p = .16, MSE = 30.01$, with a higher number of correct responses for 7-year-olds ($M = 1.29, SD = 0.02$) compared to 5-year-olds ($M = 1.08, SD = 0.02$). The analysis also indicates a significant main effect of the type of stimulus, $F(1, 339) = 58.28, p < .001, \eta^2_p = .15, MSE = 10.94$, with a higher number of correct responses for drawings ($M = 1.25, SD = 0.01$) compared to photographs ($M = 1.12, SD = 0.02$). We also found a significant main effect of emotion, $F(3, 1017) = 171.22, p < .001, \eta^2_p = .34, MSE = 42.49$. Post hoc Tukey's test indicated that there was a significant difference between each emotion ($ps < .01$): happiness ($M = 1.51, SD = 0.01$) resulted in a higher number of correct responses than the other emotions, sadness ($M = 1.23, SD = 0.02$) significantly differed from anger ($M = 1.04, SD = 0.02$), and fear lead to the smaller number of correct responses ($M = 0.94, SD = 0.03$). Results showed a significant interaction between age and emotion, $F(3, 1017) = 6.88, p < .001, \eta^2_p = .02, MSE = 1.71$. Post hoc Tukey's test indicated that there was a significant difference between 5-year-olds and 7-year-olds for sadness ($p < .001$), anger ($p < .001$) and fear ($p < .001$), but not for happiness. We found a significant interaction between type of stimulus and emotion, $F(3, 1017) = 11.63, p < .001, \eta^2_p = .03, MSE = 1.97$. We conducted planned comparisons between photographs and drawings for each emotion separately. These analyses revealed no difference for happiness. However, there was a significant difference between

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photographs and drawings for sadness, $F(1, 339) = 14.83, p < .001, \eta^2_p = .04, MSE = 1.33$, anger, $F(1, 339) = 41.70, p < .001, \eta^2_p = .11, MSE = 11.27$ and fear, $F(1, 339) = 14.09, p < .001, \eta^2_p = .04, MSE = 4.26$. Finally, there was a marginal interaction between age and type of stimulus, $F(1, 339) = 3.28, p = .07, \eta^2_p = .01, MSE = 0.62$, the difference between photographs and drawings tended to be more important for 5-year-olds than for 7-year-olds. Note that there was no significant effect of gender and no significant interaction between gender and any other factor. Finally, the overall correlation between accuracy for the photographs and drawings was assessed using Pearson's product moment correlation, so as to determine whether the two were related. The overall correlation was highly significant ($p < .001$): $r = .34$.

Discussion

The purpose of the present study was to examine children's recognition of emotional faces, by comparing two types of stimulus: photographs and drawings. We aimed to investigate whether drawings could be considered a more evocative material than photographs, as a function of age and emotion. To do so, 5 and 7-years-old children were presented with photograph and drawings displaying facial expressions of four basic emotions (i.e., happiness, sadness, anger and fear) and they were asked to perform a matching task by pointing to the face corresponding to the target emotion labelled by the experimenter. Considering our factors age and emotion, note that our results are in line with previous studies (Chronaki et al., 2015; Gross & Ballif, 1991; Herba & Phillips, 2004; Saarni et al., 2006), indicating that 7-year-olds are better than 5-year-olds at recognizing facial expressions of sadness, anger and fear (with no difference for happiness, due to a ceiling effect) and that children recognize happiness more easily than sadness, sadness more easily than anger and anger more easily than fear.

Regarding the impact of the type of stimulus on children's recognition of emotions, our results show that drawings are better recognized than photographs. More precisely, this was the case for sadness, anger and fear. The fact that we did not find any difference for happiness is very likely to be due to a ceiling effect. Interestingly, the difference between the two types of stimulus tended to be more important for 5-year-olds compared to 7-year-olds. When perceiving emotional faces, individuals can

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use either analytical (feature by feature) or more holistic (configural) processing strategies (Ellis, 1975). According to Walden and Field (1982), the strategies children use to decode emotional faces may depend on various factors including expression complexity. For instance, complex emotional faces such as angry or frightened ones may be processed using an analytic strategy so as to focus on specific facial features that can help discriminate between emotions and identify the target one. On the other hand, more simple emotional faces such as happy ones may be processed using a more economical holistic strategy. In the present study, the drawings we used were involving the same action units as the photographs but these action units were displayed in a more distinct manner, by highlighting or exaggerating the corresponding expressive facial features (e.g., eyebrows, mouth, eyes) (Cunningham & Odom, 1986). Additionally, by using drawings we intended to minimize confounds related to facial characteristics which are present in photographs of real persons but irrelevant to the emotion (e.g., gender, ethnicity, age, attractiveness of the model; facial details such as moles, wrinkles, freckles, etc.) (Elfenbein & Ambady, 2003; Hess, Adams & Kleck, 2004; Hills & Lewis, 2011; Widen & Russell, 2002). Accordingly, drawings may have focused children's attention on the specific facial features that were relevant to the recognition task, leading to a higher accuracy level, particularly for younger children who had more difficulties extracting the relevant emotional cues from photographs.

In conclusion, the results of the present study indicate that facial expressions of sadness, anger and fear are easier to recognize through drawings than through photographs, in particular for 5-years-old children. First, these findings are in line with those obtained by MacDonald et al. (1996), providing more empirical evidence to the common idea that drawings of emotional faces are easily understood by children than photographs. Second, our results also add relevant information regarding the interaction between the type of stimulus used and age and emotion, by showing that the use of drawings over photographs may be more relevant with younger children and for negative emotions. Third, as we also found an overall significant correlation between accuracy for the photographs we selected and the drawings we designed, our drawings may be considered as a simplified version of the corresponding facial expressions and could therefore be used as emotional stimulus in future emotion recognition

studies, in particular with young children. Finally, besides the fact that drawings can be an interesting material to use in research with children, the results of the present study can also have practical implications. Indeed, drawings could be used as a simplified material (compared to photographs) to enhance children's emotion recognition abilities in educational and clinical settings. For instance, this could be an interesting material to use at school or for specific training with children who have difficulties interpreting facial expressions of emotions, for instance children with learning disabilities (McKenzie, Matheson, McKaskie, Hamilton & Murray, 2000) or autism spectrum disorder (Kouo & Egel, 2016). This could be an interesting field of research for future studies.

Despite these interesting findings, the present study suffers from a number of limitations. First, as this was an exploratory study, priority was given to a large sample size and, as a consequence, we were limited in how long we could test each child, resulting in quite a low number of trials for an emotion recognition task. Second, although we chose to use a simple measure of children's accuracy, it would also be interesting and informative to measure their reaction time, when answering the task. Indeed, according to De Sonneville et al. (2002), with age, reaction time could become a more sensitive measure than accuracy in this type of task. This additional measure could provide more information relative to children's face processing when comparing recognition of drawings versus photographs. It could also resolve the problem of the ceiling effect observed for happiness (Chung & Thomson, 1995). Therefore, so as to gain precision, future studies are needed, measuring both reaction time and accuracy and using a larger number of trials.

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