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The interference effect of emotional expressions on facial identity recognition in preschool-aged children

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The present study aims to explore the influence of facial emotional expressions on pre-scholars' identity recognition was analyzed using a two-alternative forced-choice matching task. A decrement was observed in children's performance with emotional faces compared with neutral faces, both when a happy emotional expression remained unchanged between the target face and the test faces and when the expression changed from happy to neutral or from neutral to happy between the target and the test faces (Experiment 1). Negative emotional expressions (i.e. fear and anger) also interfered with children's identity recognition (Experiment 2). Obtained evidence suggests that in preschool-age children, facial emotional expressions are processed in interaction with, rather than independently from, the encoding of facial identity information. The results are discussed in relationship with relevant research conducted with adults and children.

Keywords: Face processing; Emotion; Preschool-age; Children; Identity recognition.

Face processing is an essential prerequisite for human social interaction. Looking at a face, we are able to distinguish the gender of the person whom we are talking to, we may suppose his or her age, we can say whether he or she is familiar for us, and may understand his or her emotional mood. In everyday life,

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all this information (e.g. gender, age, identity and emotional expression) is simultaneously available in a face. How the face processing system deals with the concurrent presentation of these multiple dimensions is a critical question, which only recently has attracted researchers' attention (see reviews by Calder & Young, 2005; Haxby, Hoffman, & Gobbini, 2000).

Traditional models of face perception, like the well-known Bruce and Young's (1986) model, suggest that stable (e.g. identity, race, gender, age) and transient (e.g. eye gaze, emotional expressions) facial dimensions are processed in parallel and independently one from another. However, this assumption has been challenged and progressively revised based on evidence of interactive processing of various facial dimensions in adults (see review by Calder & Young, 2005) and even in developmental populations (e.g. Spangler, Schwarzer, Korell, & Maier-Karius, 2010). In particular, adult research has shown the existence of multiple interactions between the processing of facial identity and emotional expressions, although evidence is not always consistent about the direction of such interactions. Some studies, mainly using classification (Schweinberger, Burton, & Kelly, 1999; Schweinberger & Soukup, 1998) and adaptation tasks measuring perceptual aftereffects (Campbell & Burke, 2009; Fox, Oruc, & Barton, 2008), suggest that the processing of emotional expressions is influenced by variations in facial identity, whereas identity is encoded and represented independently of emotional information. In contrast, studies measuring recognition memory abilities point out cases in which identity recognition is affected by emotional information conveyed by the face. For example, positive emotions, like smiling, significantly increase face recognition performance (e.g. Endo, Endo, Kirita, & Maruyama, 1992) and familiarity judgments (e.g. Baudouin, Gilibert, Sansone, & Tiberghien, 2000; Gallegos & Tranel, 2005; see also Dobel et al., 2008) relative to neutral expressions, whereas negative emotions, like fear or anger, significantly reduce familiarity judgments (e.g. Lander & Metcalfe, 2007).

In children as well there is quite inconsistent evidence regarding the direction of interactions between the processing of facial identity and emotional expression. Like in adults, studies measuring adaptation aftereffects in school-aged children show that variations in identity influence the perception of both positive and negative emotional expressions, whereas identity perception is not affected by variations in emotional expression (Mian & Mondloch, 2012; Vida & Mondloch, 2009), thus pointing to an asymmetric interaction between the processing of the two facial dimensions. However, studies measuring classification performance showed conflicting results. Spangler et al. (2010) found that 5-to-11-year-old children could selectively attend to identity disregarding variations in emotional expressions, either from happy to sad or the reverse, whereas Baudouin, Durand, and Gallay (2008) found that 6-to-11-year-old children were less accurate in sorting faces based on identity when emotion (happiness, neutral, or sadness) also varied between the faces compared with when all faces displayed the same emotion. Interestingly, in this study the

interfering effect of emotion was larger in younger children compared with older children. A similar developmental pattern emerged in studies measuring identity recognition across changes in emotional expression. Freitag and Schwarzer (2011) found that 3- and 5-year-old children performed better in a delayed recognition task when presented with neutral faces than with emotional faces, in which positive and negative expressions changed between immediate and delayed recognition test. Herba, Landau, Russel, Ecker, and Phillips (2006) showed that the interfering effect of positive and negative emotional expressions on identity recognition decreased with age, since children between 4 and 15 years become more and more accurate at matching the identity of simultaneously presented faces while ignoring emotion. Overall, studies using classification or identity-matching and recognition tasks provide inconsistent results, but suggest that with increasing age comes an increasing independency of representations of facial identity and emotional information.

Beside its relative inconsistency, available evidence on the relationship between the processing of facial identity and emotional information in children suffers of a possible drawback. Specifically, it remains unclear whether the interference effect of emotion on identity processing observed in many studies is due to emotional information per se or is a by-product of children's difficulty to attend, memorize and/or recognize different dimensions of the face stimulus simultaneously.

The ability to identify and recognize a specific face trait implies the capacity to attend to one source of information while ignoring others. It has been shown that when the perceptual load of a task is so high as to exceed the upper limits of available attentional resources—i.e. when our perceptual system has to deal with a great amount of information—selective attention intervenes at early stages of processing to filter out irrelevant information, so as to reduce the number of features that are attended and processed deeply enough to be identified and subsequently compete for the control of action (e.g. Lavie, 1995; Lavie & Tsal, 1994). It is thus possible that domain-general attentional abilities, rather than the specific relationships between identity and emotional information within the face representational space, might explain the interference effect of emotional information on identity processing observed in children. This might be particularly evident in younger children, whose ability to simultaneously process multiple sources of information is still poor (e.g. Huang-Pollock, Carr, & Nigg, 2002). To address this issue, we included in our delayed two-alternative forced-choice matching-to-sample task a condition in which emotional expression was kept constant between the encoding and recognition test phase, so as to overcome the possible confounding generated by the simultaneous variation of multiple facial dimensions. This condition was not included in most of the existing studies with children, which tested participants with emotional faces that changed their expression between the learning and the test phase (e.g. Freitag & Schwarzer, 2011; Herba et al., 2006).

In two different experiments, we asked 4-to-5-year-old children to recognize the identity of a target face between two alternative faces displayed simultaneously soon after the target. In Experiment 1, we compared children's ability to recognize identity in emotional (*vs*. neutral) faces when the emotional expression varied between the encoding and test phase versus remained constant. In Experiment 2, we tested whether the impact of emotional expression on identity recognition holds for both positive (i.e. happiness) and negative (i.e. fear, anger) expressions.

EXPERIMENT 1

The goal of Experiment 1 was to investigate the effect of an emotional expression (i.e. happiness), on 4- to 5-year-old children's processing of facial identity information. All children were tested in three different conditions, one in which emotional expression remained unchanged between the study and the test phase (*Unchanged expression condition*), and two in which emotional expression varied between the two phases (*Changed expression condition*). In the *Changed expression condition*, facial expression changed from neutral to happy or from happy to neutral. In order to recognize the target identity, children were required to filter out the novel information provided by the change in emotional expression, which was irrelevant to the task. Thus, in this condition children's difficulty in selecting relevant information while inhibiting the processing of irrelevant information (i.e. the change in emotional expression) may engender an interference effect of emotional expression on identity recognition. In the *Unchanged expression condition,* the emotional expression remained unchanged between the target and test faces. This condition was intended to test whether emotional expression has an impact on identity recognition when the irrelevant emotional information embedded in the familiar identity does not compete for the recruitment of selective attention, and thus could be easier to filter out. Participants' gender has also been taken into account in our analyses: although partially inconsistent, literature reports evidence of a small but robust advantage for girls in processing facial expressions (McClure, 2000).

Method

Participants. Seventy preschool-aged children were recruited from two different kindergartens after parents gave written informed consent. All of them had normal or corrected to normal vision, and all were Caucasian and from middle-class Caucasian families. All children provided their verbal assent to be involved in the experiment. Ten participants were excluded from the final sample because their recognition accuracy was less than or equal to 30% in at least one block of trials. The final sample consisted of 60 preschool-aged children (24 girls, mean

age = 59 months, SD = 5.4) assigned randomly and in equal numbers to two experimental groups: 30 in the Neutral Group and 30 in the Happiness Group.

Stimuli. A total of 100 face images were used as stimuli. The stimuli were created from digitized, high-quality grey-scale images of 100 Caucasian female full-front faces (see Figure 1). All faces were unfamiliar to the participants and were pulled out from Bosphorus Database for 3D Face Analysis (Savran et al., 2008), NimStim set of Facial expressions (Tottenham et al., 2009), Radboud Faces Database (Langner et al., 2010) and from a face database provided by the Department of Developmental Psychology, Giessen University. Fifty faces displayed a neutral expression and 50 faces displayed a happy expression at 100% of intensity. Sixty stimuli (30 neutral and 30 happy) were used for the 20 Changed Expression trials (i.e. each trial needed 3 faces; Neutral-to-happy: 1 neutral face and 2 happy faces; Happy-to-Neutral: 1 happy face and 2 neutral faces). Forty stimuli (20 neutral and 20 happy) were used for the 20 Unchanged Expression trials (i.e. each trial needed 2 faces, 2 neutral or 2 happy).

Images were adjusted using Adobe Photoshop in order to make them graphically uniform and to eliminate salient external features (e.g. hair, ears, neck). The stimuli obtained were matched based on luminance, eye colour and subjective criteria of overall similarity so as to generate 10 pairs for each condition (i.e. Changed expression Neutral-to-Happy, Changed expression Happy-to-Neutral, Unchanged expression). Ten additional faces (5 neutral and 5 happy) were used to create four pairs of stimuli to be presented in the three practice trials that preceded the experiment. All faces appeared on a black

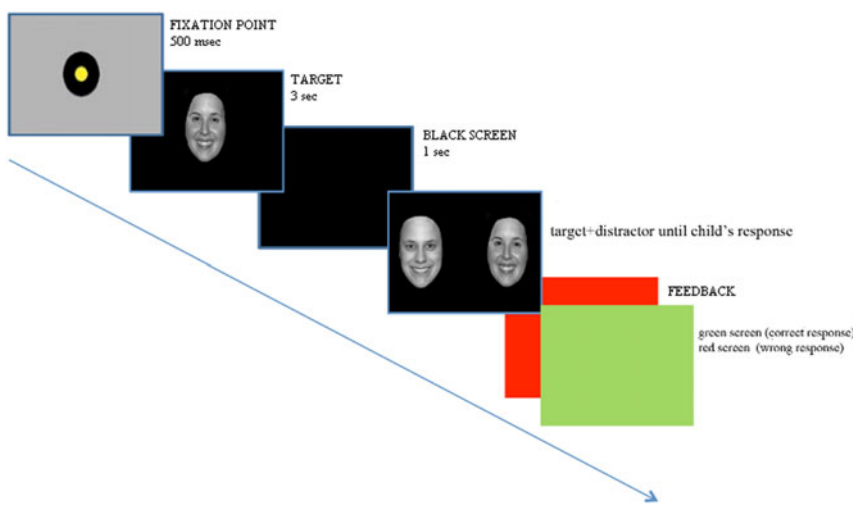

Figure 1. Example of a trial structure.

background and subtended a horizontal visual angle of 10° and a vertical visual angle of 12° when viewed from a distance of approximately 40 cm.

Apparatus and procedure. Children were tested within a delayed two-alternative forced-choice matching-to-sample task. They were told that a target face would appear on the screen and they were asked to recognize that face from two choices appearing after the initial presentation. All children were tested on a single session, in a quiet room, seated approximately 40 cm from a 15-inch PC monitor. Each trial began with a yellow circle looming at the centre of the screen for 500 ms. The target stimulus was then presented centrally for 3 s. Following a 1 s black screen, two choices, the previously presented target stimulus and a new stimulus, were presented side by side (test phase). The participants were asked to respond as accurately as possible, by pointing to the right or left target location on the screen, with the experimenter marking the child's response by pressing a computer key. Both the target and the novel stimuli remained on the screen until a response was made. Children's responses were followed by a feedback display consisting of either a green screen associated with a high tone for correct responses or a red screen associated with a low tone for incorrect responses. The purpose of the feedback was to keep children engaged in the task. The experimenter determined the start of the next trial by pressing the mouse. For an example of a trial structure see Figure 1. The left–right position of the target and novel stimuli was randomized across trials.

The experiment consisted of three blocks of trials, one for each experimental condition (*Changed expression Neutral-to-Happy, Changed expression Happy-to-Neutral, Unchanged expression*), with 10 trials for each block. In the *Changed expression Neutral-to-Happy* trials, the target face posed a neutral expression and the choices posed a happy expression at test, whereas in the *Changed expression Happy-to-Neutral* trials the target face displayed a happy expression and the choices posed a neutral expression. In the *Unchanged expression* trials, the emotional expression displayed by the faces remained unchanged between the test faces and the choices, being neutral for children in the Neutral Group and happy for children in the Happiness Group (see Figure 2). All participants were presented with the *Unchanged expression* condition as the last block, with the order of the two remaining blocks counterbalanced across participants. At the beginning of the testing session, we gave participants 4 practice trials to ensure that they understood the task. The left–right position of the target and the distracter was randomized across trials. Stimulus presentation and data collection were performed using EPrime 2.0 software. Response accuracy was recorded as the dependent variable.

Results

Mean response accuracy (expressed in percentage) for each condition was calculated for each participant in each age group. Children performed well above

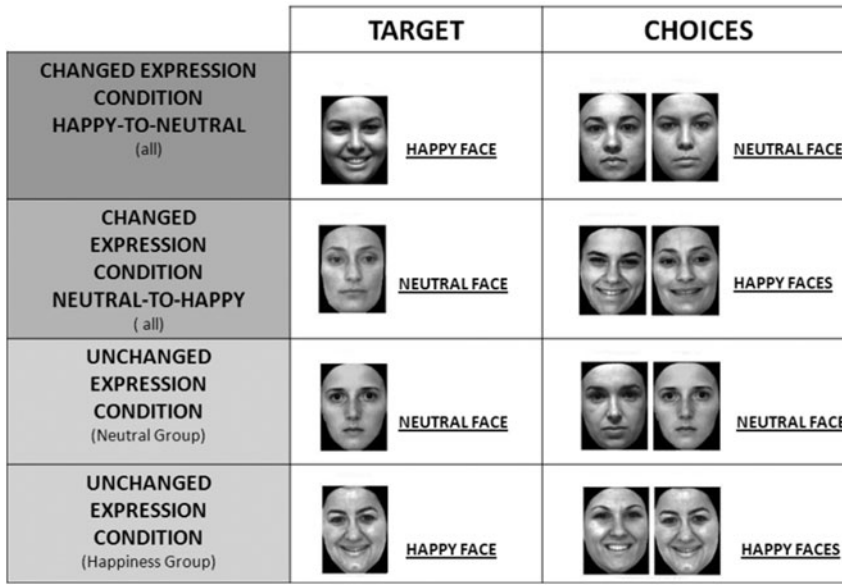

Figure 2. Examples of the stimuli used in the different experimental conditions of Experiment 1.

chance in all experimental conditions (range: $M = 45–93\%$, one-sample t test *vs.* 50%, $ps < .001$).

A preliminary analysis of variance (ANOVA) revealed no main effects or interactions involving Order as a factor (all $ps > .60$). Therefore, data were collapsed across this factor in a subsequent three-way ANOVA with Experimental Condition (*Unchanged expression, Changed expression Neutral-to-Happy, Changed expression Happy-to-Neutral*) as the within-subjects factor and Gender (male, female) and Group (Neutral, Happiness) as the between-subjects factors. The analysis revealed a main effect of experimental condition, $F(2,112) = 13.9$, $p < .01$, $\eta_p^2 = .19$, which was qualified by a significant Experimental Condition × Group interaction, $F(2,112) = 3.16$, $p < .05$, $\eta_p^2 = .05$. Independent t-tests showed that children in the Neutral Group performed better than children in the Happy Group ($M = 87\%$, $SD = 13$ *vs.* $M = 76\%$, $SD = 20$), $t\ (58) = 2.45$, $p < .05$, in the *Unchanged Expression Condition,* whereas the performance of the two groups did not differ in any other condition ($ps > .15$). Also, paired-sample t-tests showed that performance was better in the *Unchanged Expression Condition* than in the *Changed Happy-to-Neutral* condition for children in the Happy Group ($M = 76\%$, $SD = 20$ *vs.* $M = 68\%$, $SD = 17$), $t\,(29) = 2.87$, $p < .01$, as well as for children in the Neutral Group ($M = 87\%$, $SD = 15$ *vs.* $M = 68\%$, $SD = 13$), $t\ (29) = 6.22$, $p < .001$, whose performance was also superior in the *Unchanged Expression Condition*

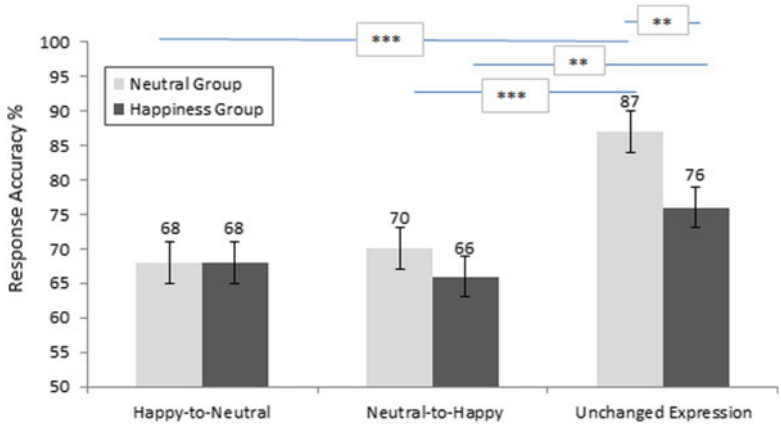

Figure 3. Children's response accuracy in Experiment 1. *$p < .05$, **$p < .01$, ***$p < .001$.

than in the *Neutral-to-Happy* condition ($M = 87\%$, $SD = 15$ *vs.* $M = 70\%$, $SD = 15$), $t\ (29) = 4.94$, $p < .001$ (see Figure 3).

Discussion

Results of Experiment 1 showed that our identity-matching task was easier for children to perform when facial expression remained constant between the encoding and the test phase than when it changed. This finding was observed not only when the unchanged expression was neutral, but also when it delivered an emotional information, i.e., happiness. In fact, children in the Happiness group were more accurate at recognizing the identity of the target face when its expression remained unchanged than in at least one of the two Changed expression conditions. Per se, this finding would be in line with the hypothesis that the interference effect of emotional expression on identity recognition is caused by children's poor domain general attentional abilities that prevent them from processing a modification that concerns multiple information (identity and emotion). This pattern of results supports the hypothesis that children' difficulty in focusing on the information relevant to the task—i.e. identity—while ignoring the irrelevant information provided by the novel emotion has an impact on children performance in tasks that measure identity recognition in the face of changing emotional expression (e.g. Freitag & Schwarzer, 2011; Herba et al., 2006).

However, on the whole results of Experiment 1 cannot be fully explained by the limits of children's selective attention abilities, since the interference of emotional expression on identity recognition was present even when the task implied lower perceptual load, which is when emotional expression remained unchanged between the encoding and test phase. Indeed, children were more accurate at matching the identity of a face that poses a neutral expression than a

happy emotional expression, irrespective of whether the expression remained unchanged throughout the task or it changed between the target and test faces. These findings indicate that an interference effect of emotion on identity recognition occurred whenever a happy emotional expression was present, irrespective of expression variations across phases.

Overall, results argue against the hypothesis of an independent encoding of identity and emotional information conveyed by faces, and suggest that happy emotional expression interferes with children's processing of identity information. Moreover, our findings indicate that the interference effect of emotional expression on identity recognition cannot be explained exclusively referring to the limits of children's general attentional abilities, as it was present even when emotional expression was kept constant between the encoding and recognition test phase. Under this testing condition, the possible confounding generated by the simultaneous variation of multiple facial dimensions was eliminated, and still children performed more poorly than in the neutral condition. In order to investigate the extent to which such interference effect is specific to happiness or is a general phenomenon induced by any emotional expression in Experiment 2, we tested children's ability to match identity in faces displaying a negative emotional expressions.

EXPERIMENT 2

Experiment 2 was aimed to investigate whether the interference effect of happiness on identity recognition observed in Experiment 1 holds when the emotional expression displayed by the face is negative, as in the case of fear and anger. To this end, preschool children's ability to recognize facial identity was tested using the same delayed two-alternative forced-choice matching-to-sample task used in Experiment 1. Based on the findings of Experiment 1, showing that happiness interfered with identity recognition even in the absence of any change in facial expression, in Experiment 2 all children were tested in the *Unchanged Expression Condition*, in which the target and the test faces displayed the same expression, either neutral or emotional, with emotion (i.e. happiness, fear, anger) varying between groups.

Method

Participants. Sixty-one preschool-aged children were recruited as in Experiment 1. All participants were Caucasian from Caucasian middle-class families and had normal or corrected to normal vision. All provided their verbal assent before participating in the experiment. As in Experiment 1, one participant was tested but excluded from the final sample because he/she performed correctly on less than 30% of the trials in one block of trials. The final sample consisted of 60 preschool-aged children (29 girls, mean age = 61.9 months; $SD = 6.8$)

assigned randomly and in equal number to three experimental groups, each corresponding to a different Emotional Condition: 20 in the Happiness Group, 20 in the Fear Group and 20 in the Anger group.

Stimuli, apparatus and procedure. All children were tested using the same delayed two-alternative forced-choice matching-to-sample task as in Experiment 1. However, stimuli and procedure differed from Experiment 1 on the following aspects. A total of 120 face images, taken from the same databases as in Experiment 1, were used as stimuli. Thirty faces displayed a neutral expression, 30 faces displayed a happy expression, 30 faces displayed a fearful expression and 30 displayed an angry expression. As in Experiment 1, the stimuli were manipulated and paired to generate 15 pairs for each facial expression. Fourteen additional faces (2 neutral, 4 happy, 4 fearful and 4 angry) were used to create 6 pairs of stimuli to be presented in the 3 practice trials that preceded the experiment (one pair of neutral stimuli and two pair of emotional stimuli). All faces appeared on a black background and subtended a horizontal visual angle of 10° and a vertical visual angle of 12° when viewed from a distance of approximately 40 cm (see Figure 4).

The experiment consisted of two blocks of trials, one for each experimental condition (Neutral *vs.* Emotional), with 15 trials in each block. In both the Neutral and the Emotional conditions, facial expressions remained unchanged between the encoding and test phases. In the Emotional condition, 20 children were shown happy expressions, 20 were shown angry faces and 20 were shown fearful faces. The order of Neutral and Emotional conditions was counterbalanced across

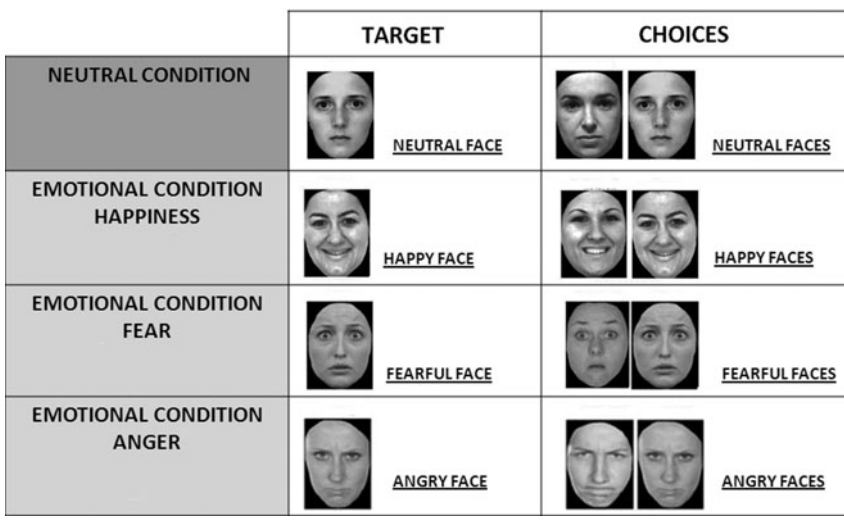

Figure 4. Examples of the stimuli used in the experimental conditions of Experiment 2.

subjects. At the beginning of the testing session, participants were given three practice trials to ensure that they understood the task. The left–right position of the target and the distracter was randomized across trials. Recognition accuracy was recorded as the dependent variable.

Results

Mean response accuracy (expressed in percentage) for each condition was calculated for each participant in each age group. Children performed well above chance level in both the neutral condition ($M = 83\%$) and the emotional condition ($M = 87\%$), $ps < .01$. In order to determine whether children's performance was modulated by the emotional content delivered by facial expression, mean response accuracy was entered into a three-way ANOVA with experimental condition (neutral *vs*. emotional) as the within-subjects factor and gender (male, female) and emotional expression (happiness, fear, anger) as the between-subjects factors. The analysis revealed a main effect of experimental condition, $F(1,54) = 5.13$, $p < .05$, $\eta_p^2 = .087$, due to children being overall more accurate in the recognition of neutral faces ($M = 87\%$, $SD = 112$) than in the recognition of emotive faces ($M = 84\%$, $SD = 12$) (see Figure 5). Importantly, there were no main effects or interactions involving the factor emotional expression.

Discussion

Results of Experiment 2 replicated and extended those of Experiment 1 by showing that, in the absence of any variation in facial expression, both positive and negative emotional expressions interfered with children's processing of identity information. Children performed better at recognizing neutral faces compared with emotive faces, thus challenging the hypothesis of an independent encoding of identity and emotional information conveyed by faces. In fact, current findings add to existing evidence showing that children's processing of identity information is expression-dependent (Baudouin et al., 2008; Bruce et al., 2000; Herba et al., 2006) rather than expression-independent (Ellis, 1992; Norbeck, 1981; Spangler et al., 2010).

A critical finding emerging from Experiment 2 is that the interfering effect of emotional expression was not modulated by the positive versus negative valence of the emotion displayed by the face, as all emotive faces, as a whole, were more difficult to match based on identity compared with neutral faces. This finding is in line with previous evidence of a generalized interference effect of emotional expressions on identity recognition in children, which occurs independently of emotional connotation (Herba et al., 2006). Nonetheless, looking at means for the different emotional conditions (see Figure 5), it is interesting to note that children's performance was lower in the happiness condition than in the anger and fear conditions. Although these differences were not significant ($ps > .50$),

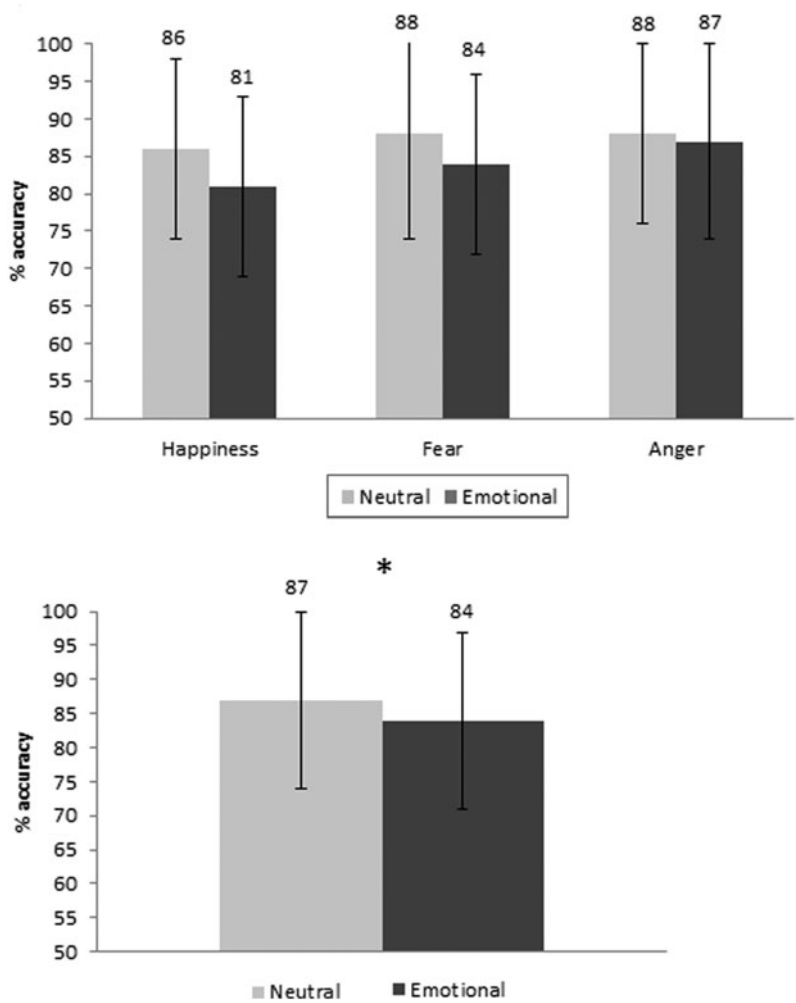

Figure 5. Children's response accuracy in Experiment 2. *$p < .05$.

they suggest that children might have experienced less interference for negative emotional expressions, which are those that are more difficult to identify (e.g. Gao & Maurer, 2010; Widen & Russell, 2003).

GENERAL DISCUSSION

The goal of the current study was to investigate whether discrimination and recognition of facial identity in preschool-aged children are affected by

the emotional expression displayed by the face or whether it is expression-independent.

Results showed that identity discrimination and recognition are weaker for both positive and negative emotional faces than for neutral faces, consistent with the proposal of an interference effect of emotional expressions on face identity recognition (Baudouin et al., 2008; Herba et al., 2006). Indeed, although children's recognition performance was always above chance, the interference generated by the emotional information conveyed by facial expression was robust and consistent, being observed (i) when a happy emotional expression was displayed by the sole target or test face or when the expression remained unchanged in both faces (Experiment 1) and (ii) when different emotional expressions, positive or negative, were presented (Experiment 2). Thus, our findings as a whole argue against the hypothesis of an independent processing of identity in preschool-aged children, suggesting an interference of emotional expressions that is not to modulated by the hedonic valence of the emotion delivered by the expression nor by the processing stage at which emotional information is provided (i.e. encoding or recognition). This evidence suggests that, when asked to recognize the identity of a face, children cannot refrain from processing the emotional information conveyed by the face, even if this is not required.

A possible explanation for the interference effect generated by emotional expression on identity recognition might take into account preschoolers' limited attentional resources, which would limit children's ability to focus on the information relevant to the task—i.e. identity—while ignoring the irrelevant information provided by emotional expression. In this vein, interference would occur because emotional information, irrespectively of its positive or negative valence, increases the perceptual load of the identity-recognition task, disrupting children's recognition performance. Our results argue against this hypothesis because the interference effect of emotion was observed not only when children were asked to disregard the change in facial expression to recognize identity, but also when the irrelevant information conveyed by facial expression remained constant throughout the task, and thus did not contribute to increase the perceptual load of the recognition task.

Although inconsistent, previous research has shown that girls outperform boys in facial emotional recognition (McClure, 2000). Our findings did not replicate this evidence, since we did not find any gender effect in identity recognition either in the Neutral condition or in the Emotional condition. It is possible that variations in emotional processing driven by gender are subtle and thus not apparent in tasks in which emotion is not the relevant feature that participants are required to process. Although no conclusions can be drawn from the current findings, future studies should examine this issue further.

The strength of the conclusions drawn from the current study hinges on the finding that in Experiment 1 children performed better in the *Unchanged*

condition than in the *Changed* conditions. Because the *Unchanged* condition was always presented as the last block of trials, one may raise the concern that the enhancement in children's performance observed in such condition was due to a sort of training effect. We feel that this interpretation is not tenable for several reasons. First, preliminary analyses for Experiment 1 showed that the factor order was far from attaining statistical significance (all ps $> .60$). Moreover, although both the Neutral and the Happiness groups had the *Unchanged* condition as the last block, the two groups performed differently, as the Neutral group outperformed the Happiness group. Furthermore, our experience in testing preschool children with this kind of paradigms tells us that, if anything, children's performance tend to decrease (rather than improve) in the last block, due to fatigue effects. Therefore, it is very unlikely that order effects had any impact on our results.

Overall, results from the current study support the idea of a mutual and bidirectional interaction between identity recognition and the processing of facial emotional expression in children. Future studies might further explore the question of how the relationship between the processing of identity and emotional expression evolves during development, shedding light on the facilitating *vs*. inhibitory role played by positive and/or negative expressions across the life span. Moreover, future studies investigating at children's processing of facial expressions in the face of variations in facial identity will provide a more complete description of the interaction between the processing of identity information and emotional expression conveyed by faces.

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