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# Positive, but not negative, facial expressions facilitate 3-month-olds' recognition of an individual face

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## Abstract

The current study examined whether and how the presence of a positive or a negative emotional expression may affect the face recognition process at 3 months of age. Using a familiarization procedure, Experiment 1 demonstrated that positive (i.e., happiness), but not negative (i.e., fear and anger) facial expressions facilitate infants' ability to recognize an individual face. Experiment 2 showed that the advantage of positive over negative facial expressions is driven by the processing of salient features inherent in the happy expression, rather than by the processing of the configural information conveyed by the entire happy face. Overall, these results support the presence of a mutual interaction between face identity and emotion recognition.

## Keywords

emotion, face processing, familiarization, identity, infancy

Identity recognition and perception of emotional expressions are essential skills for humans. Studies on adults demonstrate the existence of mutual interactions between the ability to recognize an individual face and the processing of facial emotional expressions. Not only variations in facial identity affect facial expression judgment (e.g., Schweinberger, Burton, & Kelly, 1999), but also, vice versa, variations in facial emotional expressions modulate identity recognition. Specifically, positive expressions (i.e., a smile) have a catalytic effect, increasing ratings of familiarity for both unfamiliar and familiar faces, while negative emotional expressions reduce familiarity judgments, suggesting an interference effect (e.g., Lander & Metcalfe, 2007).

Studies conducted with children converge to report a detrimental effect of variations of identity on recognition of facial emotional expressions (Spangler, Schwarzer, Korell, & Maier-Karius, 2010). However, evidence about the effect of emotional expressions on an identity recognition task is mixed. Some studies favour the idea that identity recognition is not influenced by variations in emotional expression (e.g., Spangler et al., 2010), while others suggest an interference role of facial emotion expressions, both positive and negative (e.g., Baudouin, Durand, & Gallay, 2008).

Despite the large amount of research on infants' face recognition (see de Haan, 2001, for a review) and emotion expression processing (see Grossman, 2010, for a review), only few studies have investigated in infancy the relation between these different sources of information.

Recently, using a familiarization paradigm, Turati and colleagues explored the role of positive facial emotional expression on 3-month-olds' identity recognition (Turati, Montirosso, Brenna, Ferrara, & Borgatti, 2011). Results indicated that, as in adults, infants' face recognition is enhanced when faces display a happy emotional expression, suggesting the presence of a mutual interaction between face identity and emotion recognition as early as 3 months of age. Moreover, using an adaptation of the switch design, Schwarzer and Jovanovic (2010) demonstrated that

8-month-olds are able to recognize a new combination of identity and emotional expression with upright but not upside-down faces, suggesting a joined processing of emotional expression and identity only for upright faces.

The current study examined whether and how the presence of an emotional expression may affect the identity recognition process at 3 months of age. Specifically, i) whether positive (i.e., happiness) or negative (i.e., fear and anger) facial expressions differentially affect infants' ability to recognize an individual face (Experiment 1), and ii) what perceptual features of the face with an emotional expression are crucial to trigger the observed effects (Experiment 2).

## Experiment 1

Experiment 1 investigated whether facial identity is processed independently from or in interaction with positive and negative facial emotional expressions. After a brief (20 s) familiarization with a video of a woman's face expressing a positive or negative emotion, infants were shown the familiar and a novel face with a neutral expression. As in Turati et al. (2011), infants briefly familiarized with a happy face should subsequently recognize the familiar face.

Different predictions can be made relative to negative expressions. In analogy with data on adults (Lander & Metcalfe, 2007) negative expressions, both anger and fear, might produce an interference/distracting effect on identity recognition, producing a decrement in infants' performance. A recent study described

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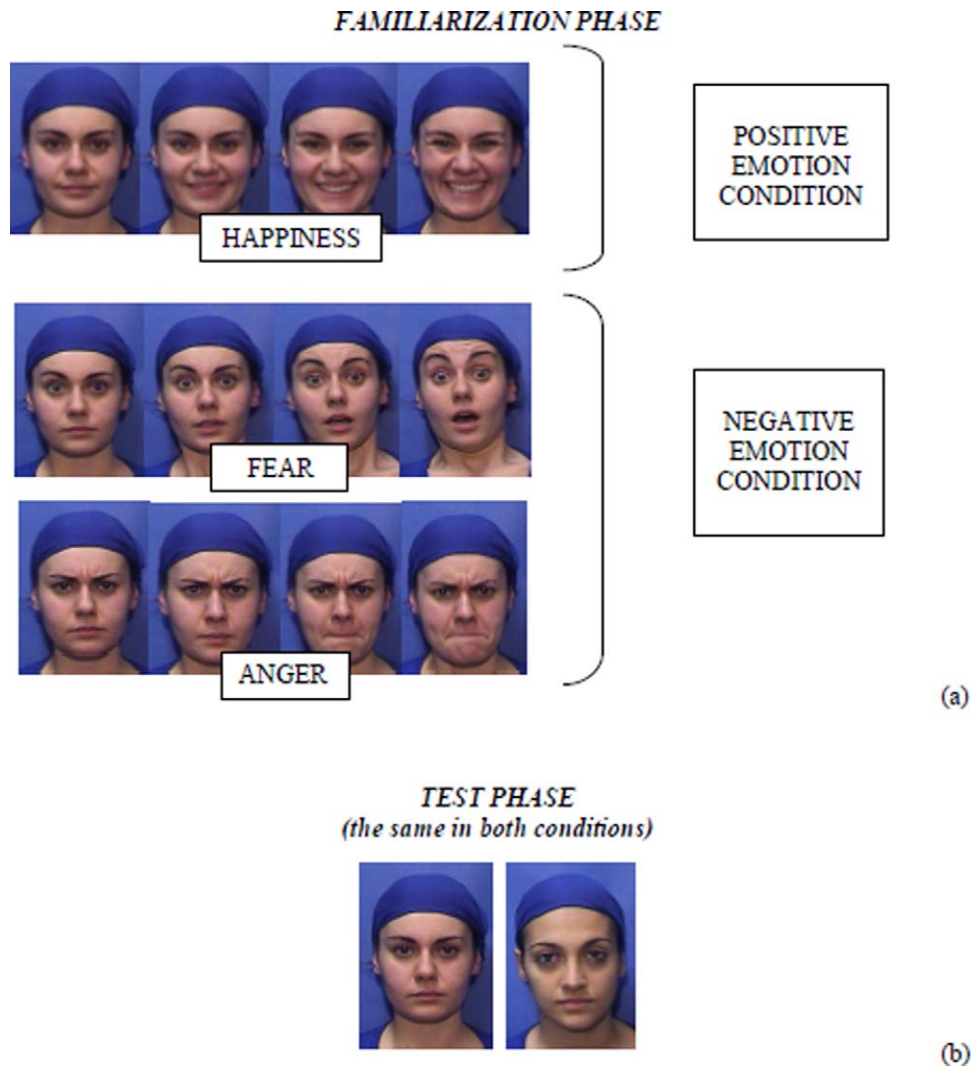Email: viola.brenna@bp.lnf.it

## FAMILIARIZATION PHASE



**Figure 1.** Examples of stimuli showed during familiarization (a) and test phase (b) in Experiment 1.

in 4- and 7-month-olds an avoidant looking-behaviour in response to threat-related emotional expressions (anger and fear) with reduced dwell times and relatively less fixations on the inner features of the face (Hunnius, de Wit, Vrins, & von Hofsten, 2011). Conversely, the effect of negative facial expressions might be analogous to the one exerted by positive emotional expressions, enhancing individual face recognition. In particular, fearful expressions might capture infants' attention, thus determining a facilitating effect on infants' ability to recognize a face (Peltola, Leppänen, Vogel-Farlet, Hietanen, & Nelson, 2009).

## Method

### Participants

Sixty-four healthy full-term 3-month-olds were tested ($M = 108$ days, $SD = 7.2$, range $= 93$–122 days, 38 males). Subjects were randomly assigned to one of two different conditions: Positive emotion (happiness, $N = 32$) and Negative emotion (fear, $N = 16$; anger, $N = 16$). Written informed consent was obtained from the infants' parents.

### Stimuli

During familiarization, the stimuli were dynamic colour video-clips composed by four different 500-ms frames, in which a Caucasian young woman's face displayed a positive (happiness) or negative (fear or anger) emotional expression (see Figure 1a). Videos depicted a gradual increasing of emotion, with a similar degree of dynamism between the stimuli. Four different identities were used, in a counterbalanced design between subjects. Static photos of women with a neutral facial expression were shown during the test phase (see Figure 1b). Each infant saw two different identities, the familiar face and a novel face. Women were always portrayed on a blue background in a full frontal pose. A blue hair band covered the women's hair. At a viewing distance of 60 cm, stimuli were 17° of visual angle in height and 15° of visual angle in width. Faces were shown in the centre of a computer screen.

### Apparatus

Infants were tested in a single session, using a familiarization paradigm, at the Laboratorio Prima Infanzia, University of Milan
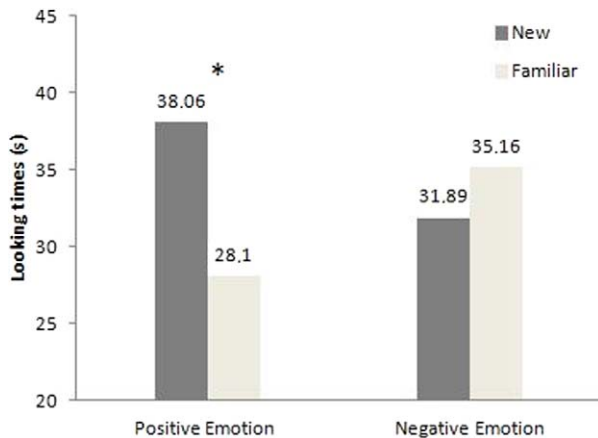
**Figure 2.** Looking times (s) toward the new and the familiar stimulus in Experiment 1.
*Note.* * $p < .05$.

– Bicocca. They were seated in an infant-seat or on their mother's lap, in front of a 24-inch PC monitor. A curtain separated the participants from the experimenter to prevent interference from irrelevant distracters. Above the monitor there was a camera recording infants' eye behaviour. An experimenter, blind to the ongoing experimental condition, recorded infants' looking times by clicking the mouse buttons (online coding).

Stimulus presentation and data collection were performed using E-Prime 2.0, which automatically computed the parameters that determined the end of each trial and the reaching of the familiarization criterion. A second experimenter coded offline the duration of looking times towards the stimuli for about one-third of the participants. Inter-coder agreement calculated by Pearson correlation was $r = .90$ for total looking time.

### Procedure

During the familiarization phase, infants were shown a face with a positive or a negative facial expression. An infant-friendly image associated with varying sounds was used as fixation point and attention catcher before the trial began. When the infant looked at the fixation point, the experimenter started the trial, pressing a key on the keyboard. Each trial consisted of a repeating cycle (3000 ms in total) that began with a black screen (500 ms), followed by the video-clip with the woman's face (2000 ms), and ended with another black screen (500 ms). Each video-clip was composed by four 500 ms frames. Each trial continued until the infant looked for a minimum of 500 ms and ended when the infant looked away continuously for 2 s. The familiarization was over when the criterion of 20 s of cumulative looking time towards the face stimulus was met.

Following familiarization, static images of the familiar and a novel woman's faces with a neutral expression were shown. Each face was presented in two different presentations and alternately, with half of the infants seeing the novel face first. Each stimulus was shown until the infant looked for at least 500 ms and he/she looked away continuously for 2 s.

### Results and conclusions

A preliminary repeated ANOVA with Presentation (First, Second) and Novelty (New, Familiar) as within-subjects factors and

Emotion (Fear, Anger) as between-subjects factor yielded no significant main effect, and allowed the consideration of only two levels of the Emotion variable in further analysis (Positive, Negative).

A repeated measure ANOVA was performed on looking times towards test stimuli, with Presentation (First, Second) and Novelty (New, Familiar) as within-subjects factors and Emotion (Positive, Negative) as between-subjects factor. The analysis revealed a main effect of Presentation, $F(1, 60) = 14.99$, $p < .01$, $\eta^2_p = .20$, and a significant Emotion x Novelty interaction, $F(1, 60) = 4.17$, $p < .05$, $\eta^2_p = .06$. Infants' looking times were greater in the first ($M = 40.58$ s, $SD = 4.21$) than in the second presentation ($M = 26.02$ s, $SD = 3.04$) of the test trials. In order to explore the Emotion x Novelty interaction, paired *t*-tests (two-tailed) were conducted. Infants familiarized with the happy expression looked longer towards the novel ($M = 38.06$ s, $SD = 5.51$) than the familiar face ($M = 28.10$ s, $SD = 4.64$), $t(29) = 2.48$, $p < .05$. Instead, infants did not discriminate the familiar ($M = 35.16$ s, $SD = 4.49$) from the novel ($M = 31.89$ s, $SD = 5.34$) face after a familiarization with a face displaying negative emotions, $t(31) = -.65$, $p > .05$ (see Figure 2).

Previous findings demonstrate that at 3 months of age, as in adults (Lander & Metcalfe, 2007), positive and negative facial emotional expressions are processed in interaction with face identity, and differentially modulate face recognition abilities. Infants' individual face recognition was enhanced or reduced depending on whether the face conveyed a positive or negative facial emotional expression.

These findings corroborate previous evidence suggesting that face recognition is enhanced when faces are smiling (Turati et al., 2011). However, the current results do not offer an answer about which perceptual features of the face with a happy emotional expression (that is, upper or lower half) differentially affected infants' ability to recognize an individual face. One possibility is that a specific feature of a happy face (e.g., the smiling mouth) captures infants' attention and allows easier identity recognition of the familiar face—i.e., feature-based processing. Evidence from adult studies (e.g., Smith, Cottrell, Gosselin, & Schyns, 2005) and computer simulations (Cottrell, Branson, & Calder, 2002) suggests that the bottom half of the face conveys crucial information in order to identify a happy facial expression. Alternatively, one may claim that positive emotional expressions have an advantage over negative ones at a configural rather than featural level of infants' face recognition processing. Experiment 2 addressed this issue.

## Experiment 2

Recognizing facial identity requires featural and configural processing as well. Configural processing includes sensitivity to first-order relations that specify the stimulus as a face, holistic processing that allows the processing of the face as a gestalt, and sensitivity to second-order relations that specify differences among individuals in the spacing of features (see Maurer, Le Grand, & Mondloch, 2002). Both the featural and the configural processing modes can be used very early in children's (Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007) and infants' face recognition (Turati, Di Giorgio, Bardi, & Simion, 2010) and processing of facial expressions (Kestenbaum & Nelson, 1990).

Experiment 2 aimed to understand whether the advantage of positive vs. negative facial expressions on face recognition, observed in Experiment 1, is based on the processing of a peculiar
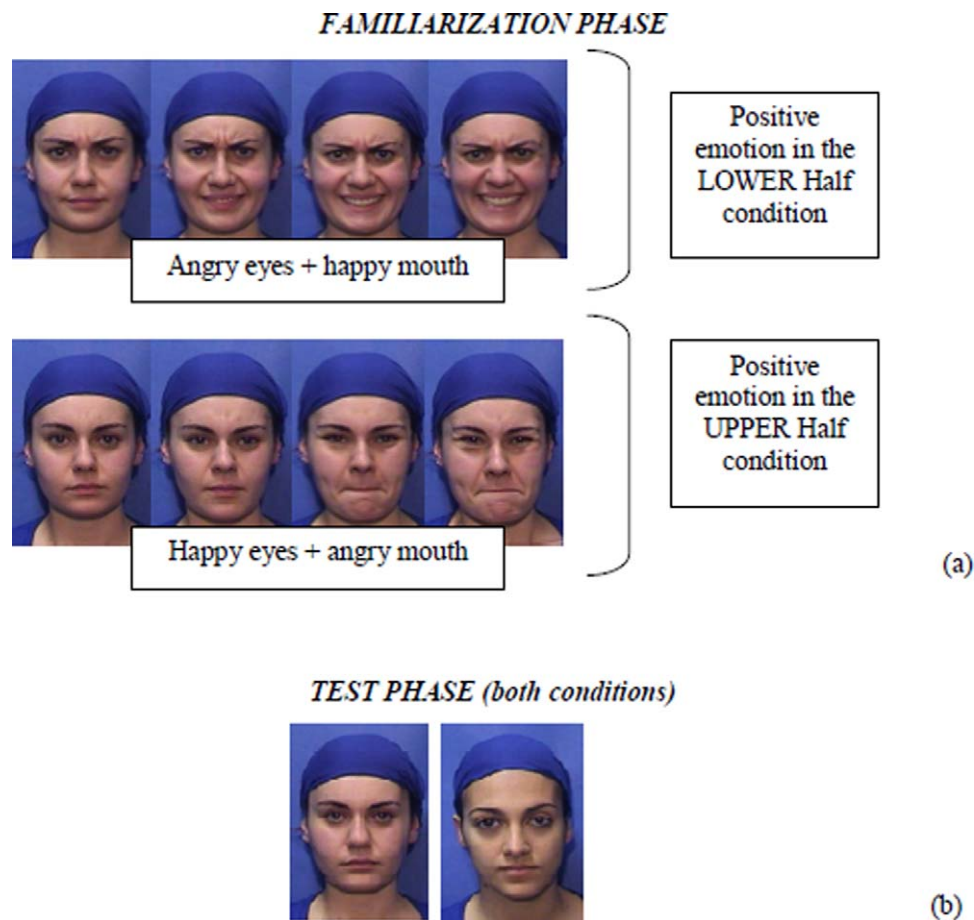
## FAMILIARIZATION PHASE



**Figure 3.** Examples of stimuli showed during familiarization (a) and test phase (b) in Experiment 2.

feature of the emotional expressions—i.e., featural processing—or on the configural processing of the entire facial emotional expressions—i.e., configural processing. In order to address this issue, infants were familiarized with a video of a composite woman's face expressing a positive emotion in the bottom half of the face and a negative emotion in the upper half of the face, or vice versa.

If a single feature (e.g., smiling mouth or "happy" eyes) of the happy face can act as a sufficient cue to give rise to the advantage of positive over negative facial expressions on infants' face recognition, infants familiarized with a face displaying the distinctive features of the happy expression in the lower half should succeed in the recognition of the individual face, suggesting a feature by feature processing. Conversely, infants' failure to recognize composite faces would support the claim that a single feature expressing happiness is not enough to support a facilitation in infants' face recognition. Therefore, happiness would exert a facilitation effect only when it is processed in a configural based mode.

## Method

### Participants

Twenty-two healthy full-term 3-month-old infants ($M = 106$ days, $SD = 9$, range = 92–119 days, 11 males) participated in the experiment. Infants were recruited in the same manner as in Experiment 1 and written informed consent was obtained from

their parents. They were randomly assigned to one of two different conditions: Upper Half Positive face ($N = 11$) or Lower Half Positive face ($N = 11$).

### Stimuli

Stimuli were colour video-clips formed by four different 500 ms frames, displaying a Caucasian woman's face with a composite emotional expression. Each frame was generated using Photoshop. Pictures used in Experiment 1 were adjusted in order to obtain faces displaying a different emotion in the top and in the bottom face half. The upper and the lower halves of each face picture used in Experiment 1 were isolated and then reassembled, piecing together one half with a positive expression and another half with a negative expression. By reason of no differences between the two negative emotions used in Experiment 1, in this study only anger was chosen for the stimuli setup.

In the Upper Half Positive face condition, the frames of the video depicted a woman's face with the features expressing a positive emotion in the top half of the face (i.e., "happy" eyes) and the features expressing a negative emotion in the bottom half of the face (i.e., "angry" mouth). Instead, in the Lower Half Positive face condition, the face displayed anger in the upper half (i.e., "angry" eyes) and happiness in the lower half (i.e., smiling mouth). In both conditions, each half of the face increases the intensity of the shown emotion frame by frame (see Figure 3a).
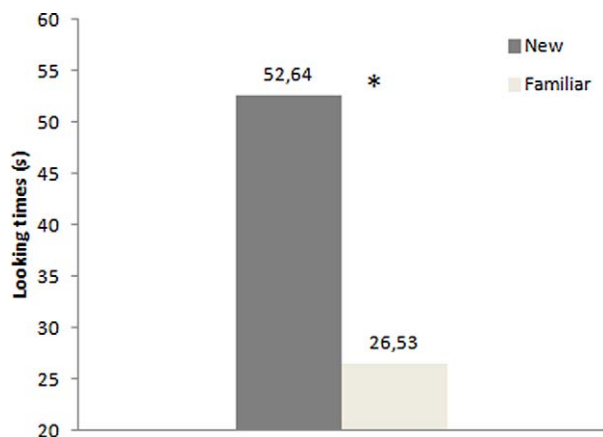
**Figure 4.** Looking times (s) toward the new and the familiar stimulus in first presentation in Experiment 2.

*Note.* * *p* < .05.

During the test phase, the stimuli were exactly the same as those used in Experiment 1 (see Figure 3b).

## Apparatus and procedure

Participants were tested in the same manner as in Experiment 1. Two different conditions were presented, randomized between subjects, Upper Half Positive face and Lower Half Positive face conditions.

## Results and conclusions

A repeated measure ANOVA was performed on looking times towards test stimuli, with Presentation (First, Second) and Novelty (New, Familiar) as within-subjects factors and Familiarization Condition (Upper Half, Lower Half) as between-subjects factor. The analysis revealed a significant Presentation x Novelty interaction, $F(1, 20) = 4.46$, $p < .05$, $\eta^2_p = .18$. In the first presentation, infants looked longer towards the novel ($M = 52.64$ s, $SD = 11.03$) than the familiar face ($M = 26.53$ s, $SD = 4.14$), $t(21) = 2.41$, $p < .05$, regardless of familiarization condition (Upper or Lower Half Positive)—see Figure 4. Results suggest that a single feature of a happy face, either smiling mouth or "happy eyes," can be a sufficient cue to create a facilitation effect on identity recognition. When familiarized with a face displaying— even partially—happiness, in the first presentation of test stimuli infants recognized the familiar face and looked longer at the novel one. These findings support the hypothesis of a feature by feature processing of emotional expressions at 3 months of life. Moreover, despite the fact that faces displaying composite emotions may look sinister to an adult, our results suggest that their effect on infants' face recognition does not overlap the one produced by negative expressions. Therefore, infants did not perceive composite emotions as negative. Finally, it is advisable to note that identity recognition occurred only in the first presentation of stimuli. During the second presentation, infants did not discriminate between the novel and the familiar stimulus. This might likely be due to a sort of familiarization to the new face during the first presentation of the test phase. Since the duration of the test phase was not fixed but infant controlled, it is possible that even the new face stimulus became "familiar".

## General discussion

The aim of the present study was to investigate whether and how emotional expressions may affect the identity recognition process at 3 months of age. Specifically, Experiment 1 examined whether positive (i.e., happiness) or negative (i.e., fear and anger) facial expressions differentially affect infants' ability to recognize an individual face. Results suggest, as in adults (Lander & Metcalfe, 2007), a different role of positive and negative emotions on 3-months-olds' identity recognition. Infants' ability to recognize a face is enhanced or reduced depending on the facial emotional expression conveyed by the face during the familiarization phase. Specifically, after familiarization with a face displaying a happiness expression, infants recognized the familiar identity in the test phase. Conversely, 3-month-olds were not able to recognize a face that displayed a negative expression (i.e., angry or fearful) during the familiarization phase. Furthermore, using face stimuli with different emotions in the top and bottom halves of the faces, Experiment 2 revealed that a single feature expressing happiness (i.e., smiling mouth or "happy eyes") is sufficient to facilitate 3-month-olds' face recognition. This outcome suggests that the effect of the happy expression on infants' face recognition is driven by the processing of the salient features inherent in the happy expression, rather than by the processing of the configural information conveyed by the entire happy face.

Although literature reports that the role of configural information in facial emotion recognition is prevalent by preschool age (Durand et al., 2007) and in adulthood (Calder & Jansen, 2005), evidence obtained in the current study is consistent with the findings reported with 7-month-old infants by Kestenbaum and Nelson (1990). In this study, infants recognized the similarity of happy faces over changing identities and discriminated happiness from fear and anger when the faces were presented upright, but not when they were presented inverted. However, after familiarization to a single face posing a happy expression, infants dishabituated to novel expressions of anger or fear, both when faces were presented upright and inverted. Moreover, after familiarization to faces with toothy smiles, infants dishabituated to nontoothy happy faces and nontoothy angry faces, both in the upright and the inverted conditions. Based on these results, it was suggested that, at 7 months, *categorizing* emotional expressions depends upon attending to configural, orientation-specific information, whereas the *discrimination* of an emotional expression can be done on a featural basis, regardless of the orientation of the stimuli. Moreover, when salient features are available (i.e., toothy smiles), the infants base their discrimination on such features rather than on configural information.

Recent findings showed a sensitivity to configural cues in infants as young as 3 to 4 months of age, when they have to recognize a familiar face identity (Bhatt, Bertin, Hayden, & Reed, 2005; Quinn & Tanaka, 2009; Turati et al., 2010; Turati, Sangrioli, Ruel, & de Schonen, 2004). In accord with Kestenbaum and Nelson (1990), evidence from the current study suggests that, in the first months of life, the availability of a salient feature will determine whether faces are discriminated on a featural or on a configural basis. Happy faces include salient features, such as the smiling mouth or the happy eyes, that infants can take advantage of in order to recognize a face. In other words, although infants are capable of processing configural face information, infants' face recognition might benefit from the presence of salient face features as a basis for discriminating the stimuli. When the features of a happy

expression (that is, a smile) are available, infants can focus on that information to base their discrimination. Overall, the present study supports the idea of a mutual and bidirectional interaction between identity recognition and facial emotional expression-processing as early as 3 months of age.

Finally, it is advisable to note that outcomes from the current study were obtained using dynamic face stimuli. Our stimuli were dynamic in all conditions in both experiments, and degree of motion of each video was controlled, therefore motion cannot be considered the discriminating variable between our conditions. However, further research may investigate whether an effect of facilitation for the recognition of happy faces can be found also with static face pictures. Indeed, still photographs do not capture the liveliness and true form of facial expressions that occur in day-to-day interactions.

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