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POSITIVE AND NEGATIVE FACIAL EMOTIONAL EXPRESSIONS: THE EFFECT ON INFANTS' AND CHILDREN'S FACIAL IDENTITY RECOGNITION

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(XXIV)

“There is no behavior pattern, however intellectual, which does not involve affective factors as motives; but, reciprocally, there can be no affective states without the intervention of perceptions or comprehensions which constitute their cognitive structure […]. The two aspects, affective and cognitive, are at the same time inseparable and irreducible (Piaget & Inhelder, 1969)”.

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ABSTRACT

Aim of the present study was to investigate the origin and the development of the interdipendence between identity recognition and facial emotional expression processing, suggested by recent models on face processing (Calder & Young, 2005) and supported by outcomes on adults (e.g. Baudouin, Gilibert, Sansone, & Tiberghien, 2000; Schweinberger & Soukup, 1998). Particularly the effect of facial emotional expressions on infants' and children's ability to recognize identity of a face was explored. Studies on adults describe a different role of positive and negative emotional expressions on identity recognition (e.g. Lander & Metcalfe, 2007), i.e. positive expressions have a catalytic effect, increasing rating of familiarity of a face, conversely negative expression reduce familiarity judgments, producing an interference effect. Using respectively familiarization paradigm and a delayed two alternative forced-choice matching-to-sample task, 3-month-old infants (Experiment 1, 2, 3) and 4- and 5-year-old children (Experiment 4, 5) were tested. Results of Experiment 1 and 2 suggested an adult-like pattern at 3 months of age. Infants familiarized with a smiling face recognized the new identity in the test phase, but when they were shown with a woman's face conveying negative expression, both anger or fear, they were not able to discriminate between the new and familiar face stimulus during the test. Moreover, evidence from Experiment 3 demonstrated that a single feature of a happy face (i.e. smiling mouth or "happy eyes") is sufficient to drive the observed facilitator effect on identity recognition. Conversely, outcomes obtained in experiments with pre-school aged suggested that both positive and negative emotions have a distracting effect on children identity recognition. A decrement in children's performance was observed when faces

displayed an emotional expression (i.e. happiness, anger and fear) rather than a neutral expression (Experiment 4). This detrimental effect of a happy expression on face identity recognition emerged independently of the processing stage -i.e., encoding, recognition, encoding and recognition- at which emotional information was provided (Experiment 5). Overall, these findings suggest that, both in infancy and in childhood, facial emotional processing interacts with identity recognition. Moreover, observed outcomes seem to describe an U-shaped developmental trend of the relation between identity recognition and facial emotional expressions processing. The results are discussed by referring to Karmiloff-Smith's Representational Redescription Model (1992).

INTRODUCTION

Recent suggestions emphasize a high interdependence between emotion and cognition (e.g., Storbeck & Clore, 2007), traditionally described as independent entities. The present study focuses on a paradigmatic case in which this relation can manifest itself, e.g. face processing. Faces provide us a lot of information about gender, identity, age, ethnic group of the person whom we are talking to and reveal also what could be his or her emotional mood through different facial emotional expressions. Thus, during face processing emotion and cognition unavoidably meet each other.

In everyday life, all information conveyed by a face is presented simultaneously and recognizing, identifying, and responding appropriately to that is one of the most important human social skills. How the face processing system deals with the concurrent presentation of these multiple dimensions is an important issue for researchers interested in face processing. Recent evidence assumes the existence of multiple interactions between different face dimensions (Calder & Young, 2005), overcoming traditional models that have suggested distinct pathways (Bruce & Young, 1986).

Specifically, many studies focused on the relation between identity recognition and facial emotional expression processing, deepening the general issue about the interplay between emotion and cognition. This evidence suggests an interdependence between these dimensions, showing that the ability to recognize facial identity do not seem to be independent from the emotional expression conveyed by the face and vice versa adults' classification of different emotional expressions is affected by identity variations. Processing of emotional expression is affected by identity variations (Baudouin, Gilibert, Sansone, & Tiberghien, 2000; Schweinberger, Burton, & Kelly, 1999;

Schweinberger & Soukup, 1998). Also, positive emotional expressions (i.e., a smile) increase ratings of familiarity for both unfamiliar and famous faces, while negative emotional expressions significantly reduce familiarity judgments (Dobel, Geiger, Bruchmann, Putsche, Schweinberger, & Junghofer, 2008; Gallegos & Tranel, 2005; Lander & Metcalfe, 2007)

The present study aims to explore the *origin* and the *development* of the interdependence between identity recognition and facial emotional expression processing, investigating the nature of this relation during infancy and childhood. As for infancy, some evidence suggests an influence of familiarity of face on facial emotion expression recognition, e.g. showing a better infants' competence to discriminate among facial expressions portrayed by their mothers than among facial expressions portrayed by strangers (Kahana-Kalman & Walker-Andrews, 2001; Walker-Andrews, Krogh-Jespersen, Mayhew, & Coffield, 2011). To date, only one study has suggested an effect of facial emotion processing on 8-month-olds' identity recognition (Schwarzer & Jovanovic, 2010).

Conversely, results on the influence of information about identity on recognition of emotional expressions during childhood converge to suggest an interference effect of face familiarity on children' performance (Herba, et al., 2008; Spangler, Schwarzer, Korell, & Maier-Karius, 2010), but studies regarding the relation in the opposite direction, i.e. the influence of emotional expression on identity recognition, do not provide univocal suggestions. Some studies demonstrated an interference effect of emotions (Baudouin, Durand, & Gallay, 2008; Herba, Landau, Russell, Ecker, & Phillips, 2006; Mondloch, Geldart, Maurer, & Le Grand, 2003). Conversely, others

described an independent processing of identity information from emotional expressions (Ellis, 1992; Spangler, et al., 2010).

The current investigation includes a series of experiments conducted with infants of 3 months of age (Experiment 1, 2 and 3) and 4- and 5-year-old children (Experiment 4 and 5) and aims to provide evidence regarding the effect of facial emotional expression on identity recognition during development.

Two different face recognition tasks were used, according with the tested age. Particularly, a familiarization paradigm was used with infants and a delayed two-alternative forced-choice matching-to-sample task with preschool-aged children. Both tasks refer to the ability to discriminate among different exemplars of the face category, recognizing a face as familiar. Specifically, at one hand we tested 3-month-olds in order to investigate the beginning of the interaction between identity recognition and emotional expression processing and at another hand we observed 4- and 5-year-olds with the aim of exploring the development of this interplay. Knowledge about skills of identity processing and competences of emotion recognition in infants and children have led the choice of testing just these ages. Although the ability to recognize a face is documented since birth, some recent neuropsychological studies that measured scalp-recorded brain electric potentials (Halit, de Haan, & Johnson, 2003) or performed positron emission tomography (PET) scans (Tzourio-Mazoyer, de Schonen, Crivello, Reutter, Aujard, & Mazoyer, 2002) suggested that the first signs of cortical specialization for faces can be observed in 2- to 3-month-olds. Furthermore, studies on emotional expressions recognition suggest that although some evidence supports an early newborns' ability to differentiate facial expressions (Farroni, Menon, Rigato, & Johnson, 2007), it is by 3 to 4 months that infants can reliably discriminate among at

least some expressions (Grossman, 2010). Therefore, also because of their easier testability than younger, 3-month-olds seemed an appropriated target for the fixed aim to explore the interdependence between emotional expression recognition and facial identity processing in the first months of life.

The choice to test 4- and 5-year-olds with the goal to better understand the development of this interaction is based on recent suggestions on children face processing. Traditional approaches have proposed that preschoolers' performance on face perception tests does not reach adult levels until adolescence and robustly improves between 5 years and adulthood (e.g., Carey & Diamond, 1977; Carey, Diamond, & Woods, 1980; Mondloch, Dobson, Parsons, & Maurer, 2004; Maurer, Le Grand, & Mondloch, 2002). Conversely, recent studies suggest qualitative presence of all key phenomena related to face individuation (encoding of novel faces, holistic processing effects, face-space effects, face-selective responses in neuroimaging) at the earliest ages tested, typically 3-5 years of age, proposing a fully maturity of face processing in early childhood (Crookes & McKone, 2009; McKoneac, Crookesb, Jefferycd, & Dilkse, 2012). Regarding emotional expressions recognition, results indicate that by 5 years of age, children are adult-like, or nearly adult-like, for recognition of the happy expression. Children's sensitivity to other expressions continues to improve between 5 and 10 years of age (e.g., surprise, disgust, fear) or even after 10 years of age (e.g., anger, sad). For these reasons, preschool-age children seemed an optimal sample to investigate target-processes during their development.

In the *first chapter*, after a brief description about the history of the investigations on the relation between emotion and cognition, a theoretical background of this study is described. Specifically, literature regarding how the ability to recognize an individual

face interact with facial emotional expression processing during infancy and childhood is proposed. Finally, at the end of the chapter aims of the study are explained.

The *second chapter* describes three experiments conducted with 3-month-olds. In Experiment 1 the effect of the presence or absence of a happy expression on infants' identity recognition was tested. Experiment 2 compared the role of positive *vs.* negative emotional expressions. Experiment 3 specifically focused on the infants' perception of the happy expression, investigating whether the effect of this emotion on face recognition is based on the processing of a peculiar feature or on the holistic processing of the entire facial emotional expression

In the *third chapter* two experiments conducted with 4- and 5-year-olds were described. Experiment 4 investigated whether the presence of an emotional expression, i.e. happiness, fear or anger, affected 4- and 5-year-olds' ability to recognize facial identity Experiment 5 focused on the study of the effect of happy expression on children's identity recognition, varying the phase of the task (i.e. encoding and/or test) in which the happy facial expression was presented.

The *last chapter* provides a general discussion of the obtained results, with particular reference to Karmiloff-Smith's Representational Redescription Model (1992).

1

The Study of the Relation between Emotion and Cognition in the First years of Life: the case of Face Processing

1.1 Emotion and cognition as the two sides of the same coin

Emotion and cognition have long been treated as independent entities in the history of psychology and until recently these different areas of interest rarely overlapped. First studies were almost exclusively focused on cognition, shutting out emotion from the field of investigation: in the 19th century much evidence was collected from psychophysicists and physiological psychologists about sensation and perception, but they said very little about emotion. Gradually, simultaneously with studies on cognition, also emotions found a placement in psychological research and became a topic of investigation for disciplines as social, personality, or clinical psychology. Between the end of the 19th century and the beginning of the 20th century, some theories attempted to describe the process of emotional reactions. According with James-Lange Theory of Emotion (James, 1884), emotion is "the feeling of bodily changes which follow the perception of an exciting event […]. We feel sorry because we cry, angry because we

strike, afraid because we tremble": when we are presented with an emotional stimulus, we feel a physiological arousal, which causes the experience of emotion. See Figure 1.1. This theory offers an explanation of emotional experience, underlying the biological basis of emotions but without any involvement of cognition.

Figure 1.1 James-Lange Theory of Emotion (1884). Physiological activity (arousal) precedes the emotional experience. No reference to cognition.

This hypothesis was challenged in the late 1920s by Cannon and Bard, who theorized that physiological changes are caused by emotions. On the base of this theory, when an emotional stimulus happens, we feel emotions and physiological changes at the same time: Cannon and Bard proposed that the activation and regulation of emotional expression is controlled by the thalamus, hypothesizing the existence of a separate emotional system in the brain (Cannon, 1927). See Figure 1.2.

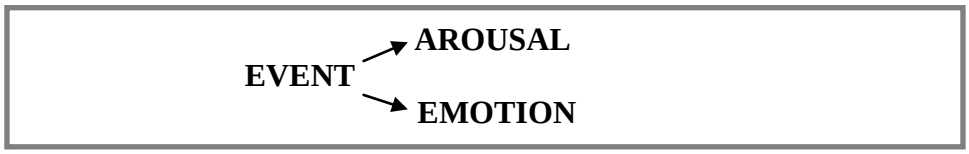

Figure 1.2 Cannon and Bard theory of emotion (1927) physiological arousal and emotion occur at the same time. No attention to the role of cognition.

Except for this discussion about the description of the process of emotional reactions and the attempts of definition of specific pathways of emotion (MacLean, 1949; Papez, 1937), with behaviorist approach and the stimulus-response theory (Watson, 1913), emotion (and cognition as well) was left out the human chance of knowledge for many years, especially in USA: according to this approach behavior can be described and explained without references to mental events or to internal psychological processes.

One of the first theory that emphasized the inseparability of emotion and cognition was Piaget's structuralist/constructivist point of view: the early mental structures described in this model are affective as well as cognitive because arise from the infant's actions, that have affective components (Piaget & Inhelder, 1969).

In the 60's, cognitive revolution defined emotion as a cognitive construction and declared a primacy of cognition: according to this approach cognition comes first, and emotion is determined by cognition. Specifically, Schachter & Singer (1962) introduced a new theory about emotion that took into account the influence of cognitive factors: this assumption is well-known as the Two Factors Theory of Emotion, that suggests that emotion comes from a combination of a state of arousal and how we cognitively label that arousal. See Figure 1.3. According with this hypothesis, the process begins with the emotional stimulus which is followed by the physical activation. Then, this reaction is associated to a specific emotion (cognitive labeling) and we have a conscious experience of emotion.

Figure 1.3 Two Factors Theory of Emotion (Schachter & Singer, 1962). Two factors determine experience of Emotion : Physiological arousal and Cognition (reasoning of the event)

In the 80's this view was exacerbated by cognitive appraisal theory of Emotion (Lazarus, 1984), that states that a thought must come before any emotion or physiological arousal and emotions result from these cognitive interpretations of events, even in the absence of physiological arousal. According with this theory we decide what to feel after interpreting or explaining what has just happened. The interpretation of the

event as good or bad and what we believe is the cause of the event produces the experience of emotion. See Figure 1.4.

Figure 1.4 Cognitive Appraisal Theory of Emotion (Lazarus, 1984). Cognition comes before any emotion or physiological arousal

This cognitive leadership was challenged by Zajonc that proclaimed the independence of emotion from cognition, arising the significant debate about the relation between these two entities (Zajonc, 1980). According to this view, affect doesn't require extensive cognitive processing to occur and emotion and cognition constitute independent sources of effects in information processing. In his 1980 American Psychologist article, Zajonc claimed that emotion could be free from cognition and unconscious (see Figure 1.5), not only because it is no-cognitive, but because it can operate independently from a cognitive processing stream, introducing a possible neural separation of affective pathways.

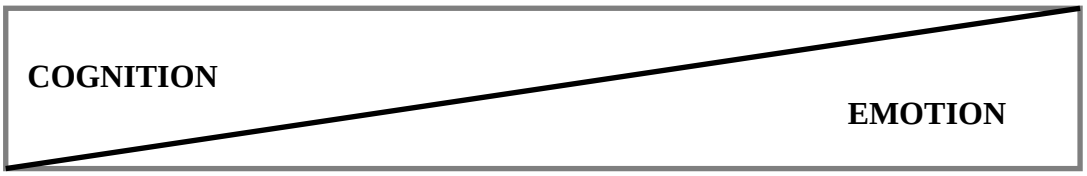

Figure 1.5 Zajonc 's theory. The independence between Cognition and Emotion

In the 90's this revaluation of emotion brought about a revival of the studies regarding its neural basis, giving birth to affective neuroscience (Panksepp, 1996). Already in the first half of the twentieth century, researchers as Sherrington, Cannon, Papez and Hebb were immensely interested in the brain mechanisms of emotional behavior and one factor that hindered work on emotions was that the problem of how the brain makes emotions seemed to have been solved in the early 1950s by the limbic system concept

(MacLean, 1949, 1952). Affective and cognitive neuroscience gradually emphasized that specific brain structures that appear to be primarily linked to emotional processes, yet interact extensively with other brain systems underlying cognitive functions. One of these structures is amygdala, with its extensive connections to brain areas thought to underlie cognitive functions, such as sensory cortices, the hippocampal complex, and the prefrontal cortex (Young, Scannell, Burns, & Blakemore, 1994). Little by little, cognition and emotion are coming to be viewed as complementary rather than antagonistic processes and are becoming two sides of the same coin. See Figure 1.6. At present, a variety of studies suggests that emotional signals can influence cognition (see Öhman & Flykt, 2000 for a review). For instance, several researches have shown more rapid detection of emotional stimuli among neutral distracters than vice versa: some attentional benefits have been reported when targets were faces with positive or negative expressions (Eastwood, Smilek, & Merikle, 2001; Hansen & Hansen, 1988; Öhman, Flykt, & Esteves, 2001; (White, 1995), spiders (Kindt & Brosschot, 1997) or snakes (Öhman, Lundqvist, & Esteves, 2001). These and other data show how affect and cognition are in fact highly interdependent (Storbeck & Clore, 2007) and prompt to study this interaction.

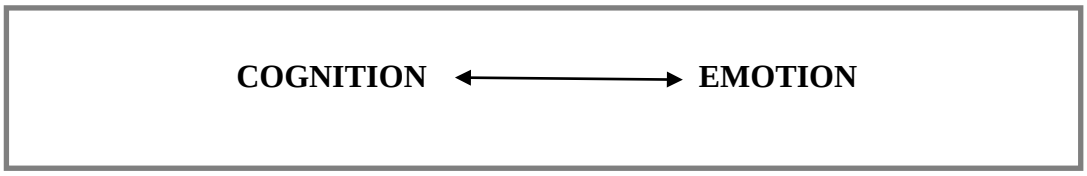

Figure 1.6 Recent point of view of an interaction between Emotion and Cognition (Storbeck & Clore, 2007)

An excellent area of studies in which the investigation regarding the relation between emotion and cognition has founded an important placement is Face Processing.

1.2 The case of Face Processing

Faces are unique, highly salient and biologically significant visual stimuli for humans and primates. They reveal a great deal of information for successful social life, such as the identity, gender, age and emotional state. Looking at a face, all this information is presented simultaneously. How the face processing system elaborates the concurrent presentation of these multiple dimensions is a main question for researchers interested in face processing. In this area, the interdependence between identity recognition and facial emotional expression processing was particularly investigated. This represents an extension and implementation of the study of the relation between emotion and cognition.

Figure 1.7 Different gender, age, ethnic group, emotion expression of faces. From NimStim Face Stimulus Set (Tottenham, et al., 2009).

Traditional models on adults' face perception, like the well-known Bruce and Young's (1986), proposed separate processing of the different kinds of information embedded in a face. The model proposed by Bruce and Young (1986), after reinforced by Haxby and

colleagues' neurological framework (Haxby, Hoffman, & Gobbini, 2000) suggests distinct pathways for the visual analysis of facial identity and facial expressions (see Figure 1.8). At the heart of both models, i.e. Bruce and Young's and Haxby and colleagues', there is the idea that facial identity and expression are recognized by functionally and neurologically independent systems. This suggestion is supported by many psychological studies. For example, some studies on human brain injuries showed selective impairments in the recognition of facial identity or facial expression (Bruyer, et al., 1983; Etcoff, 1984; Tranel, Damasio, & Damasio, 1988; Young, Newcombe, de Haan, Small, & Hay, 1993). Furthermore, studies on nonhuman primates showed different responses to facial identity and expression by different cell populations (Hasselmo, Rolls, & Baylis, 1989) and functional imaging studies confirmed different neural correlates for the perception of facial identity and facial expression (Sergent, Ohta, MacDonald, & Zuck, 1994; Winston, Henson, Fine-Goulden, & Dolan, 2004). Even though this remarkable number of observations supports a functional independence, few recent findings also suggest that there may be conditions in which different aspects of face perception mutually interact. The idea of a dissociation between these two kinds of facial cues is not at issue, but some authors focused their attention on how this dissociation should be interpreted.

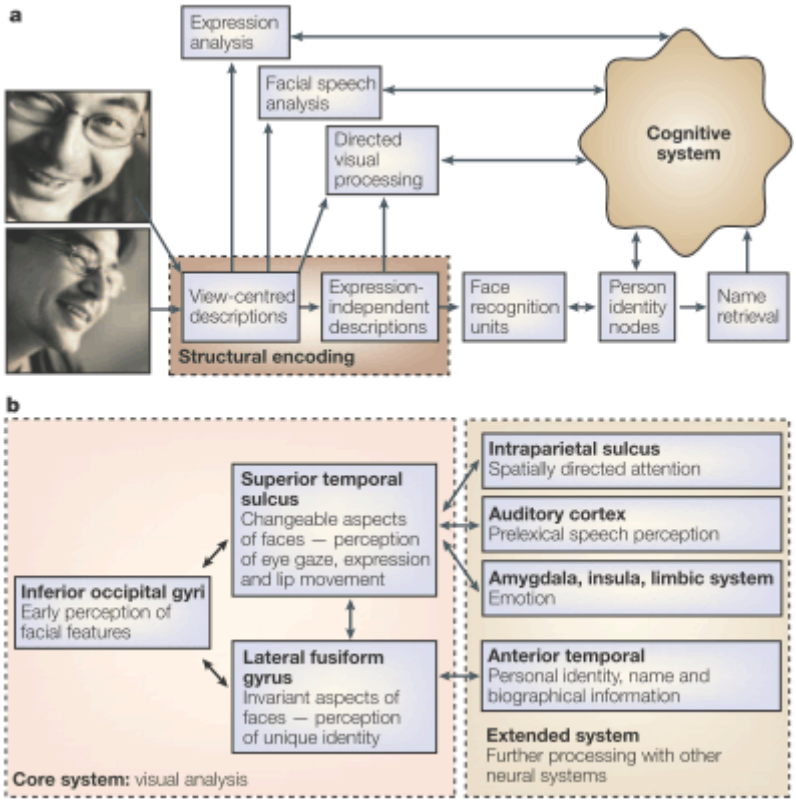

Figure 1.8 Bruce and Young's (1986) functional model of face processing (panel a) and human neural system for face perception proposed by Haxby and colleagues (2000; panel b). From Calder & Young (2005).

Bruce & Young (1986) framework has remained the dominant account of face perception until recently, when few authors challenged it, providing a different conception, i.e. assuming the existence of multiple interactions between different face dimensions (Calder & Young, 2005).

First, some data supported the idea of an asymmetric relationship between perception of facial identity and emotion conveyed by a facial expression. Schweinberger and colleagues (Schweinberger, Burton, & Kelly, 1999; Schweinberger & Soukup, 1998) using a speeded classification task that required participants to selectively attend to one dimension (e.g. identity and facial expression) of a face while disregarding other dimensions, showed that Reaction Times (RTs) for expression judgments were

influenced by irrelevant variation in facial identity, i.e. decreasing when stimulus was familiar to subject.

Later, Baudouin and colleagues (2000) suggested that also changes in facial emotional expression can affect judgment of familiarity of a face: when subjects had to categorize faces as familiar or unknown or had to estimate that degree of familiarity on a rating scale, positive emotional expressions (i.e., a smile) increased these ratings (Baudouin, Gilibert, Sansone, & Tiberghien, 2000). Moreover, Gallegos and Tranel (2005) measured RTs, while participants named familiar famous faces displaying happy or neutral expressions: they found that naming was significantly faster for the happy faces, supporting the hypothesis that emotion can influence visual identification.

Finally, some results advanced the proposal that positive and negative emotional expressions might play a different role on identity face recognition (Lander & Metcalfe, 2007): these data confirmed the smiling familiarity bias proposed by previous studies (e.g. (Baudouin, et al., 2000; Gallegos & Tranel, 2005) and showed that the presence of a negative expression, unlike neutral or positive, can reduce judgment of face' familiarity. These and other results (e.g. Dobel, Geiger, Bruchmann, Putsche, Schweinberger, & Junghofer, 2008) suggest a mutual interaction between identity recognition and facial emotional expression processing in adults.

Figure 1.9 Examples of Face Stimuli used in the studies suggesting an interaction between identity recognition and facial emotional expression processing (Dobel et al., 2008).

In the light of the most part of these results, Calder and Young (2005) proposed an overtaking of the traditional view of fully independent coding of identity and emotional expression in aid of the hypothesis of a *relative segregation*.

1.3 Emotion and cognition in the first years of life: how the ability to recognize an individual face may interact with the capacity to process facial emotion expressions.

Also from the developmental cognitive neuroscience point of view, emotion and cognition, traditionally considered as separate processes, are described as an intricately bound developmental process (Bell & Wolfe, 2004). They are dynamically linked and work together to process information and execute actions (Cacioppo & Berntson, 1999). Current suggestions remind that developmental research can be enriched by studies of the role of emotions in organizing a child's thinking, learning and action and by studies of the role of thinking, learning and action in the regulating of emotion (Cole, Martin, & Dennis, 2004). A recent study focused on the early development of emotion control skills and their relation to cognitive processes and suggest that emotion control as measured by mother report and emotion understanding underlie advances in both cognitive control and cognitive understanding during the preschool years (Blankson, O'Brien, Leerkes, Marcovitch, Calkins, & Weaver, 2012). As in adults, studies on infants' and children's face processing allow to better understand this interplay between emotion and cognition during development.

About *infancy*, a large amount of research, better described in the next chapter, has studied infants' face identity recognition (see De Haan, 2001, for a review) and facial emotion expression processing (see Grossman, 2010, for a review), but only few studies have investigated the relation between these different sources of information, i.e.

whether and how identity recognition interacts with facial emotion expressions processing. As in adults, evidence suggest also in infancy an influence of familiarity on facial emotion expressions recognition. Walker-Andrews and colleagues, as before Barrera and Maurer (Barrera & Maurer, 1981), have shown that 3.5-months-olds discriminate more easily among facial expressions portrayed by their own parents than among facial expressions portrayed by a stranger (Walker-Andrews, Krogh-Jespersen, Mayhew, & Coffield, 2011). Moreover, in Kahana-Kalman & Walker-Andrews' study (2001) using intermodal matching procedure, 3.5-month-old infants showed a better competence to detect the congruence between voice and facial emotional expressions, when the expressions were displayed by infants' mother than female strangers.

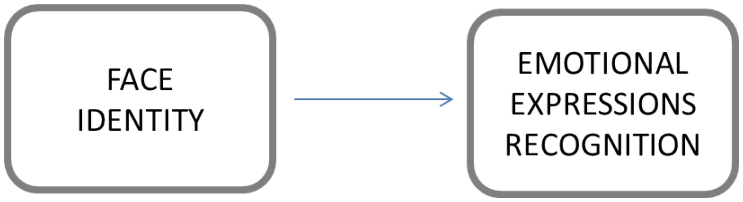

Figure 1.10 Evidence from studies on infants suggest an influence of familiarity of a face on emotional expression recognition.

Only one study has recently investigated the relation between identity and facial expressions processing during infancy in the opposite direction, i.e. considering the effect of facial emotional expressions on identity recognition. Using an adaptation of the switch design, Schwarzer & Jovanovic (2010) suggested that 8-month-old infants process facial identity in conjunction with emotional expression when faces are presented in canonical orientation - i.e. upright -, but they do not when face are inverted and configural processing is disrupted.

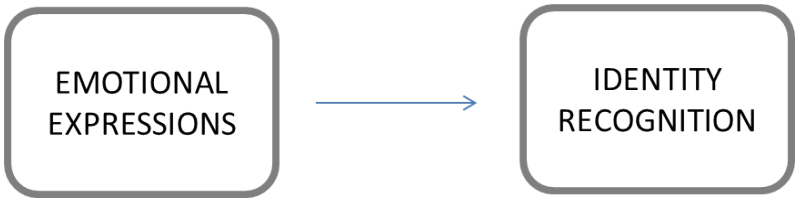

Figure 1.11 Schwarzer & Jovanovic' (2010) results suggest an influence of emotional expression processing on infants' identity recognition.

About older *children*, the properties of the relation between identity recognition and emotional expression processing in childhood have been more studied than in infancy. Results on the influence of information about identity on emotional expressions recognition converge to suggest an interference effect of face familiarity on children' performance: e.g. when negative emotion as anger, fear or disgust are displayed by a familiar face children show a lower recognition accuracy (Herba, et al., 2008) and 5- to 11-year-old hardly ignore information about identity during a classification of facial emotional expressions (Spangler, Schwarzer, Korell, & Maier-Karius, 2010).

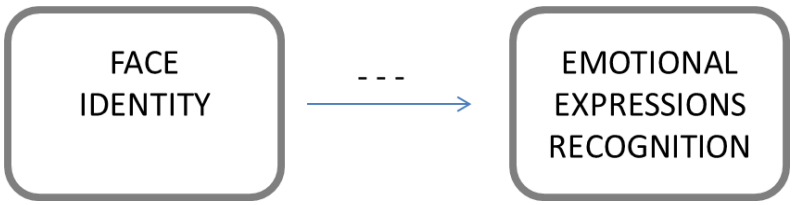

Figure 1.12 Evidence from studies on children suggest an interference effect of face identity on emotional expressions recognition

Studying the relation between identity and facial expression processing in children in the opposite direction, i.e. exploring the effect of emotional expression on identity recognition, data are still controversial. Two different hypotheses interchange in the recent literature: at one side, some studies suggest an *independent encoding of identity*, i.e. variations in emotional expression do not influence children' identity recognition (Ellis, 1992; Norbeck, 1981; Spangler, et al., 2010). Conversely, at another side, other outcomes allow to hypothesize an *interference effect* of emotional expression on

identity recognition, i.e. when faces varying in emotional expression children are less accurate in identity recognition (Baudouin, Durand, & Gallay, 2008; Bruce, et al., 2000; Herba, Landau, Russell, Ecker, & Phillips, 2006; Mondloch, Geldart, Maurer, & Le Grand, 2003).

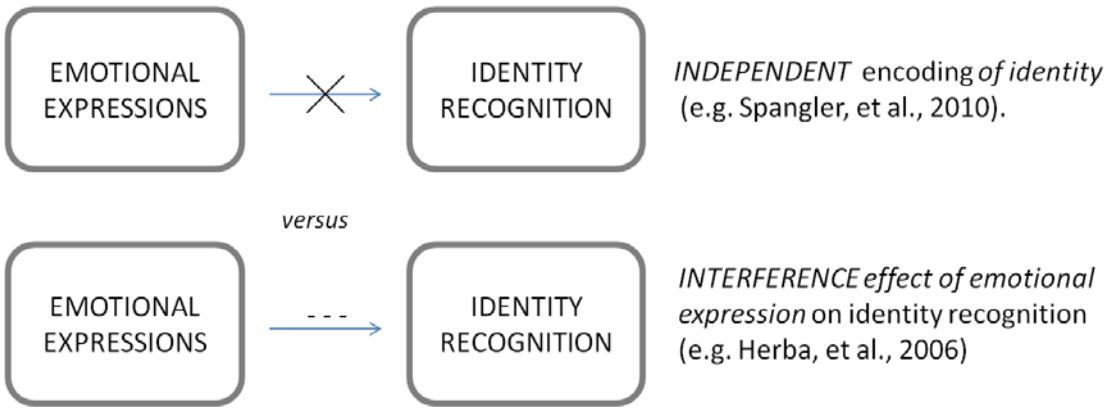

Figure 1.13 Two different hypotheses about the effect of emotional expressions on identity recognition in children

1.4 The study of development: aims of the present study

Aim of the here presented studies was to investigate the relation between facial emotional expressions processing and identity recognition in the first years of life. Why is it important to study this topic in infants and children? And, more generally, why is it important to study child development? First developmental researchers focused their studies on children' different performances at different ages, in order to explain observed gaps as changes in thought organization (e.g. in Piaget) or in cognitive competences (e.g. in Human Information Processing approach). In this point of view, the aim of developmental psychology was to study different stages of development, in order to fix specific goals at each specific age. However, developmental study can be seen in a different way: as Karmiloff-Smith (1992) suggested, developmental research can be not only a purpose, but it can be used as a tool to understand human cognition.

Specifically, in this perspective, aim of developmental studies should be understanding how infants and children get the tasks: the focus of attention is on processes and on brain organization. Developmental psychology becomes essential to investigate also adult mind: some knowledge about the origin and development of a specific competence is an important device for a better comprehension of the adult brain architecture. For example, the study of the first appearance of a skill at early ages can help to deepen the role of experience and deals with one of the main question of psychology, i.e. the nature-nurture relationship.

Concerning the topic of this study, i.e. the relation between identity recognition and facial emotional expression processing, the investigation about this interplay at different ages provides some blinkers about its structuring. It allows to understand the origin and development of the interdependence between identity and facial emotional expression processing observed in adult. Moreover, this examination offers an excellent input to improve existing face processing models. In particular, using the familiarization paradigm with infants, this study investigated how face identity and emotional expressions are processed a 3 months of life and how the relation between these facial dimensions can be described at this age. 3-month-olds seemed an optimal sample because a lot of studies showed their suitable competence in identity recognition and in emotional expressions discrimination. One may claim that face identity and emotional expressions are initially processed independently before being integrated at a later developmental stage. Conversely it is possible that upfront the interplay between these processes is unavoidable. Therefore, the part of the project regarding infancy aimed to study the origins of the interdependence between identity and emotion processing and the nature of this relation in the first year of life. On the other hand, the part of the work

regarding preschool-aged children, aimed at observing the path of development of this connection, studying 4- and 5-year-old's skills to recognize the identity of an individual face varying in emotional expressions. In the light of the inconsistency in literature about this topic in older children, the goal of the studies conducted with preschool-aged was to compare the hypothesis of an independent encoding of identity (e.g., Spangler, et al., 2010) with the hypothesis of an interference effect of emotional expressions (e.g., Herba, et al., 2008).

2

The Effect of Positive and Negative Emotional Expressions on the recognition of an individual face during infancy. The peculiar effect of happiness

After a brief description of the theoretical background of the study, this chapter presents 3 different experiments, in which using a familiarization paradigm 3-month-old infants were tested for their ability to recognize the identity of faces displaying different emotional expressions. The overall aim of these experiments was to understand the relation between identity recognition and facial expressions processing during infancy and specifically whether and how the presence of a facial emotional expression influences 3 month-olds' facial identity recognition.

2.1 Theoretical Background of the study

As mentioned in Chapter 1, many studies have investigated infants' face processing ability and their competence of recognition of facial emotion expressions (de Haan, 2001; Grossman, 2010), but scarce research has explored how these skills interplay during infancy.

Particularly, the study of infants' face processing has played a prominent role in the developmental field within the last two decades and well-know are studies regarding newborn's early face recognition abilities. Evidence suggests that highly schematized faces and photos of real faces spontaneously capture newborns' attention more than other, equally complex, visual objects (Johnson & Morton, 1991; Macchi Cassia, Turati, & Simion, 2004). Moreover, few-day-olds reveal a visual preference for their mother's face over the face of a stranger woman (e.g., Pascalis, de Schonen, Morton, Deruelle, & Fabre-Grenet, 1995) and are capable to recognize an unfamiliar face to which they have been habituated (Pascalis & de Schonen, 1994; Turati, Macchi Cassia, Simion, & Leo, 2006) Furthermore, newborn infants look longer at attractive than unattractive faces (Slater, et al., 1998), appear to be sensitive to the presence of the eyes, and prefer to look at faces that engage them in eye contact (Batki, Baron-Cohen, Wheelwright, Connellan, & Ahluwalia, 2000; Farroni, Csibra, Simion, & Johnson, 2002).

Regarding facial emotion recognition, developmental psychologists have focused on the question of how the perception of emotion develops during the first year of life (Grossman, 2010). Previous evidences suggesting newborns' discrimination between facial expressions (Field, Cohen, Garcia, & Collins, 1983; Field, Woodson, Greenberg, & Cohen, 1982) were recently confirmed, at least for some expressions, by Farroni and

colleagues (2007), using visual preference and habituation procedures. See Figure 2.1. When a fearful expression is compared to a happy one, newborns looked significantly longer at the latter, demonstrating that newborns are capable to discriminate happy from fearful expressions.

Figure 2.1 Stimuli used in Farroni, Menon, Rigato, & Johnson (2007). Results suggest newborn' discrimination between fear and happiness

Moreover, other studies testing older infants have shown that by 3 months infants can discriminate between happy and surprised faces (Young-Browne, Rosenfeld, & Horowitz, 1978) and happy from angry faces (Barrera & Maurer, 1981) and by 4 months look longer at happy than angry or neutral expressions (LaBabera, Izard, Vietze, & Parisi, 1976) and at happy faces than sad faces, only when faces are toothy (Oster, 1981). Furthermore, there is evidence that 4-month-olds can discriminate between mild and intense examples of fearful faces (Nelson & Ludemann, 1986) and that 6-month-olds reliably discriminated between varying intensities of happy and angry facial expressions (Striano, Brennan, & Vanman, 2002). About the skills of categorization, from 5 months, infants habituated to different faces wearing different degrees of smiling can categorize the facial expression of smiling across variations in both individuals and intensities of smile and they respond to a fearful expression as belonging to a different affect category than smiling. These results suggest a competence of categorizing happiness at 5 months (Bornstein & Arterberry, 2003),

although 6- to 7-month-old infants can't categorize fear or surprise (Kotsoni, de Haan, & Johnson, 2001). See Figure 2.2. It is possible that early skills of categorization are restricted to more familiar emotions - i.e. happiness-, and the ability to form categories of happy expressions might not develop until after 7 months of age.

Figure 2.2 Facial expressions presented to 5-month-olds in Bornstein and Arterberry (2003). Results suggest the infants' ability to categorize happiness categorize the facial expression of smiling.

Finally, by the end of the first year of life, infants begin to use others' expressions to interpret external events and to guide their behavior in uncertain situations (Grossman, 2010; Sorce, Emde, Campos, & Klinnert, 1985).

As concerns the effect of familiarity on identity face recognition, some studies have described an adult-like pattern. As adults, infants recognize more easily emotional expressions when portrayed by familiar faces, specifically their own parents, than non-familiar face (Barrera & Maurer, 1981; Kahana-Kalman & Walker-Andrews, 2001; Walker-Andrews, Krogh-Jespersen, Mayhew, & Coffield, 2011). This evidence suggests that infants are facilitated in their recognition of emotional expressions by the familiarity of their parents and support a face processing model in which, also in infancy, familiarity of a face affects identity processing.

A recent study (Schwarzer & Jovanovic, 2010) have investigated the relation between emotional expression and identity processing, aiming to understand whether

information on the identity of a face is processed in relation to social aspects, such as the emotional expression. See Figure 2.3. More specifically, the study explores whether 8-month-old infants process facial identity and emotional expression of a face independently or in conjunction with one another, using an adaptation of the switch design. In the habituation phase, a face (e.g. identity A) showing a positive expression and another face (e.g. identity B) showing a negative expression were presented. In the subsequent test phase a familiar habituation face, a switch face, and a novel face were shown. In the switch face, facial identity or emotional expression of habituation faces was combined with facial identity or emotional expression of the other habituation face, e.g. face identity A posed a negative expression similar to that posed by face identity B or vice versa.

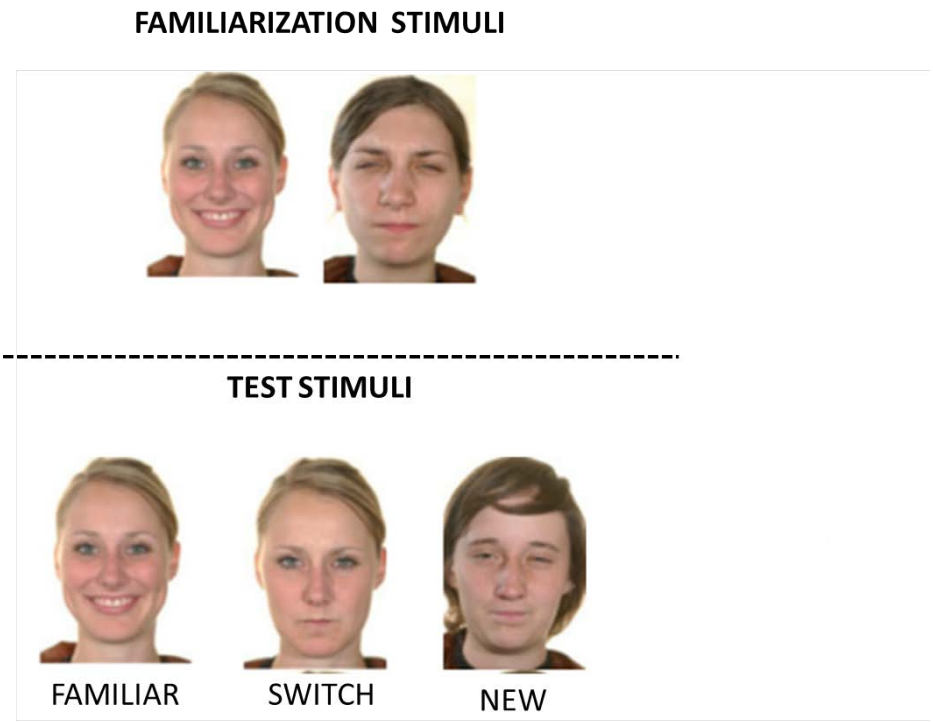

Figure 2.3 Examples of stimuli used in Schwarzer and Jovanovic (2010). Results suggest that 8-month-olds process facial identity in conjunction with emotional expression when faces are presented in canonical orientation.

Faces were presented in canonical and inverted orientation. Results show that 8-month-olds differentiate between switch and habituation faces only in the upright condition but not in the inverted condition. As it is known that inversion disrupts information on the relationship or combination of different information (Cohen & Cashon, 2001; Turati, Sangrioli, Ruel, & de Schonen, 2004), evidence suggests a face processing model in which, also in infancy, information of identity is processed in conjunction with emotional expression. These results pave the way to the investigation of the nature of this combined processing.

The experiments described in this chapter fit in with this issue, aiming to understand how identity processing and emotion recognition interplay during infancy. Specifically, the study investigated i) whether and how an emotional expression could affect 3-month-olds' ability to recognize an individual face as familiar; ii) whether positive vs. negative emotional expressions have a different effect on identity processing; iii) what perceptual features of the face displaying an emotional expression are crucial to drive the observed effects.

2.2. Experiment 1: Identity Recognition of Happy and Neutral Faces in 3-month-old infants

Experiment 1 aimed to understand the effect of happiness in infants' processing of a new facial identity. Three-month-old infants were familiarized with a neutral or happy face in order to investigate the effect of the presence or absence of happiness on infants' identity recognition.

Given the lack of specific evidence for early infancy from prior research, detailed hypotheses could not be generated. However, at least two different scenarios might be

advanced. In analogy with the results obtained with 4- to 15-year-old children (Herba, et al., 2006), one possibility was that emotional expression might interfere with face identity recognition, producing a decrement in infants' face recognition performance. Conversely, as observed in adults (Dobel et al., 2008; Lander & Metcalfe, 2007) a positive emotional expression might exert a facilitator effect on infants' proficiency in recognition of face identity, inducing an enhancement in infants' identity recognition performance. Moreover, with the aim to test also the role of time of exposition, two different times of familiarization were used, i.e. brief (20 s of cumulative time of fixation) and long (40s). Time used as familiarization criterion could be a decisive variable: the facilitation provided by the happy emotional expression might be stronger when the recognition task is more demanding for infants limited cognitive resources, that is when infants are exposed to a face for brief (20 s) rather than a long (40 s) familiarization period.

2.2.1 Method

Seventy-three healthy full-term 3-month-old infants (mean age = 105 days; range = 85–121, 34 males) were tested. They were recruited from birth records provided by neighboring cities or from a list of infants obtained from community pediatricians and parents gave their written informed consent before testing began. Twenty-three additional infants were excluded from the final sample because of technical problems (n = 4) or because fussiness resulting in failure to complete all test trials (n = 19). Infants awake and in alert state were randomly assigned to one of two different conditions: Happiness condition (n = 37) and Neutral condition (n = 36). The study was approved by the Ethic Committees of Scientific Institute ‘‘E. Medea.

Stimuli

During familiarization, the stimuli were dynamic color video-clips composed by 4 different 500-ms frames, in which a Caucasian young woman face displayed an happy (see Figure 2.4, a) or neutral facial expression (see Figure 2.4, b). Stimuli were dynamic stimuli in both conditions and videos were designed so as to have a similar degree of dynamism (frames in each video running at the same speed and rhythm).

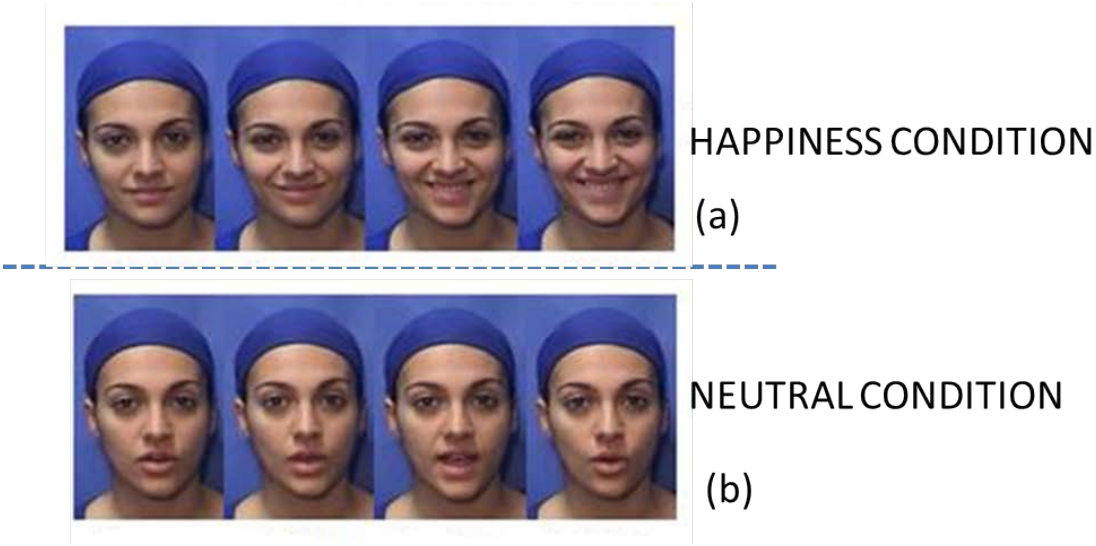

Figure 2.4 Familiarization Stimuli in Happiness (a) and Neutral Condition (b) of Experiment 1

In the happiness condition the four frames depicted a gradually increasing smile. In the neutral condition, the inner face features moved without expressing any emotion (the four frames were extracted from a video of a counting woman, alternating open and closed mouth). Four different identities were used, in a counterbalanced design between subjects: each infant was familiarized with one, out of the four, video-clip. Each video-clip was repeated in a loop until the familiarization criterion was reached.

Static pictures of women with a neutral facial expression were shown during the test phase (see Figure 2.5). Each infant saw two different identities, the familiar face and a

novel face.

Figure 2.5 An example of familiar and new face presented in test phase.

As in familiarization as in test phase, women were portrayed on a blue background in a full frontal pose with blue hair band covering the women's hair. Peculiar features (e.g., piercing, beauty spots) were removed to avoid possible interferences. 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 center of a computer screen.

Apparatus

Experimental sessions were run in two twin laboratories (Laboratorio Prima Infanzia, Università degli Studi di Milano-Bicocca and Centre for the Study of Social Emotional Development of the at Risk Infant, Scientific Institute "E. Medea", Bosisio Parini, Lecco, Italy). Infants were tested on a single session, using a familiarization paradigm, in either lab. 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 behavior. An experimenter, blind about the ongoing experimental condition, recorded infants' looking times clicking the mouse buttons (on line coding).

Stimulus presentation and data collection were performed using EPrime 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 off-line 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 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 face (2000 ms) and ended with another black screen (500 ms). Each trial continued until the infant looked for a minimum of 500 ms and ended when the infant looked away continuously for 2 sec. Each video-clip was composed by four 250 ms-frames. See Figure 2.6. There were two different conditions of familiarization: half infants were familiarized with a criterion of 20 s of cumulative looking time towards the face stimulus (*brief familiarization*), the other half with a criterion of 40 s (*long familiarization*).

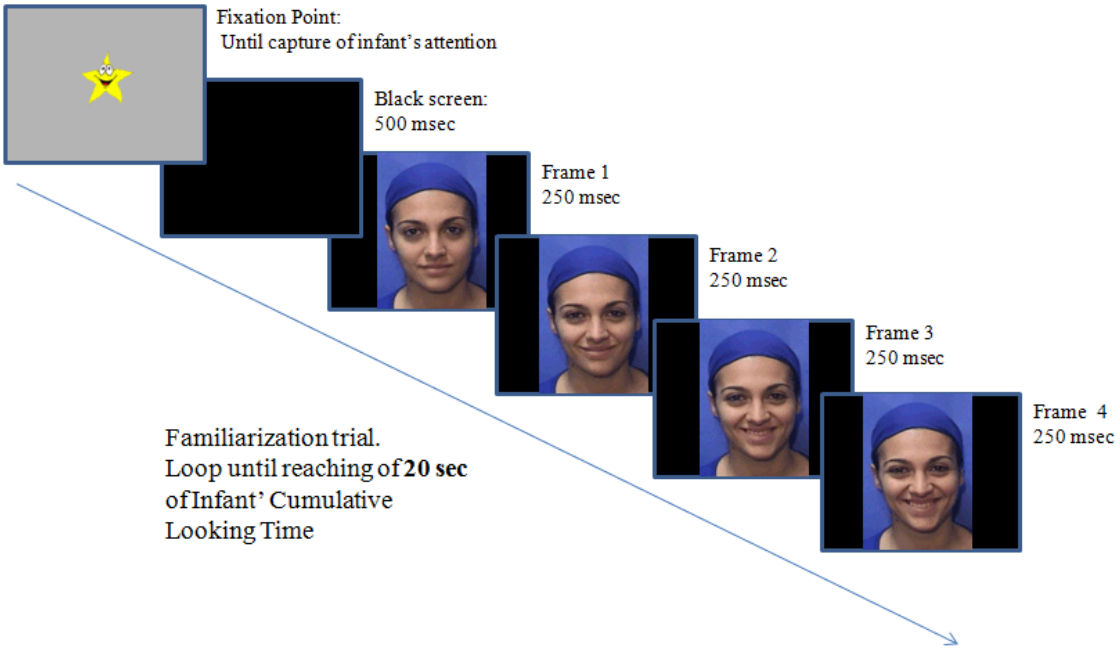

Figure 2.6 The sequence of events in each trial of familiarization phase.

Following familiarization, static images of the familiar and a novel woman 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 at least 500 ms and he/she looked away continuously for 2 sec. Among trials attentional catchers were presented. See Figure 2.7.

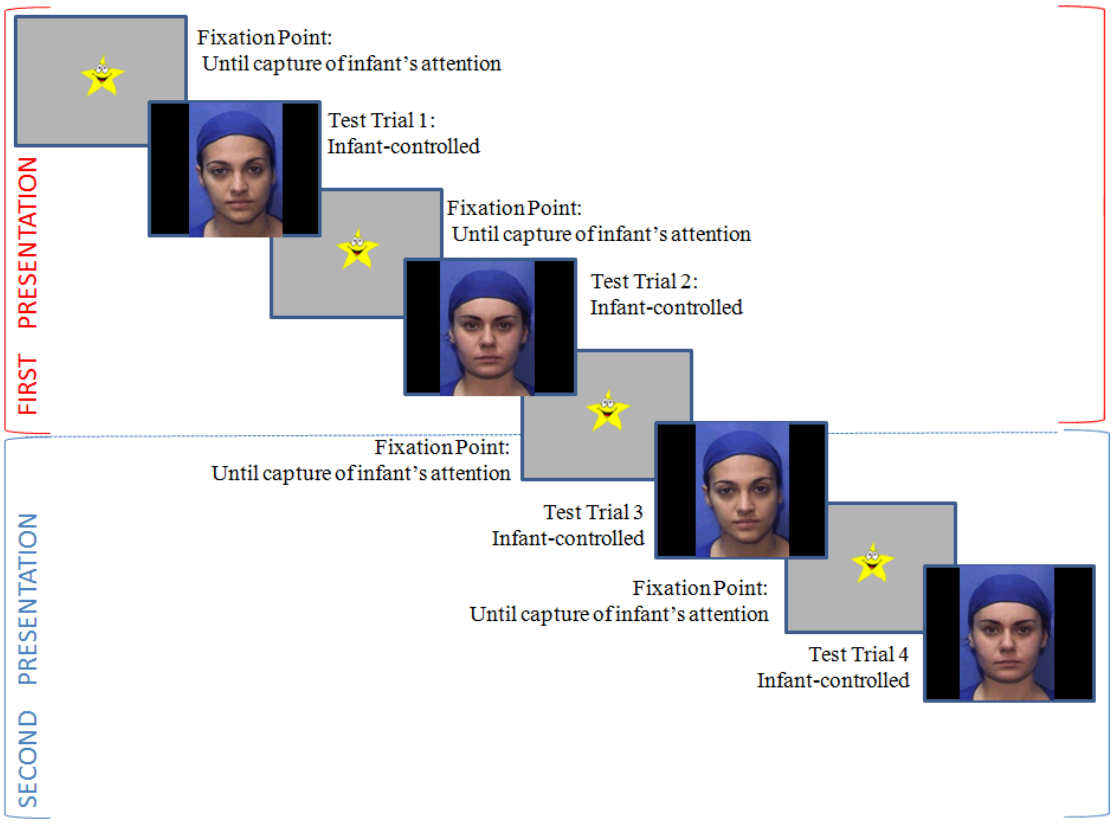

Figure 2.7 The sequence of events in test phase

2.2.2. Results

Data analyses were conducted on both familiarization and test phase. Regarding the familiarization phase, in both conditions (*brief* and *long*) the happy and the neutral conditions did not differ in the number of trials required to reach the criterion times. In the brief familiarization condition (20 s), the mean number of trials in the happiness condition (M = 9.10, SD = 2.02) was similar to the mean number of trials in the neutral condition (M = 9.00, SD = 1.08), $t(36) = 0.187$, $p > .05$. Similarly, in the long familiarization (40 s), the number of trials did not differ in the two conditions (happiness, M = 17.00, SD = 1.50 and neutral M = 18.61, SD = 3.57), $t(33) = 1.861$, $p > .05$.

To determine whether facial emotional expression affected 3-month-old infants' ability to recognize an individual face, looking times (s) toward the familiar and the novel faces in test phase were considered. An ANOVA was performed with Amount of familiarization (20 s vs. 40 s) and Emotion (Neutral vs. Happiness) as between-subjects factors, and Presentation (first vs. second) and Novelty (new vs. familiar) as within-subjects factors. The ANOVA revealed a main effect of Novelty, $F(1, 69) = 8.01$, $p < .01$, $\eta^2_p = .10$ and Presentation, $F(1, 69) = 21.29$, $p < .01$, $\eta^2_p = .24$ and a significant Emotion x Presentation x Novelty interaction, $F(1, 69) = 4.03$, $p < .05$. $\eta^2_p = .05$. In order to further explore this interaction, two separate ANOVAs were performed on looking times during the first and the second stimuli presentation. The analysis had Emotion (Neutral vs. Happiness) as between-subjects factors, and Novelty (new vs. familiar) as within-subjects factor. For the first presentation (Figure 2.8) the analysis indicated a significant Novelty x Emotion interaction, $F(1, 69) = 5.95$, $p < .05$, $\eta^2_p = .08$. Paired t-tests (two tailed) were conducted to compare means obtained. The findings indicated that, for the happiness condition, there was a significant difference between looking time for the new (M = 39.29 s; SD = 5.15) and familiar (M = 28.27 s; SD = 5.01) face stimulus, $t(36) = 3.08$, $p < .01$. For the neutral condition the comparisons between the new (M = 30.89 s, SD = 5.23) and the familiar (M = 33.77 s, SD = 5.09) face stimulus did not reach statistical significance, $t(35) = 0.669$, $p > .50$. For the second presentation (Figure 2.9) results showed a main effect of novelty, $F(1, 69) = 7.54$, $p < .01$. $\eta^2_p = .09$. Infants, in both conditions, looked longer toward the novel stimulus (M = 24.13 s; SD = 2.9) than the familiar one (M = 17.18 s; SD = 1.6).

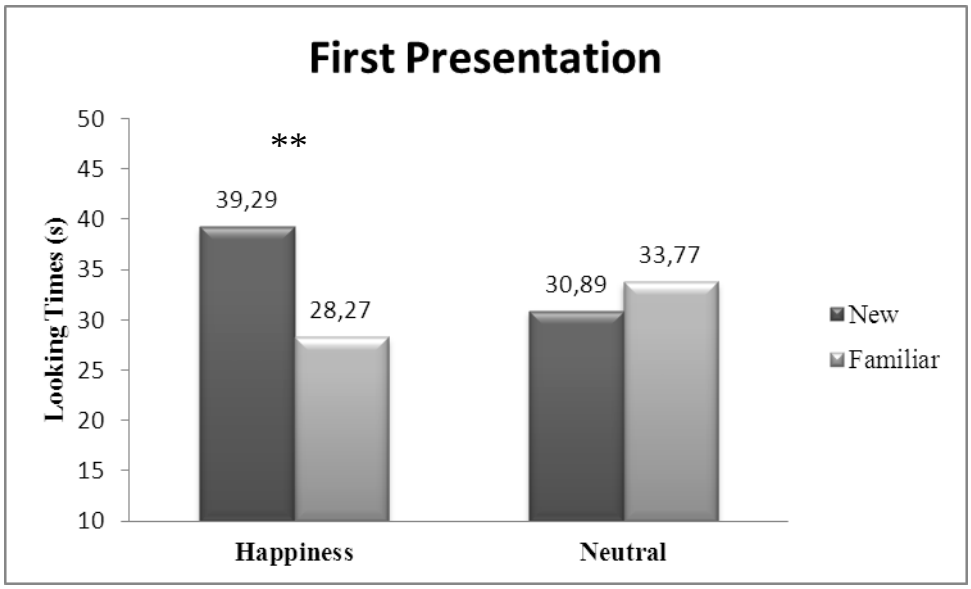

Figure 2.8 Looking times (s) toward the new and the familiar stimulus in the first test presentation. **$p < .01$.

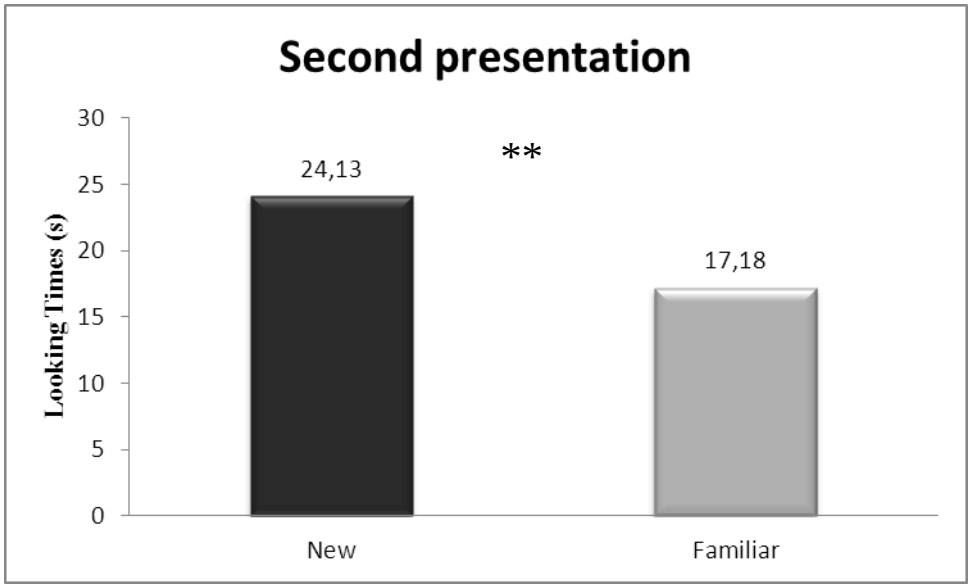

Figure 2.9 Looking times (s) toward the new and the familiar stimulus in the second test presentation. *$p < .01$.

2.2.3. Discussion

Obtained results suggest that 3-month-olds' face recognition capacity is enhanced when faces are smiling rather than displaying a neutral emotional expression. Infants familiarized with a happy face are capable to recognize a novel imagine of the same face the first time it is shown during the test phase (in the first presentation). Conversely, when familiarized to a neutral face, infants recognized the familiar identity only during the second test presentation. Probably, infants in the neutral condition used the first test presentation as an additional familiarization trial that allowed them to fully elaborate the familiar face, and then recognize it during the second test presentation. Indeed, in the neutral condition, the test stimuli in the first presentation were observed by infants for more than 30 s each (30.89 s for the novel face, 33.77 s for the familiar face). Since no substantial differences were obtained for infants belonging to the brief (20 s) or long (40 s) familiarization group, plausibly the extra 20 s of total fixation time allotted to the long familiarization group were still not sufficient in order to complete and establish infants' recognition of a neutral face.

It is also important to note that the recognition advantage observed for happy over neutral faces was not a mere consequence of the dynamic information that is invariably associated with the expression of an emotion, because even the inner features of the neutral faces were in motion (i.e., the women were video recorded while counting). Therefore, our results cannot be interpreted as an effect of dynamic versus static information. In order to be effective, motion of face features should have an overall emotional value.

These results propose an adult-like pattern in which positive emotional expressions (i.e. smile) increased ratings of familiarity of faces (Baudouin, et al., 2000) and weaken the idea of an independence between face identity and emotional expression recognition.

Overall, in addition to previous evidence showing that infants' processing of emotional facial expression is facilitated when the person who is displaying the emotion is familiar (Barrera & Maurer, 1981; Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002), evidence from the present study supports the idea of a mutual and bidirectional interaction between identity recognition and emotional expressions processing.

In order to better understand this interplay and to explore the influence of negative expressions on facial identity recognition a second experiment was performed.

2.3. Experiment 2: Positive and negative expressions in 3-month-old infants' identity recognition

In Experiment 1 a facilitator effect of smiling faces on identity recognition was observed. In Experiment 2, the differential effect of positive and negative expressions on identity recognition was investigated. Infants were familiarized with faces displaying different emotions, i.e. happiness, anger or fear, with the aim to compare possible different effects. As concerns to positive emotion, i.e. happiness, a confirmation of results obtained in the first experiment is expected. Regarding negative expressions different predictions can be advanced. In analogy with adults (Lander & Metcalfe, 2007), negative expressions, both anger and fear, might produce a decrement in infants' performance of identity recognition, corroborating the hypothesis of an interference effect and the idea of a different role of positive vs. negative emotional expressions. As in a recent study with 4- and 7-month-old infants, an avoidant looking behavior in response to threat-related emotional expressions (anger and fear) might be observed (Hunnius, de Wit, Vrins, & von Hofsten, 2011). On the contrary, negative facial expressions might capture infants' attention, producing an effect analogous to the one exerted by positive emotional expressions, enhancing individual face recognition.

Finally, processing of identity might be affected in different ways by expressions of fear and anger. Seven-month-old infants disengaged their fixation significantly less frequently from fearful faces than from control stimuli and happy face (Peltola, Leppänen, Vogel-Farlet, Hietanen, & Nelson, 2009): these results could suggest a peculiar effect of fearful expressions on infants' identity recognition.

2.3.1.Method

Participants

Sixty-two healthy full-term 3-month-olds were tested (*M* = 108 days, range = 93-122 days, 38 males). Subjects were randomly assigned to one of two different conditions: Positive emotion (happiness; N = 30) and Negative emotion (fear; N = 16; anger N = 16). They were recruited as in Experiment 1 and written informed consent was obtained from the infants' parents. Thirty-Two additional infants were excluded from the final sample because of technical problems (n = 2) or because of fussiness or disattention during testing (n = 30).

Stimuli

As in Experiment 1, familiarization stimuli were video-clips displaying a Caucasian young woman face. In each video, the woman displayed a positive (i.e. happiness) or a negative (i.e. fear or anger) emotional expression, see Figure 7. Stimuli were designed so as to have a similar degree of dynamism (4 frames of 250 msec in each video running at the same speed and rhythm, as in Experiment 1) and all videos depicted a gradually increasing of emotion. Four different identities were used, in a counterbalanced design between subjects. The same static photos of women with a neutral facial expression used in Experiment 1 were shown during the test phase (see Figure 2.10). At a viewing

distance of 60 cm, stimuli were 17° of visual angle in height and 15° of visual angle in width and faces were shown in the center of a computer screen.

Apparatus and Procedure

Participants were tested in the same manner as in Experiment 1. Because of no difference between the different times of familiarization used in Experiment 1, infants were familiarized according to a single criterion, i.e. 20 s of cumulative looking time towards the face stimulus.

Instead, familiarization phase was differentiated between subjects depending on the emotion displayed in the video. Half infants were familiarized with a video of a woman displaying a positive emotional expression (i.e., happiness, N = 32), the other half with a video of a woman expressing a negative emotion (i.e., fear, N = 16 and anger, N = 16).

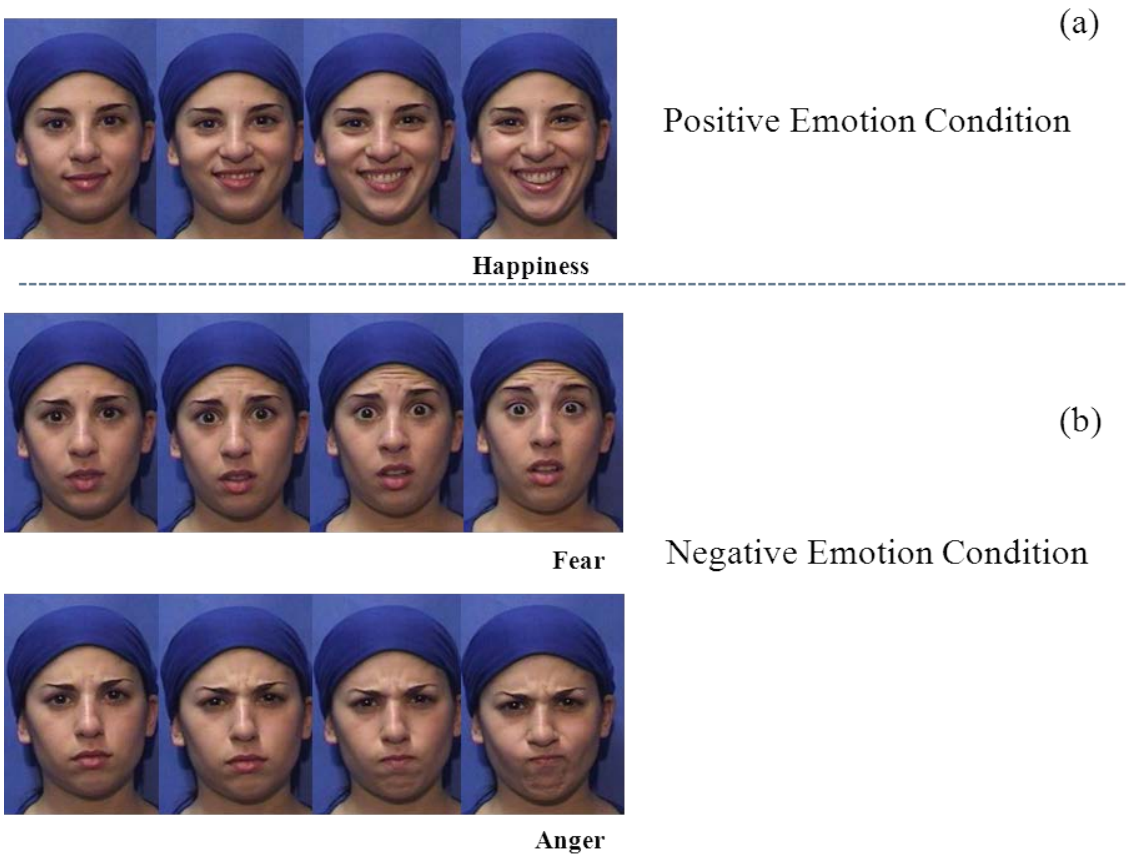

Figure 2.10 Familiarization Stimuli in Positive (a) and Negative emotion Condition (b) of Experiment 2

Figure 2.11 Neutral Face presented in Test Phase of Experiment 2

2.3.2. Results

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 considering 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 sec, SD = 4.21) than in the second presentation (M = 26.02 sec, 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 more towards the novel (M = 38.06 sec, SD = 5.51) than the familiar face (M = 28.10 sec, SD = 4.64), $t(29) = 2.48$, $p < .05$). Instead, infants familiarized with a face displaying negative emotions did not discriminate the familiar (M = 35.16 sec, SD = 4.49) from the novel face (M = 31.89 sec, SD = 5.34), $t(31) = -.65$, $p > .05$. See Figure 2.12.

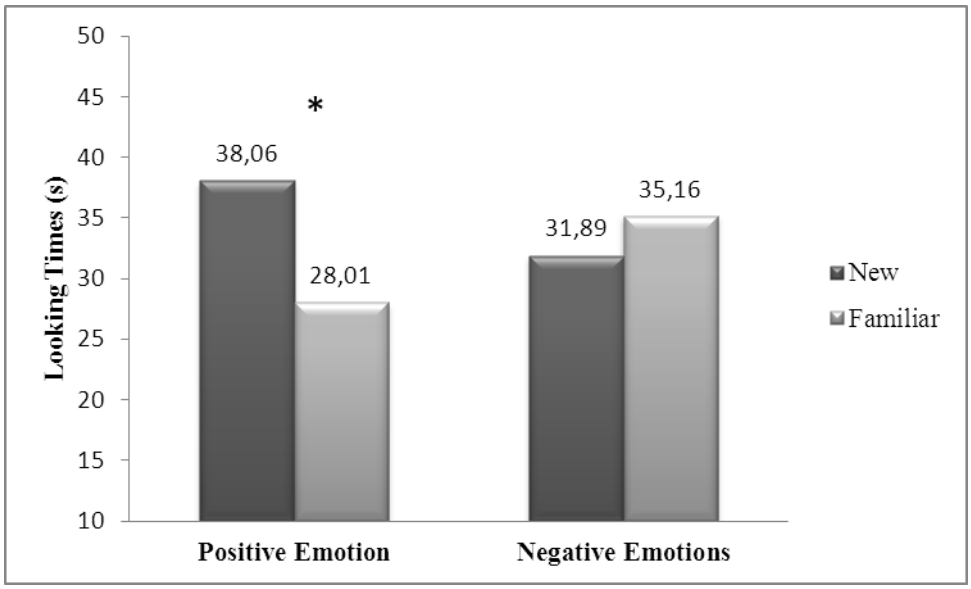

Figure 2.12 Looking times (s) toward the new and the familiar stimulus in Positive Emotion and in Negative Emotions condition in Experiment 2. *p < .01.

In order to understand the processes underlying these different effect of negative and

positive emotional expressions, further analyses on infants' looking behavior were conducted. Considering number of fixations during the familiarization phase, infants shown positive emotion (M = 1.17, SD = .379) did not differ from infants familiarized with negative emotion (M = 1.16, SD = .448), $t(60)$ = .099, p >.90. Also regarding number of trials needed to reach the familiarization criterion, the first group (M = 8.97, SD = 1.03) did not differ from the other one (M = 9.47, SD = 1.72).

2.3.3. Discussion

Results suggest that during infancy, 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. As observed in Experiment 1, the presence of a positive emotion, i.e. a facial expression of happiness, leads to a facilitator effect on identity recognition of a face. Conversely, when the face conveys a negative facial emotional expression infants' identity recognition ability is reduced.

Again, as in Experiment 1, evidence supports an adult-like pattern, in which smiling faces have a peculiar enhancing effect and conversely negative emotions, both anger and fear, interfere with identity processing of a face (Lander & Metcalfe, 2007).

Results from analyses conducted on familiarization phase don't show different looking behavior during exposition of different emotional stimuli, i.e. an avoidant looking behavior in response to threat-related emotional expressions (anger and fear) as suggested by Hunnius et al. (2011). Indeed, the observed pattern cannot be explained by a different looking behavior during familiarization phase. However, the employment of other techniques, e.g. eye-tracker, might provide important information about infants' visual exploration of emotional faces.

Moreover, obtained findings suggest no difference between angry and fearful expressions, putting the two emotions on the same footing. However, these results do not deny the peculiar role of fear suggested by Peltola et al. (2009), instead allows to extend this hypothesis also to another negative emotion as anger. Indeed, in Peltola' study angry expression was not included in the investigation. Future studies should explore this interesting issue.

Notwithstanding these relevant suggestions about the interaction between emotional expression processing and identity recognition during infancy, results from Experiment 2 do not offer any information about what perceptual features of the face with a happy emotional expression (i.e., upper or lower half) differentially affected infants' ability to recognize an individual face. Experiment 3 was performed in order to investigate this question.

2.4. Experiment 3: The role of peculiar features of happy expression.

Aim of Experiment 3 was to understand what perceptual features of a happy face are crucial to enhanced identity recognition in infants. Particularly, the study investigated whether the advantage of positive vs. negative facial expressions on face recognition is based on the processing of a peculiar feature of the happiness expression or on the holistic processing of the entire facial emotional expressions. In the first case, we could suggest a *featural* processing of emotional expression, otherwise a *configural* processing could be proposed. One important distinction made in the literature is between the "featural" and "configural" information contained within a face (Carey & Diamond, 1977). Featural information refers to face elements that can be referred to in relative isolation such as the size and shape of the eyes, nose, and mouth. In contrast, configural information refers to the spatial layout of these elements within the face.

Specifically, Maurer and colleagues have defined configural processing of a face including i) the sensitivity to first-order relations that specify the stimulus as a face, ii) holistic processing that allow the processing of the face as a gestalt, iii) sensitivity to second-order relations that specify differences among individuals in the spacing of features (Maurer, Le Grand, & Mondloch, 2002). Both these processing modes, i.e. featural and configural, are used very early in infants' face recognition, both in identity (Schwarzer, Zauner, & Jovanovic, 2007; Turati, Di Giorgio, Bardi, & Simion, 2010) and emotional expressions recognition (Kestenbaum & Nelson, 1990).

Many study suggest a sensitivity of infants to first-order relations from the beginning of life (e.g. Simion, Valenza, & Umiltà, 1998), instead the sensitivity to second-order relations is documented from 6 months of life (Bertin & Bhatt, 2004; (Thompson, Madrid, Westbrook, & Johnston, 2001). Using a version of the composite paradigm adapted to infants, Turati and colleagues (2010) provided a clear demonstration that 3-month-olds are able of processing a face holistically, as a gestalt (Turati, Di Giorgio, Bardi, & Simion, 2010).

The composite face paradigm is a method widely used to provide evidence for face holistic processing in adults and children: A composite stimulus is made by joining the top half of a familiar face (cut below the eyes) with the bottom half of another familiar face. When composite faces are presented to observers, they are slower to name the top half of such a composite face when the top and bottom parts are vertically aligned, creating a new face stimulus, than when the same top and bottom parts are laterally (i.e., misaligned). See Figure 2.13 for an example of composite face.

Figure 2.13 Aligned and misaligned composite faces. From Macchi Cassia, Picozzi, Kuefner, Bricolo, & Turati (2009)

In the Turati et al.'s study (2010) infants looked longer at the face with a familiar top half when the top and the bottom face halves were misaligned, revealing a discrimination between stimuli, but they did not differentiate between familiar and new half in the aligned condition. These results confirm the involvement of a holistic processing in identity recognition at 3 months of age.

Findings regarding infants' processing of facial expressions suggest that infants operate with both featural and configural processing modes. Kestenbaum and Nelson (1990) found that when a categorization of happy versus sad/angry faces was only possible using configural processing, i.e. by attending to several features at the same time, 7-month-old infants succeeded in categorizing the expressions only when the faces were presented upright. When the facial emotions could be distinguished from one another by focusing on only one feature, e.g. with faces with a toothy smile, the infants were successful at categorizing both upright and inverted faces. Therefore, when young

infants process facial expressions they seem to be able to do this on the basis of single features as well as on the basis of more configural information.

The aim of the Experiment 3 was to explore whether and how featural and configural processing are enrolled in identity recognition of a face emotionally connoted. In order to address this issue infants were familiarized with faces displaying "composite emotions". Specifically, infants were shown with videos of composite women's faces 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*.

Some hypotheses can be advanced. 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 a half of a face (upper or lower, indistinctly) should succeed in the recognition of the individual face, suggesting a feature by feature processing. If only the specific feature of smile can arise the observed facilitator effect, only infants familiarized with face displaying a smile in the lower half should discriminate new and familiar stimuli. Instead, if the eyes are the feature triggering the enhancing effect, we should observe a preference for new stimulus in test phase only with infants familiarized with a face displaying happiness in the upper half. 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.

2.4.1. 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 2 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

As in previous experiments, stimuli were color video-clips formed by 4 different 500-ms frames, displaying a moving Caucasian woman's face. Each frame was generated using Photoshop and displayed a composite emotional expression. Pictures used in Experiment 2 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 2 were isolated and then reassembled, piecing together one half with a positive expression and another half with a negative expression.

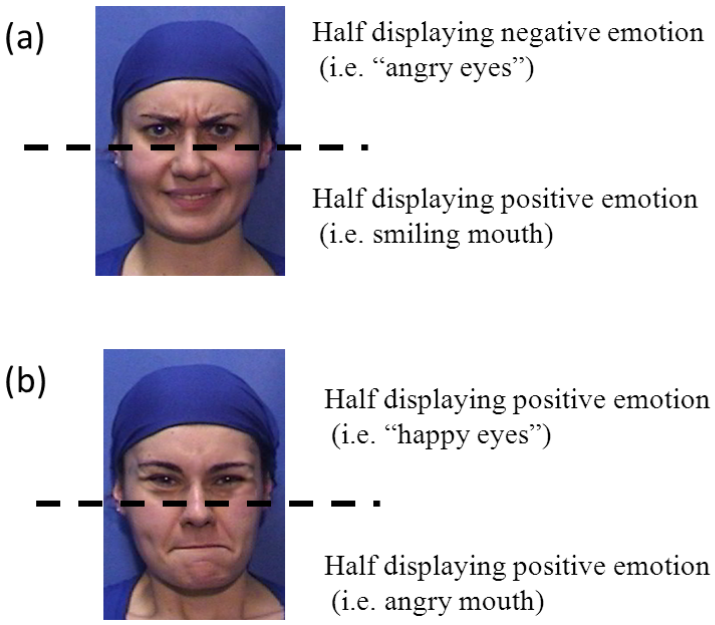

Figure 2.14 Examples of video-frames used in the Lower Half Positive face condition (a) and in the Upper Half condition (b) of Experiment 3

By reason of no differences between the two negative emotions used in Experiment 2, i.e. anger and fear, in this study only anger was chosen for the stimuli setting up. 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). See Figure 2.14, a. 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). See Figure 2.14, b.

In both conditions, each half of the face increased frame by frame the intensity of the shown emotion (Figure 2.15).

Positive Emotion in the LOWER Half Condition
(Angry eyes + Happy mouth)

Positive Emotion in the UPPER Half Condition
(Happy eyes + Angry mouth)

Figure 2.15 Familiarization Stimuli in Positive Emotion in the Lower Half (a) and Positive Emotion in the Upper Half Condition (b) of Experiment 3

During the test phase, the stimuli were exactly the same as those used in previous experiments, see Figure 2.5 and 2.11.

Apparatus and procedure

Participants were tested in the same manner as in Experiment 2. Two different conditions were presented, randomized between subjects, Upper Half Positive face and Lower Half Positive face conditions. Familiarization criterion was 20 s of cumulative fixation times.

2.4.2. Results and Conclusions

In order to explore what perceptual feature of happiness triggers the observed enhanced effect, 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 ($M = 52.64$ sec, $SD = 11.03$) than the familiar face ($M = 26.53$ sec, $SD = 4.14$), $t(21) = 2.41$, $p < .05$), both in Upper and in Lower Half Positive conditions.

See Figure 2.16. In the second presentation of stimuli in the test phase, infants included in both groups did not discriminate between the new (M = 27.35 sec, SD = 5.51) and the familiar face (M = 32.48 sec, SD = 8.62), $t(21) = -.605$, $p > .55$.

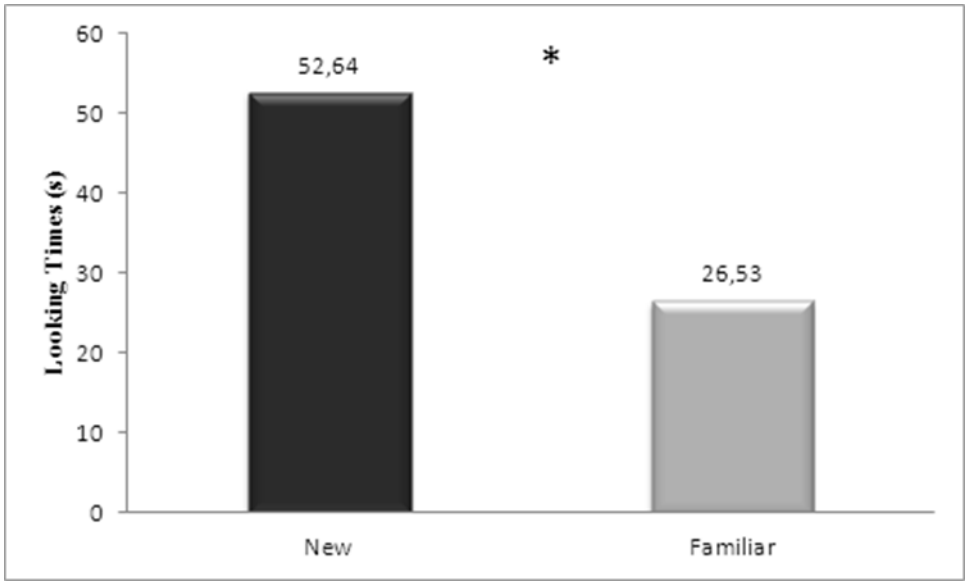

Figure 2.16 Looking times (s) toward the new and the familiar face during the First Presentation of Experiment 3. *p < .05.

2.4.3 Discussion

Results of experiment 3 suggest that a single feature of a happy face, both smiling mouth and "happy eyes" are a sufficient cue to give rise a facilitation effect on identity recognition. When familiarized with a face displaying, even though partially, happiness, in the first presentation of test stimuli infants recognized the familiar face and looked longer at the novel one. It is advisable to note that recognition of the familiar face occurred only in the first presentation, but not in the second one. This might be explained with a sort of familiarization also 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" for infants. However, data regarding first presentation of test stimuli support the hypothesis of a feature by

feature processing of emotional expressions at 3 months of life: a single feature expressing happiness seems to be enough to elicit an easier identity recognition and infants seem to use an analytic analysis of emotional stimulus. This evidence are consistent with Kestenbaum and Nelson' findings (1990) suggesting 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. 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, supporting the hypothesis of configural processing during categorization task. However, after familiarization to a single face posing a happy expression, infants discriminated between the familiar expression of happiness and novel expressions of anger or fear, both when faces were presented upright or inverted. Moreover, after familiarization to faces with toothy smiles, infants dishabituated to nontoothy happy face and nontoothy angry faces, both in the upright and the inverted conditions, supporting a feature-by-feature processing of emotional expression at 7 months of age.

As better discussed in the next paragraph, these outcomes suggest an early perception of emotional expressions based on analytic processing of the face, suggesting a pattern that moves away from adult model proposed by a recent Tanaka and colleagues' study (Tanaka, Kaiser, Butler, & Le Grand, 2012).

2.5. The role of positive and negative expressions on identity recognition in infancy: general discussion of results.

The aim of the experiments presented in this chapter was to understand whether the presence of an emotional expression in a face affects identity recognition during infancy. In order to explore this issue, we tested 3-month-olds' ability to recognize a face to which they were familiarized, changing the emotion displayed by the face during the familiarization phase.

Results from Experiment 1 demonstrate that a positive facial expression, i.e. happiness, facilitates 3-month-olds' identity recognition of a face. When familiarized with a video of a woman displaying a happy expression, infants are able to identify the familiar face since the first presentation of the test stimuli. Conversely, infants familiarized with a neutral face showed this ability, i.e. they discriminated the new and the familiar stimulus, only during the second presentation of the test stimuli.

This finding suggests an adult-like pattern in which smile is a cue to familiarity (Baudouin et al., 2000): both adults and infants recognize easily a smiling face rather than neutral faces, advising a facilitator effect of positive facial expressions on identity recognition processing (see Figure 2.17).

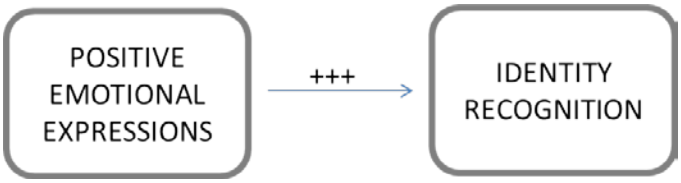

Figure 2.17 According to the results obtained in Experiment 1 Positive emotional expressions affect identity recognition, exerting a facilitation effect on infants' recognition processes.

Moreover, together with other previous results on infants (Barrera & Maurer, 1981; Kahana-Kalman & Walker-Andrews, 2001; Walker-Andrews et al., 2011) these

findings support the idea of a bidirectional interplay between facial emotional expressions recognition and identity processing, during infancy as in adulthood.

Studies on adults not only demonstrate that positive expressions have a catalytic effect, increasing ratings of familiarity of faces, they also show that negative expressions reduce familiarity judgments, suggesting an interference effect (e.g. Lander & Metcalfe, 2007). Experiment 2 investigated whether, as in adults, positive and negative facial expressions differentially affect infants' ability to recognize an individual face a second experiment was performed.

Results showed that infants' face recognition was enhanced or reduced depending on whether the face conveyed a positive or negative emotional expression, as in adults. See Figure 2.18.

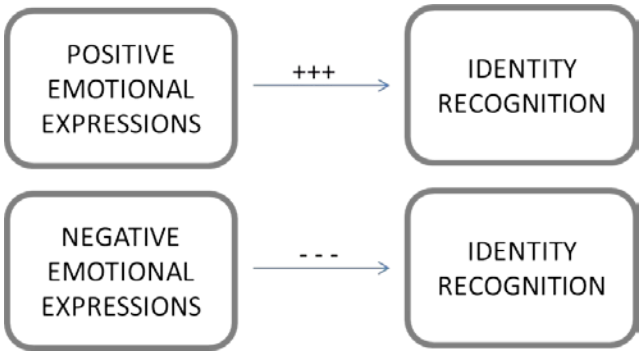

Figure 2.18 Results from Experiment 2 suggest a facilitator role of positive emotional expressions and conversely an interference effect of negative emotional expression on identity recognition.

Taken together, results from Experiment 1 and Experiment 2 propose an infant face processing model very close to recent adult models, in which information about emotional expressions and identity mutually interact and different emotions differently affect identity processing. Moreover, evidence from Experiment 1 and 2 assigns a peculiar role to happy expression: smiling face are recognized more easily than others,

both neutral and displaying negative expressions faces. This result led to focus our attention on happy expression in Experiment 3.

Happiness is a special emotion for humans and sensitivity to happy expressions develops more quickly than sensitivity to any other expression (Gao & Maurer, 2010). Infants just 1–4 day-old look longer at a happy face than at a fearful face with which it is paired (Farroni, et al., 2007). Moreover, during infancy and childhood happiness is presumably the most frequent emotion experienced by humans and the contest in which they learn and build relationships. Experiment 3 aimed to understand what perceptual features of a happy face lead observed the catalytic effect on 3-month-olds' face recognition abilities. Upline of this investigation there was the question regarding whether this facilitator effect is based on feature-by-feature or configural/holistic processing of happiness expression. Literature generally converges to suggest that adults recognize faces more holistically than other types of objects (Tanaka & Farah, 1993). However, there is less consensus about whether adults' recognition of facial emotional expressions is based on holistic processing of the entire face or on the analytic processing of particular features. A recent Tanaka and colleagues (2012)'s study suggests that the perception of facial expressions is not strictly holistic or analytic. It is probably more accurate to characterize emotion recognition as lying on an analytic to holistic processing continuum (Farah, 1991). Specifically, the authors suggest that there are conditions in which an expression is perceived holistically and others in which it is perceived analytically. Through three experiments, Tanaka and colleagues (2012), using composite paradigm, concluded that when emotional information is conflicting, i.e. when faces conveyed artificially more than one emotion (incongruent condition), the identification of a facial expression is slower, less accurate

and more holistic. Conversely, they provide evidence for featural processing of pure expressions of happiness and anger. Indeed, adults were no faster or more accurate when they have to recognize happiness in the bottom half of a whole happiness face than when the happy bottom half was presented singularly or combined with a neutral half. These findings suggest that recognition of the happy expressions was analytic, unaffected by information in the to-be-ignored face half.

Results of Experiment 3 suggest a featural processing at 3 months of age, also when information is conflicting, i.e. when the face displaying artificially two different emotions. This evidence is consistent with another study on infants (Kestenbaum & Nelson, 1990) and allows to hypothesize that only during development infants and children learn to shift between configural and analytic processing of emotional expressions. It is important to note that 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, et al., 2004). Results of the current study don't suggest an absolute absence of configural processing in infancy, but advice that, in the first months of life, the availability of a salient feature might 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 to process 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 (i.e., a smile) are available, infants can focus on that information to base their discrimination.

It is due to note some limitations of the presented experiments. Firstly, the exclusive use of familiarization paradigm does not allow to provide any suggestion about infants' visual scanning of stimuli. Particularly, in Experiment 3, when composite faces were presented to infants, the use of the eye-tracker would have been an useful tool to understand which feature capture mainly infants' attention.

Moreover, we have contrasted positive vs. negative emotional expressions, considering as displaying positive expression only smiling faces. Further studies might investigate the effect of another positive expression, i.e. surprise, on infants' and children's identity recognition. However, this studies should be performed with older infants, i.e. 6-month-olds, because only by this age, infants categorize surprised expressions across different individual faces and discriminate surprised from happy expressions (Caron, Caron, & Myers, 1982) and angry expressions (Serrano, Iglesias, & Loeches, 1992).

Finally, in order to investigate whether and how featural and configural processing are enrolled in infants' identity recognition of a face emotionally connoted, infants were familiarized with face displaying "composite emotions". This stimuli were faces expressing a happy expression in the bottom half of the face and an angry expression in the upper half of the face or *vice versa*. Further studies could analyze the effect of other kinds of composite emotions, i.e. happiness-neutral, happiness-fear, anger-fear, anger-neutral or fear-neutral, in order to understand i) whether a single feature of a happy face is a sufficient cue to give rise a facilitation effect on identity recognition, also when other facial features are neutral or fearful; ii) whether the interfering effect of negative expressions is observed also when infants were shown with stimuli composed by different negative features or stimuli composed by angry or fearful and neutral features. These studies could help to understand whether the featural processing of emotional

expression suggested by results of Experiment 3 must be related only to happiness or can be generalized to other emotions.

However, overall outcomes from experiments described in this chapter suggest an adult-like interdependence between identity processing and facial emotional recognition, in which, as in adults, positive emotions have a catalytic effect on identity recognition of a face and conversely the presence of a negative expression interferes with the identification of an individual face.

Moreover, evidence suggests an important gap between infants' and adults' facial emotional expression perception: both during infancy and in adulthood an alternation of holistic and analytic processing is documented, but the conditions in which they use one or the other change during the development.

Aim of this chapter was to provide some evidence about the *origins* of the interdependence between recognition of facial emotional expressions and identity processing, studying this interplay during infancy. In the next chapter, testing older children will allow to have some suggestions about the *development* of this interplay during childhood.

3

Effect of Emotional Expressions on Facial Identity Recognition in Preschool-Age Children

This chapter presents 2 different experiments in which using an identity-matching task 4- and 5-year-old children were tested for their ability to recognize the identity of faces displaying different emotional expressions. If the studies on infants described in the previous chapter were aimed to understand the *origins* of the relation between identity processing and facial emotions recognition, here the goal was to investigate the *development* of this relation during children' growth. In order words, we explored how the interplay between identity recognition and facial expressions processing evolves during childhood. One may claim that the presence of a facial emotional expression affect facial identity recognition in a stable way throughout development, from infancy to adulthood. On the contrary, during the development different variations might occur in the relation between identity recognition and facial emotional expression processing and developmental changes might be observed among infancy, childhood and adulthood.

In fact, the properties of the relation between identity recognition and emotional expression processing in childhood have been studied more extensively than in infancy, evidence indicating a complex interplay between the processing of these two facial dimensions (Herba et al., 2006; Spangler et al., 2010).

3.1 Influence of facial identity on children's recognition of emotional expressions

Concerning the influence of facial identity on children's recognition of emotional expressions, literature converges to suggest that, as showed in Figure 3.1, face familiarity may produce a distracting inhibitory effect on emotion recognition.

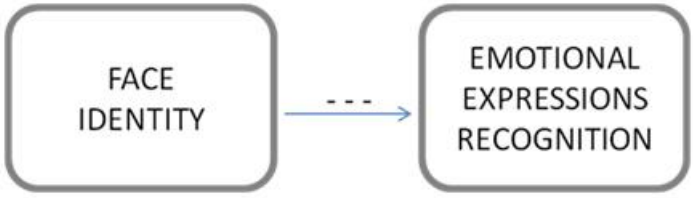

Figure 3.1 Recognition of face identity interferes with emotional expression recognition in children.

For example, in an emotional expression recognition task with familiar and unfamiliar faces, 4- to 15-year-olds showed lower recognition accuracy for anger, fear and disgust when these emotions were displayed by familiar faces compared to stranger faces (Herba, et al., 2008). An interference effect of facial identity on emotion processing was also found in an emotional expression sorting task where 5- to-11-year-olds were unable to ignore the irrelevant information concerning facial identity during the classification of emotional expressions (Spangler et al., 2010). Moreover, using a face adaptation paradigm, Vida and Mondloch (2009) found that children, like adults, perceive facial

expression and identity in a partially integrated manner, because children's categorization of emotional expressions was dependent on variations in facial identity (Vida & Mondloch, 2009).

3.2 Influence of emotional expressions on children's recognition of facial identity

Results about the influence of facial emotional expressions on identity recognition in preschool-aged and school-aged children are all mixed, as suggested by Figure 3.2. According to some studies, in childhood identity recognition is not influenced by variations in emotional expression, thus implying an *independent* encoding *of identity* in children's face processing (Ellis, 1992; Norbeck, 1981; Spangler, et al., 2010). On the contrary, other studies suggest that children fail to recognize identity when faces vary in emotional expression, thus implying *an interference effect of emotional expression* on identity recognition (Baudouin et al., 2008; Bruce, et al., 2000; Herba et al., 2006; Mondloch et al., 2003).

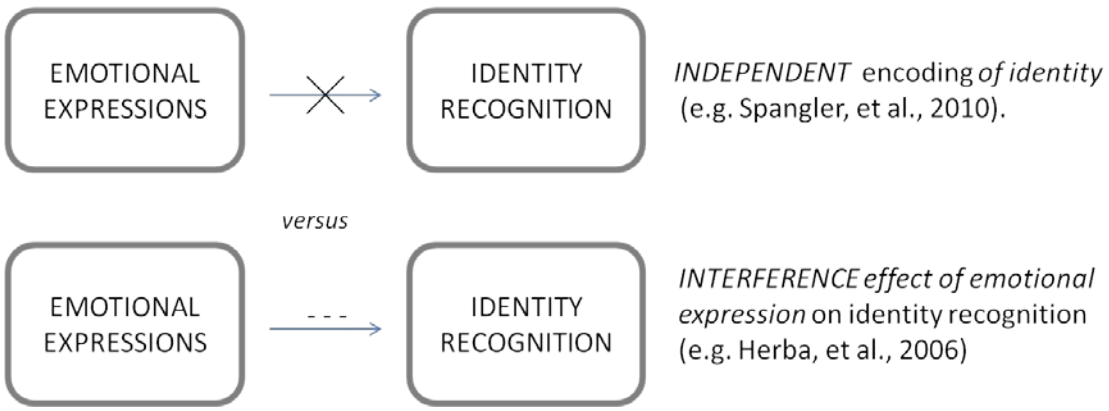

Figure 3.2 Different hypotheses regarding the influence of facial emotional expressions on children' identity recognition

An independent encoding of identity in children is supported by findings obtained by Spangler and colleagues (2010), showing that, when asked to classify neutral as well as emotional faces according to identity in a speeded sorting task, 5- to 11-year-olds were able to direct attention selectively to facial identity disregarding variations in emotional expressions. Moreover, Norbeck (1981) investigated 3- and 5-year-olds' ability to recognize identity across changes in emotional expression (i.e., anger, happiness, sadness and fear) and described a substantial recognition ability in 3-year-olds with significant improvements to age 5. Using a simultaneous identity-matching task, in which faces varied by emotion (surprise, smile and grimace), Ellis (1992) observed that 3-year-olds performed at chance, whereas 5-year-olds achieved high accuracy and 8-to-11-year-olds performed at ceiling, supporting the argument of an increasing independency of identity recognition from the processing of emotional information with increasing age. A similar developmental trend was also reported by Freitag and Schwarzer (2011), who found that, in a delayed face recognition task, 3-year-olds' performance was affected by variations in emotional expressions whereas 5-year-olds' performance was not.

Evidence supporting the hypothesis of an *interference effect of emotional expressions* on facial identity recognition includes the finding by Herba and colleagues (2006), showing that when 4- to 15-year-olds were asked to match the identity of target emotive faces, emotional expressions (i.e. fear, anger, disgust, sadness, happiness) and their intensity influenced children's performance. In a similar way, when 6- and 8-year-old children were asked to recognize a target face among three distracters differing in the

emotional expression displayed, they performed at chance, and even adults were prone to errors (Mondloch et al., 2003).

3.3 Experiment 4: Children' identity recognition of neutral and emotional faces

The study described in this chapter aims to provide a contribution to this discussion, testing pre-scholars' ability to recognize individual face displaying different emotional expressions. Overall, the goal was to investigate whether facial identity is processed by children independently from emotional information included in a face, in line with the *hypothesis* of an *independent encoding* of identity (e.g., Spangler et al., 2010), or whether it is processed in interaction with emotional information, in line with the *hypothesis* of an *interference effect of emotional expressions* (e.g., Herba et al., 2008). Two different experiments were performed using a delayed two-alternative forced-choice matching-to-sample task, in which 4- and 5-year-olds were asked to match a target face to two simultaneously presented test faces appearing after the target. In order to understand the effect of facial emotional expression processing on identity recognition, emotion conveyed by target and test faces was differentiated among different conditions.

Experiment 4 investigated the relation between identity and facial emotional expressions processing in children, examining whether the presence of an emotional expression, both positive and negative, may affect their recognition of facial identity. Specifically, 4- and 5-year-old children were tested with a delayed two-alternative forced-choice matching-to-sample task. In compliance with this paradigm, after children were presented briefly with a target face, they were asked to match the stimulus target to one of two alternative face stimuli showed simultaneously. Facial emotional expressions

displayed by stimuli were varied between subjects, maintaining the same neutral or emotional expression between target and test stimuli. We used happy, fearful, anger and neutral faces.

According with the hypotheses described in the previous paragraph, different predictions can be advanced. Children might be able to recognize indifferently identity of neutral and emotionally portrayed face This outcome would suggest in childhood a coding of information about face identity independent from emotional expression processing, supporting Spangler et al.' (2010) hypothesis. Conversely, children' performance might be better for the recognition of neutral faces as compared to emotive faces, both negative and positive, in analogy with results obtained by Herba et al. (2006). This would favor an interference effect of the processing of emotional information conveyed by faces on identity recognition. Moreover, a third hypothesis might be that the interfering effect of emotional information on the processing of identity information is dependent upon the nature of the emotional expression displayed by the faces. Specifically, according with adults' results (Dobel et al., 2008; Lander & Metcalfe, 2007) and infants' outcomes described in the previous chapter, negative expression could have an interfering effect on children' recognition of facial identity. On the contrary identity of a face displaying a positive emotion as happiness could be recognized more easily by children.

Finally, because we tested 4- and 5-year-olds, a specific effect of age could be founded. A recent review (Gao & Maurer, 2010) suggests that by 5 years of age children are adult-like, or nearly adult-like, for happy expressions on all measures. Children's sensitivity to other expressions continues to improve between 5 and 10 years of age (e.g., surprise, disgust, fear) or even after 10 years of age. For this reason, it is possible

that different levels of skills in younger and older children may modulate the appearance of interference and/or facilitation effects.

3.3.1. Method

Participants

Twenty-nine 4-year-olds (14 girls, mean age = 4 years and 6 months, SD= 2.89) and thirty-seven 5-year-olds (19 girls, mean age = 5 years and 6 months, SD = 3.69) were tested. They were recruited in two different Italian kindergartens and parents gave their written informed consent before testing began. All children were middle class and Caucasian and had normal or corrected to normal vision. All of them provide a verbal assent to be involved in the experiment. An additional 4-year-old participant was tested but excluded from the final analyses because of failure to reach criteria established for data analyses (recognition accuracy below 30% in at least one block). Children were randomly assigned to three different groups, each corresponding to a different Emotional Condition. Specifically, 8 4-year-olds and 12 5-year-olds were assigned to the Happiness condition, 14 4-year-olds and 12 5-year-olds were assigned to the Fear Condition and 7 4-year-olds and 13 5-year-olds were assigned to the Anger Condition.

Stimuli

Stimuli were high-quality grey-scale images of 120 Caucasian female faces. Women were portrayed in a full frontal pose and all were unfamiliar to tested children. Photo 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, Dotsch, Bijlstra, Wigboldus, Hawk, & van Knippenberg, 2010) and from a face database provided by the Department of Developmental Psychology, Giessen

University. Thirty faces displayed a neutral expression, 30 faces displayed a happy expression, 30 displayed an angry expression and 30 displayed a fearful expression. Seven additional pairs of stimuli were used for the 3 practice trials that preceded each test session: for these trials images of 2 additional neutral faces, 4 happy faces, 4 fearful faces, 4 angry faces were used. Using Adobe Photoshop, images were adjusted in order to make them graphically uniform and to eliminate salient external features (e.g., hair, ears, neck). Obtained stimuli were matched on the basis of overall similarity, luminance and eyes and eyebrow color to generate 15 pairs for each facial expression (i.e., neutral, happiness, anger and fear). 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 3.3.

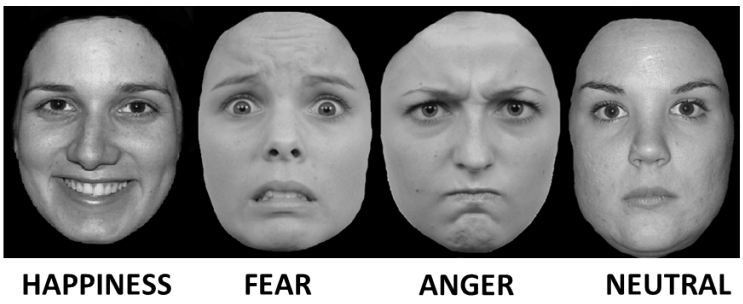

Figure 3.3 Examples of stimuli used in Experiment 4

Apparatus

Children were tested on a single session, in a quiet room of the kindergarten. They were seat approximately 40 cm from a 15-inch PC monitor, alongside of the experimenter. Children were tested using a two-alternative forced-choice matching-to-sample task. The experimenter told children that a target face would appear in the center of the screen and that they had to recognize this face between two different alternatives

simultaneously presented on the screen after the target presentation. Stimulus presentation and data collection were performed using E-prime 2.0, which recorded children' response.

Procedure

The experiment consisted of two blocks of trials, one for each experimental condition (Neutral *vs.* Emotional), with 15 trials in each block. Each trial began with a yellow circle looming at the center of the screen for 500 msec and is composed by an encoding and a test phase. In the encoding phase, the target stimulus was then presented centrally for 3 s. Following a 1 s black screen, in test phase two choices were presented side by side, i.e. the previously presented target stimulus (target) and a new stimulus (distractor). Children 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 (M for "right", Z for "left"). Both the target and the novel stimuli remained on the screen until a response was performed. 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 experimenter determined the start of the next trial by pressing the mouse. For an example of a trial see Figure 3.4. The left–right position of the target and novel stimuli was randomized across trials.

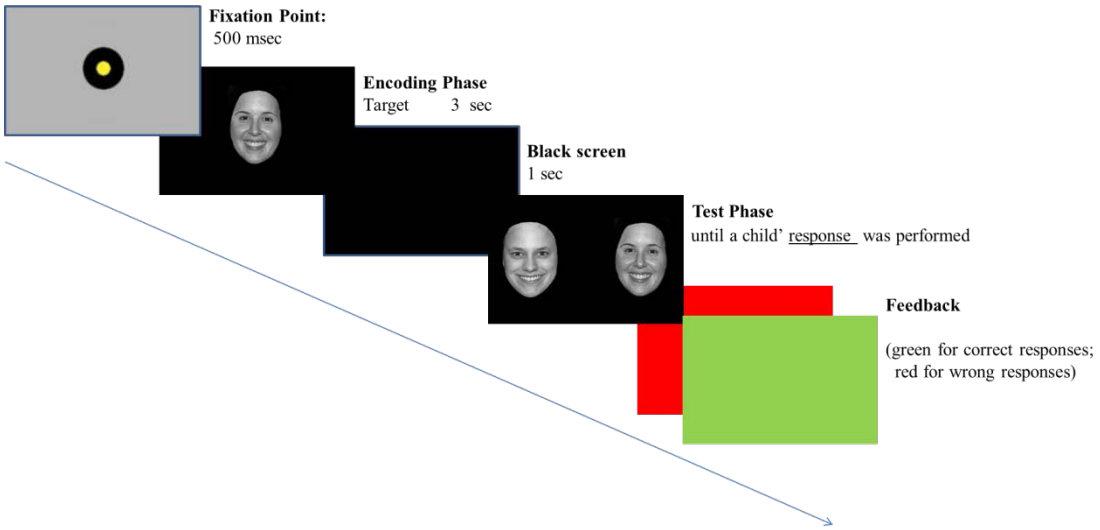

Figure 3.4 The sequence of events in a trial

In both the Neutral and the Emotional conditions, facial expressions remained unchanged between the encoding and test phases. For children tested in the Happiness Group faces in the Emotional Condition displayed a happy expression, for children tested in the Fear Group the faces displayed a fearful expression, for children tested in Anger Group the faces displayed an angry expression (see Figure 3.5). The order of Neutral and Emotional conditions was counterbalanced across subjects. At the beginning of the testing session participants were given 3 practice trials to ensure that they understood the task. Recognition accuracy was recorded as the dependent variable.

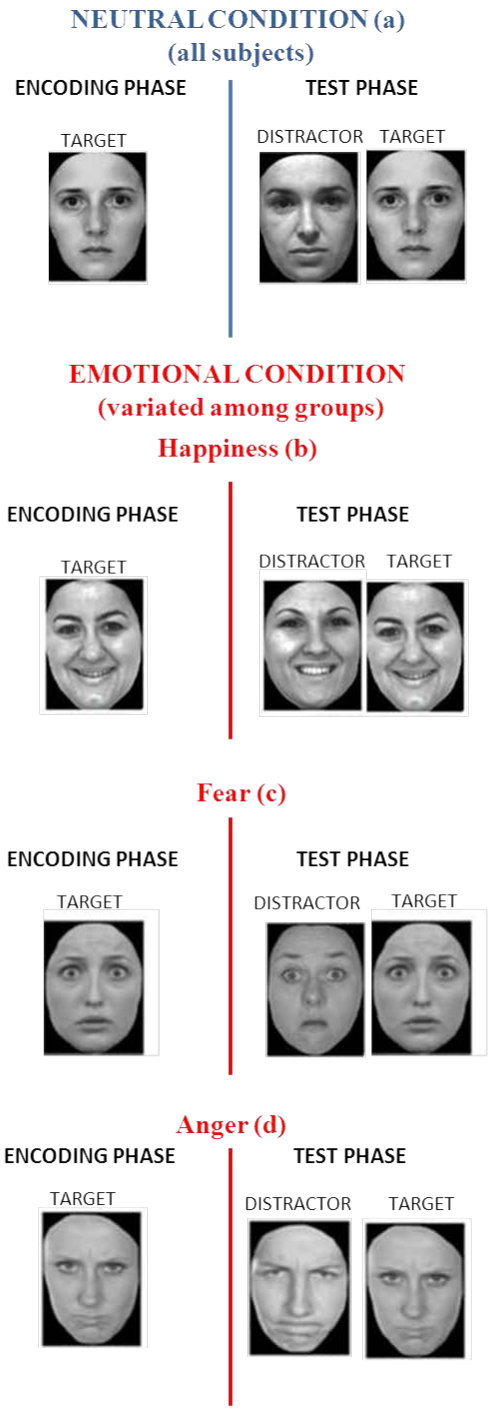

Figure 3.5 Examples of the stimuli presented in the Encoding and Test Phases during the Neutral (a), Happiness (b), Fear (c) and Anger (d) conditions.

3.3.2. Results

Mean response accuracy (expressed in percentage) for each condition was calculated for each participant in each age group. All children performed well above chance level, i.e. 50%, in both the neutral condition (M = 83% and 91% for the 4- and the 5-year-old respectively; ps < .01) and the emotional condition (M = 77% and 87% for the 4- and the 5-year-old respectively; ps < .01). In order to understand whether facial emotional expressions affected children's ability to recognize facial identity, an ANOVA was performed with experimental condition (neutral vs. emotional) as within-subjects factor and emotional expression (happiness, fear, anger), age (4, 5 years) and gender as between-subjects factors. The analysis revealed a main effect of age, $F(1, 54) = 13.95$, $p < .01$, $\eta^2 = .20$, with older children (M = 89%, SD = 9.2) performing better than younger children (M = 80%, SD = 11.8). Moreover, more meaningfully there was a main effect of experimental condition, $F(1, 54) = 6.99$, $p < .05$, $\eta^2_p = .11$. Children were overall more accurate in the recognition of neutral faces (M = 87%, SD = 11.2) than in the recognition of emotive faces (M = 82%, SD = 14.7) (see Figure 3.6). Importantly, there were no main effects or interactions involving the factor emotional expression, i.e. among happiness, fear and anger.

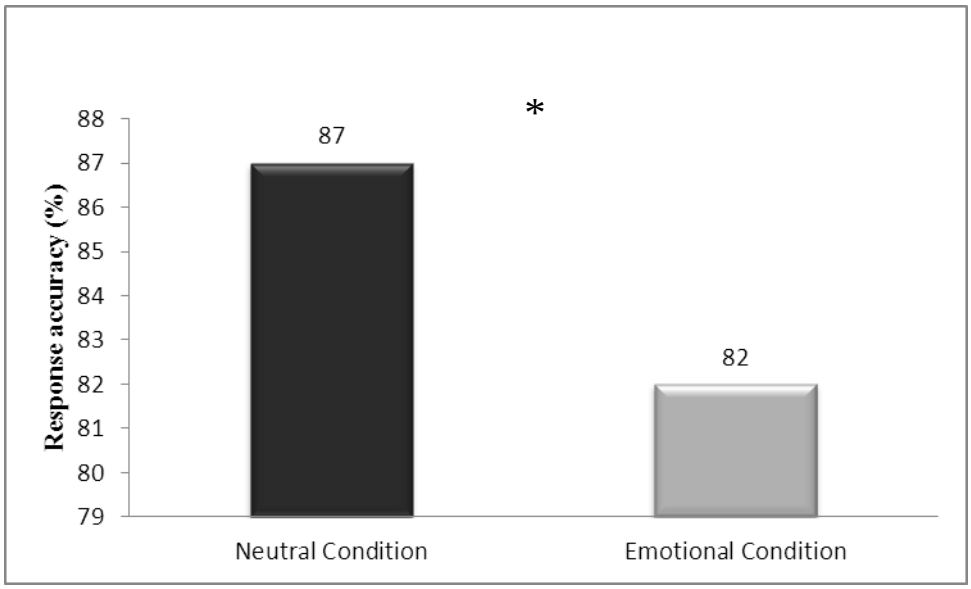

Figure 3.6 Children's response accuracy (expressed in percentage) in Experiment 4 * *p* <.05

3.3.3. Discussion

Outcomes of Experiment 4 suggest an influence of facial emotional expressions on identity recognition in 4- and 5-year-old children, arguing against the hypothesis of an independent encoding of identity and emotional information conveyed by faces. Children tested in an identity-matching task recognize more easily neutral faces compared to emotive faces, suggesting that processing of emotional expressions interfered with processing of facial identity. These results support the above described hypothesis of *interference effect of emotional expressions* on facial identity recognition. As in Herba et al. (2006), when children have to match the identity of target emotive faces, the recognition task is more difficult than when children are asked to indentify target neutral faces.

Not surprisingly, older children showed a higher recognition accuracy than the younger ones. However, the interfering effect of emotional expressions on identity recognition was not modulated by participants' age, as it was present in 4- as well as in 5-year-olds without differences between ages.

Moreover, unlike results on adults (Baudouin et al., 2000; Dobel et al., 2008; Gallegos & Tranel, 2005; Lander & Metcalfe, 2007) and infants described in the previous chapter, the presence of a positive or a negative facial expression did not affect differentially children' identity recognition. The observed effect of interference was not modulated by the valence of the emotion conveyed by the face. All emotive faces, both positive and negative, were more difficult to match based on identity compared to neutral faces. Thus, our findings are in agreement with previous evidence suggesting a generalized interference effect of emotional expressions on identity recognition in children, which occurs independently of emotional connotation (Herba et al., 2006).

In particular, the happy expression do not seem to have any facilitation on identity recognition in pre-scholar age, instead it appears to produce an interference effect. In order to better explore this outcome exerted by happiness on children's face identity processing, Experiment 5 was performed.

Using a similar delayed two-alternative forced-choice matching-to-sample task with 4- and 5-year-olds, Experiment 5 investigated whether this interfering effect varies when the happy emotional expression is maintained invariant between encoding and test phase as compared to when the happy expression is present only in one of the two processing phases.

3.4 Experiment 5: The role of happy expression on pre-scholers' identity recognition.

The goal of Experiment 5 was to investigate the effect of happy emotional expression on 4- and 5-year-old children's processing of identity facial information. Specifically, varying the phase of the task (i.e., encoding and/or test) in which the happy facial expression was presented, the study want to test whether positive emotional cues interfere more with the encoding stage or the recognition stage of the identity-matching task. Children were tested within three experimental conditions. See Figure 3.8. In two of these conditions, facial expressions were varied between the encoding and test phase of the task, i.e. presenting happiness in the encoding phase and neutral in the other one or vice versa. In a third condition, as in Experiment 4, facial expressions was kept constant between phases, but emotion conveyed by the face was changed between groups. For one group of children the facial expression that remained constant was a neutral one, whereas for a second group of children the facial expression was a happy one. Three possible scenarios can be described. One possibility is that the interfering effect, as suggested by Herba et al.'s data (2006), appears only when faces are smiling during the encoding phase. This outcome would suggest that interference created by the presence of an emotional expression happens while the face stimulus is encoded. Conversely, it might be that the interference of emotional expressions is observed only during recovery phase, suggesting that this obstructing action of emotional processing takes place at this stage of the face processing. Finally, the presence of a happy expression might have a similar interfering effect on identity recognition, both when presented in the coding and in recovery phase.

3.4.1. Method

Participants

Thirty 4-year-old (13 girls, *mean age* = 4;6, *SD* = 5.43) and thirty-three 5-year-old (12 girls, *mean age* = 5;3, *SD* = 5.45) were tested. They were recruited in another two different Italian kindergartens, according with the same criteria described in Experiment 4. All children were Caucasian, middle class and had normal or corrected to normal vision. Before testing begun, parents of each child provided their informed consent and children gave their verbal assent. Nine added children were tested, but they were excluded from the final analyses because of failure to reach criteria established for data analyses (their recognition accuracy was less than 30% in at least one data block). Children were randomly assigned to two experimental groups (17 4-year-olds and 16 5-year-olds in Neutral Group and 13 4-year-olds and 17 5-year-olds in Happiness Group).

Stimuli

Stimuli were 100 high-quality grey-scale images displaying Caucasian female faces. As in Experiment 4, women were portrayed in a full frontal pose and all were unfamiliar to tested children. Photo 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. Half of the faces (N = 50) displayed a neutral expression and half (N = 50) displayed a happy expression. See Figure 3.7. Twelve additional photos were used for the 3 practice trials that preceded each test session: for these trials images of 6 additional neutral faces and 6 happy faces were used. As in Experiment 4, images were made uniform, eliminating

neck and external salient features as hair and ears. They 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. Faces were matched on the basis of overall similarity, luminance and eyes and eyebrow color to generate 40 pairs of stimuli.

Figure 3.7 Examples of Neutral and Happy Face Stimuli used in Experiment 4 and 5

Apparatus and procedure

Children were tested on a single session, in a quiet room of the kindergarten, keeping the apparatus described in Experiment 4. The experiment consisted of three blocks of trials, one for each experimental condition (Neutral-Happy, Happy-Neutral, Homogeneous Expression), with 10 trials for each block. As showed in Figure 3.8, in Neutral-Happy trials faces displayed a neutral expression at encoding and a happy expression at test, whereas in Happy-Neutral trials faces displayed a happy expression at encoding and a neutral expression at test. In Homogeneous Expression trials the emotional expression displayed by the faces remained unchanged between encoding and test phase, and were varied between groups, being neutral for children in the Neutral Group and happy for children in the Happiness Group.

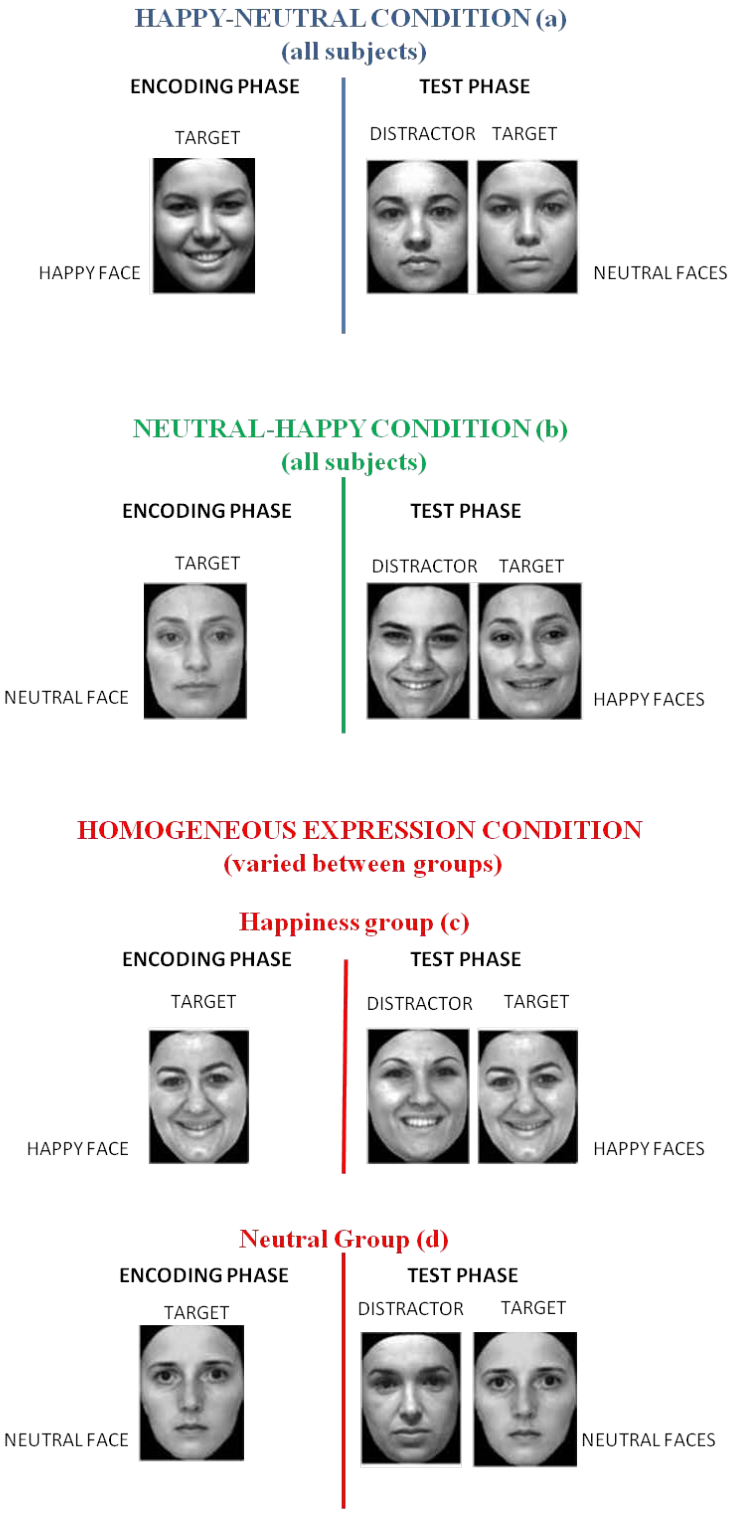

Figure 3.8 Examples of the face stimuli presented during Encoding and Test Phases in Happy-Neutral (a), Neutral-Happy (b) and Homogeneous expression (c, d) conditions. Face Stimuli showed in the Homogeneous Expression varied between groups. To children included in Happiness group Happy faces were presented both in Encoding and Test Phase. Conversely, neutral faces were shown to children of Neutral Group.

All participants were presented with the Homogeneous 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 3 practice trials to ensure that they understood the task. Each trial began with a yellow circle looming at the center of the screen for 500 msec and is composed by an encoding and a test phase. The sequence of events in a trial was the same as described for Experiment 4 and the left–right position of the target and distracter face was randomized across trials.

3.4.2. Results

As in Experiment 4, mean response accuracy (expressed in percentage) for each condition was calculated for each participant in each age group. Both Four- and Five-year-old children performed well above chance level in all experimental conditions (see table 3.1).

		Neutral Group			Happiness Group		
		HAPPY-NEUTRAL	**NEUTRAL-HAPPY**	**HOMOGENEOUS EXPRESSION**	**HAPPY-NEUTRAL**	**NEUTRAL-HAPPY**	**HOMOGENEOUS EXPRESSION**
4-year-Olds	*M*	65 %	66 %	81 %	69%	64%	71%
	SD	*15.3*	*17.6*	*13.9*	*17.5*	*13.2*	*21.0*
5-year-olds	*M*	71 %	76 %	90 %	68 %	67 %	80 %
	SD	*14.9*	*11.9*	*12.3*	*18.1*	*15.7*	*19.8*

Table 3.1. Mean Response Accuracy for Each Condition in Experiment 2. All Means were Significantly Different from Chance (50%) (One-Sample T tests, ps <.01).

In order to investigate whether an emotional expression of happiness influenced children's ability to recognize facial identity differently according to the phase of the identity matching task in which emotion was presented, an ANOVA was performed with Experimental Condition (Neutral-Happy, Happy-Neutral, Homogeneous Expression) as the within-subjects factor and Group (Neutral Group *vs* Happiness Group), Age (4 *vs* 5 years) and Gender as between-subjects factors. The analysis revealed a main effect of Experimental Condition, $F(2, 110) = 10.48$, $p < .01$, $\eta^2_p = .16$, and a significant Experimental Condition x Group interaction, $F(2, 110) = 3.29$, $p < .05$, $\eta^2_p = .05$. Specifically, in the Homogeneous condition children exposed with Neutral faces (Neutral Group) performed better ($M = 86$, $SD = 13.7$) than children that shown happy faces (Happiness Group, $M = 76$, $SD = 20.4$), $t(61) = 2.21$, $p < .05$. Moreover, other independent-samples showed that the two groups did not differ in any other condition (*p*s >.15).

However, children in Happy Group had a better performance in the Homogeneous Expression Condition than in Happy-Neutral condition ($M = 66$, $SD = 14.5$) and in Neutral-Happy condition ($M = 68$, $SD = 17.5$), although only the comparison with Happy-Neutral condition reached statistical relevance, $t(29) = -2.87$, $p < .01$ (see Figure 3.9).

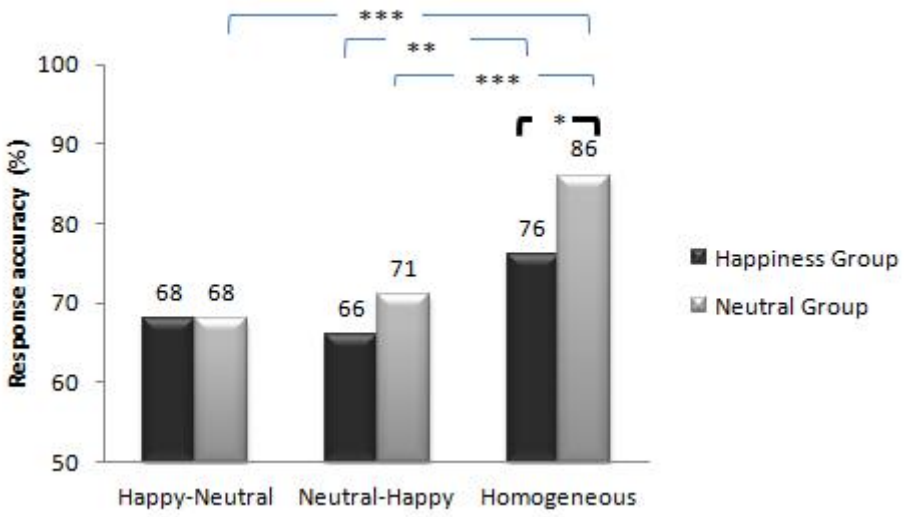

Figure 3.9 Children's response accuracy in Experiment 5 .* *p* <.05, ** *p* <.01, * *p* <.001,**

3.4.3. Discussion

Results of Experiment 5 confirmed the interference effect of happy facial emotional expression in 4- and 5-year-olds found in Experiment 4. Moreover, outcomes allow to extend the conclusions from the previous experiment, showing that interference effect occurs independently of the processing stage at which emotional expression is provided. When asked to match the identity of a face which exhibits a neutral expression children performed better as compared to when they are asked to match the identity of a face which displays a happy emotional expression: this interfering effect of emotion is observed irrespective of whether the emotional expression remains unchanged throughout the task or it changes between the encoding and test phase of the task. However, our findings suggest that the matching task is easier when emotional expression remains unchanged between encoding and test phase than when there is a change of facial expression. This was confirmed from the finding that performance in the homogeneous condition is higher than at least one of the two non-homogeneous conditions even for children in the happiness group, who were presented with happy

faces throughout the task. Nevertheless, in the homogeneous condition children who were presented with happy faces performed poorly than children who were presented with faces displaying a neutral expression.

3.5 The role of positive and negative expressions on identity recognition in pre-scholars: general discussion of results.

The aim of the investigation described in this chapter was to explore whether, at 4 and 5 years of age, face identity is processed independently or in interaction with facial emotional expressions. Indeed, recent studies advanced two different hypotheses regarding the influence of emotional expression on identity recognition. Some authors suggested an interference effect of emotion (Baudouin et al., 2008; Herba et al., 2006; Mondloch et al., 2003). Conversely, others described an independent processing of identity information from emotional expressions (Ellis, 1992; Norbeck, 1981; Spangler et al., 2010). In order to clarify this issue and contribute to the debate, children were tested within a delayed two-alternative forced-choice matching-to-sample task. Neutral and emotional faces were presented.

Evidence from Experiment 5 is consistent with the proposal of an interference effect of emotional expressions on face identity recognition (Baudouin et al., 2008; Herba et al., 2006; Mondloch et al., 2003). Although children's recognition performance was above chance in all conditions, i.e. with both neutral and emotional faces, the effect of interference produced by the presence of an emotional expression was robust and consistent. Without age-related differences, both 4- and 5-year-olds recognized more easily neutral faces compared to emotive faces, suggesting that processing of emotional expressions interfered with processing of facial identity. The disrupting effect was observed indistinctly for both positive (i.e., Happiness) and negative (i.e., Fear and Anger) facial expressions. These outcomes strongly cross the hypothesis of an

independent processing of identity in preschool-aged children, suggested by Spangler and colleagues (2010). Moreover, these findings evidently distinguish the children-pattern of the relation between identity and emotional expression processing from adults' and infants' models.

Firstly, an interesting discussion regards the reasons of the observed discrepancy among studies investigating the relation between identity recognition and facial emotional expression recognition in pre-scholars. Results from the experiment here described support the interference effect hypothesis, but could be important to understand why there is no agreement among outcomes. A possible explanation of this incongruity may be related to the characteristics of the face stimuli employed. In particular, the investigations documenting an interference effect of facial emotional expressions, e.g. the present study, used face stimuli in which only the inner facial features were displayed and the outer facial features (i.e., hair) were removed.. As a consequence, the identity-matching task might be more difficult and children may have been more sensitive to the impact of interference of emotional connotation.

Secondly, one may wonder why the observed interference effect is generalized to both positive and negative emotional connotations, and not confined to negative emotional expressions, as in adults (Baudouin et al., 2000; Gallegos & Tranel, 2005; Lander & Metcalfe, 2007) and in infants (experiments described in the previous chapter). The happy expression seems to have a different effect on children' identity face recognition than described at other ages.

Possible interpretations of these outcomes will be better dealt in the last chapter. Here, it is possible to touch on this discussion, providing different readings of results.

These findings on children, in conjunction with ones on adults and infants, seem to define an U-shaped developmental trend regarding the relation between recognition of identity and processing of positive emotions, i.e. a facilitating effect is observed in infants and adults, but not in preschool-age children. Like all U-shaped phenomena, children's difficulty to filter out positive emotional information while processing face identity in our study may be only an apparent regression (see Goldin-Meadow, 2004). Indeed, it is well known that, during the preschool years, social skills in general and specifically emotional competences (Gao & Maurer, 2010) undergo a huge improvement, which may render 4- and 5-year-old children particularly sensitive to the emotional information conveyed by faces and may hinder children's capacity to ignore emotion expressions in order to recognize identity, irrespectively of the positive or negative connotation of the emotion displayed. Alternatively, one might take into account preschoolers' general limited cognitive resources, claiming that the processing of the multiple face dimensions may represent a heavy load for children of this age. In this vein, interference occurs because emotions, independently from their positive or negative value, imply a supplementary load that produces a decrement in children's identity recognition performance.

Overall, outcomes described in this chapter demonstrated that emotional expression processing modulates preschooler's ability to recognize the identity of an individual face, decreasing their recognition performance. Taken together, results from 4 and 5 experiment, suggest a different interplay between identity end emotion processing in children. As described in Figure 3.10, both positive and negative facial emotional expressions interfere on children' performance in an identity-matching task.

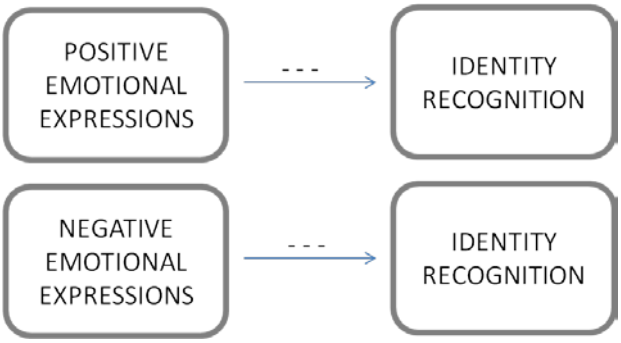

Figure 3.10 Interference effect of both negative and positive emotional expressions on children' face identity matching.

Aim of the current chapter was to provide outcomes regarding the development of the interaction between identity and facial emotional expressions processing, testing pre-scholar children. In next and last chapter overall outcomes from studies on infants and children will be discussed in order to provide a description of the developmental path of this interplay.

4

General Discussion & Conclusions

4.1 A comparison between infants' vs. children's results

The present study aimed to investigate the *origins* and *development* of the interplay between recognition of identity and perception of emotional expressions in faces. Recent models on adults have suggested that the ability to recognize facial identity do not seem to be independent from the emotional expression conveyed by the face and *vice versa* adults' classification of different emotional expressions is affected by identity variations. On one hand, some studies have shown that smiling faces are judged more familiar than faces displaying negative expression (Gallegos & Tranel, 2005). On the another hand other data have suggested that facial expressions conveyed by familiar faces are evaluated as more positive than facial expressions displayed by strangers (Baudouin et al., 2000; Schweinberger et al., 1999; Schweinberger & Soukup, 1998). Based on this evidence, Calder and Young (2005) proposed that processing of identity and emotional expressions have a bidirectional impact one on the other and advanced

the possibility of a relative segregation of these processes, rather than a completely independent coding as previously suggested in the Bruce and Young's model (1986).

In order to investigate the pattern of interaction between identity recognition and facial emotional expression processing, three experiments on infants and two on preschool-age children were conducted.

Using the familiarization paradigm, the effect of the presence or absence of a happy expression during 3-month-olds' identity recognition was tested in Experiment 1. Results suggested that infants' ability to recognize the identity of a face is enhanced when faces displayed a happy expression - i.e. smiling faces –than when faces conveyed a neutral expression. Thus, in Experiment 2 the role of positive *vs.* negative emotional expressions was explored. By the same apparatus and procedure, infants were familiarized with faces displaying happiness, anger or fear. Outcomes confirm the catalytic effect of happiness on infants' identity recognition and suggest an interference effect of negative emotional expressions, both fear and anger. Together with the results from Experiment 1, evidence supports an interplay between identity and facial emotional expression processing during infancy in which, as in adults, positive and negative emotional expressions have a different effect on the ability to recognize facial identity. In Experiment 3 we focused on expression of happiness, investigating what perceptual features of a happy face are crucial to generate the observed facilitator effect. Infants were familiarized with faces displaying "composite emotion", i.e. faces expressing happiness in the bottom half and anger in the upper half or *vice versa.* Results show that the presence of a single feature of happiness, a "smiling" mouth as happy eyes, is enough to facilitate identity recognition.

Overall, outcomes obtained from experiments on infants suggest, a pattern of interdependence in which positive expressions have a catalytic effect, increasing rating of familiarity of faces, while negative expressions reduce familiarity recognition, producing an interference effect. This pattern is strikingly similar to the one observed in adults (Dobel et al., 2008; Gallegos & Tranel, 2005; Lander & Metcalfe, 2007)

Conversely, outcomes obtained in experiments with older children, i.e. 4- and 5-year-olds, propose a different scenario. Children, as infants, cannot disregard information regarding the emotional expression of a face, but both positive and negative emotions have a distracting effect on identity recognition: 4- and 5-year-olds recognize more difficultly faces displaying emotional expressions than neutral faces. This result was observed for both positive and negative emotional expressions and independently of the processing stage at which emotional expression is provided

Specifically, using a delayed matching to sample task, Experiment 4 have investigated whether the presence of an emotional expression, i.e. happiness, fear or anger, affect 4- and 5-year-olds' ability to recognize facial identity. Results suggest that emotional expressions, both positive and negative, interfere on identity recognition. Children recognize more easily neutral face compared with happy, angry or fearful faces.

Finally, using the same task, Experiment 5 focused on happiness, aiming to understand whether the interfering effect varies in accordance with different task phases, i.e. whether a happy expression interferes more with the encoding stage or the recognition stage of the identity-matching task. Results confirm the interfering effect observed in Experiment 4 and suggest that this interference occurs independently of the task phase in which emotional expression appears.

Compared with literature on adults and results obtained on infants, outcomes of Experiment 4 and 5 suggest a peculiar role of the presence of emotional expressions during childhood. At this age, both positive and negative expressions interfere with identity processing, giving rise to a decrease of children ability to recognize a face. This result support the hypothesis of an interference effect of emotion (e.g. Herba et al, 2006), moving away from the suggestion of an independent coding of identity (Spangler, et al., 2010). See Figure 4.1

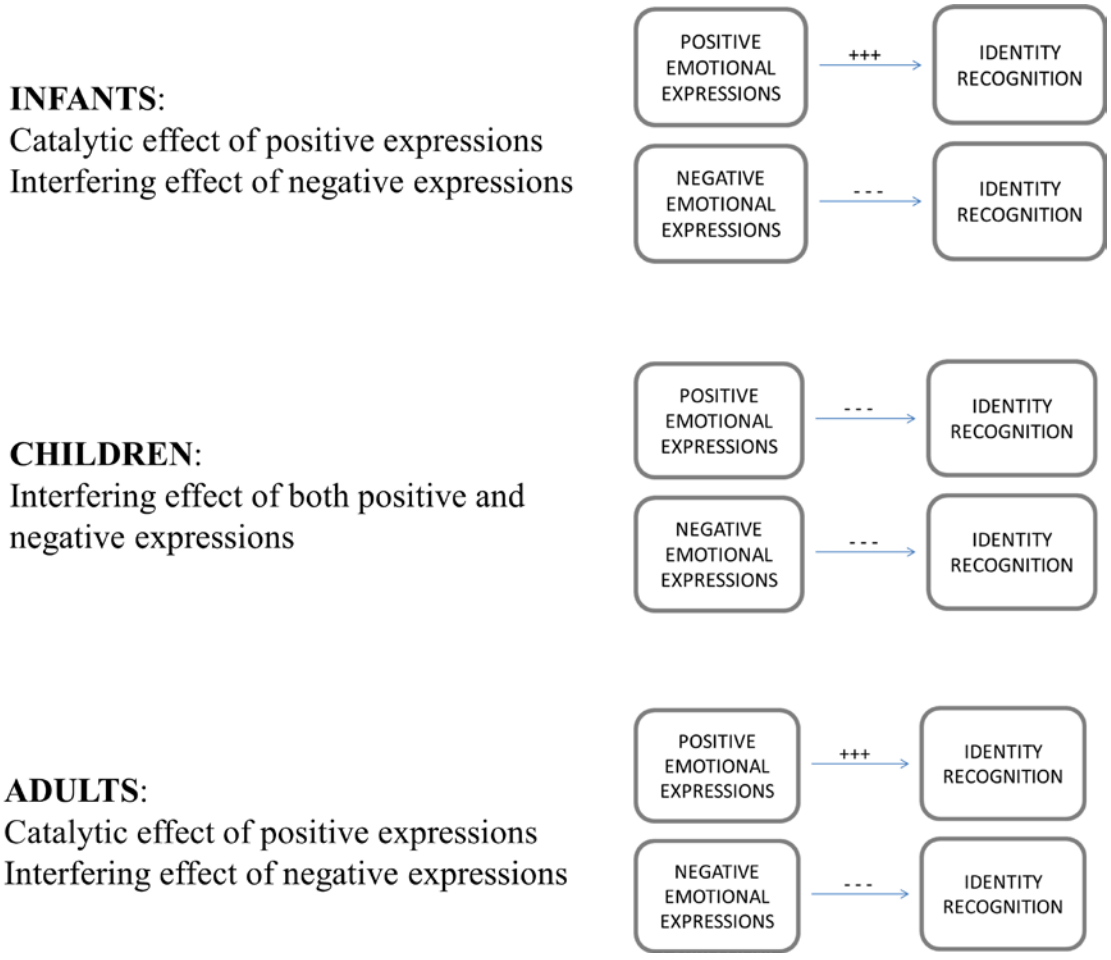

Figure 4.1 Results from our studies suggest an adult-like pattern of the interplay between emotional expression processing and identity recognition during infancy. In infants, as in adults, a positive facial expression facilitates face identity recognition and a negative expression interferes with recognition. Conversely, in children, a distracting effect of emotional expressions was observed regarding both positive and negative expressions. Results suggest an U-shaped developmental trend of the relation between identity recognition and emotional expression processing.

Described findings seem to describe an U-shaped developmental trend of the relation between recognition of identity and processing of facial emotion expressions. Specifically, the age-related differences are related with the perception of positive emotional expressions. The catalytic effect of smiling faces observed in infants and adults was not confirmed in Experiments with children, in which all emotions, both positive and negative, have an interfering effect on the ability to recognize the identity of a face.

Different interpretations of this U-shaped trend could be advised. Firstly, during development, and particularly over the pre-school years, emotional skills as recognition of facial expressions is improving and have an important increase (Gao & Maurer, 2010). This refinement of competences might render pre-school aged children particularly sensitive to the presence of facial emotional expressions, positive as negative, and might interfere with the competence to focus on only one information (e.g. identity) disregarding other information conveyed (e.g. emotion). Moreover, pre-scholars' competence to recognize an emotional expression is still less accurate than adults' (Batty & Taylor, 2006) and a possible confusion between different emotion could generate an interfering effect. For example, recent studies show that happy expressions were often confused with fearful expressions by preschool-aged children, whereas negative expressions were often confused with other negative expressions (Székely, et al., 2011). Therefore, a first interpretation of observed results explains the interference of information concerning (related to) emotions as a consequence of the developing competence to recognize emotional expression.

An alternative reading of results assigns the interference to the difficulty in managing different sources of information. In this vein, the task of recognizing the identity of face

conveying emotional information is too difficult compared with the children's limited cognitive resource. The presence of emotional expressions, both positive and negative, on a face seems to imply a supplementary load of information: this overburden might produce a decrement in children's identity recognition. Particularly, the task may demand a sophisticated level of attentional control that children have yet to achieve.

Finally, a third interpretation of results relates the observed interfering effect to the lack of flexibility in using face processing strategies, i.e. feature-by-feature vs. configural processing. A recent study investigating developmental changes in facial expression processing between 3 years of age and adulthood (Roberson, Kikutani, Döge, Whitaker, & SMajid, 2012) suggests a face processing model in which a threshold level of attentional control must be reached before children can develop adult-like configural processing skills and be flexible in their use of face processing strategies. Therefore, results obtained in our study could be explained by a similar lack of attentional control and flexibility.

4.2 Representational Redescription (RR) Model as interpretation of obtained results.

Representational Redescription Model (*RR*, Karmiloff-Smith, 1992) provides an interesting theoretic frame to better describe our observed outcomes. This model was proposed by Karmiloff-Smith in her 1992 work, *Beyond Modularity of Mind*, and aims to describe the development as a development of representations, along an implicit-explicit continuum. Specifically, it depicts a series of representational levels which children pass through, underlying a gradual change along the "implicit-explicit" continuum. Karmiloff-Smith initially talks about 3 recurrent phases that occur within the RR model. In the first phase, the child focuses on information from the external

environment to create “representational adjuctions”: these variations do not alter pre-existing representations and do not imply a real representational change, but involve the addition of new data. This phase culminates with a “behavioral mastery” for task within a domain. Then, Karmiloff-Smith describes a second internally-focused phase during which there is a marked change of representations. The temporary disregard for external information can lead to some hardenings and mistakes and can generate downturns in performance. The final phase involves a reconciliation of internal representations and external data, as children achieve a complete representation in which children can perform a task successfully and have explicit verbal knowledge for the concept. It is important to note however that “downturn” described in the second phase is simply at the level of performance on a task, but not at the representational level or children’s level of knowledge within a domain. As showed in Figure 4.2, the same performance can be produced by different representation: the so-called “behavioral mastery”, i.e. an adult-like performance, does not imply an adult representation. So, it is essential to discriminate *behavioral change* (that can generate an U-shape developmental trend) and *representational change.*

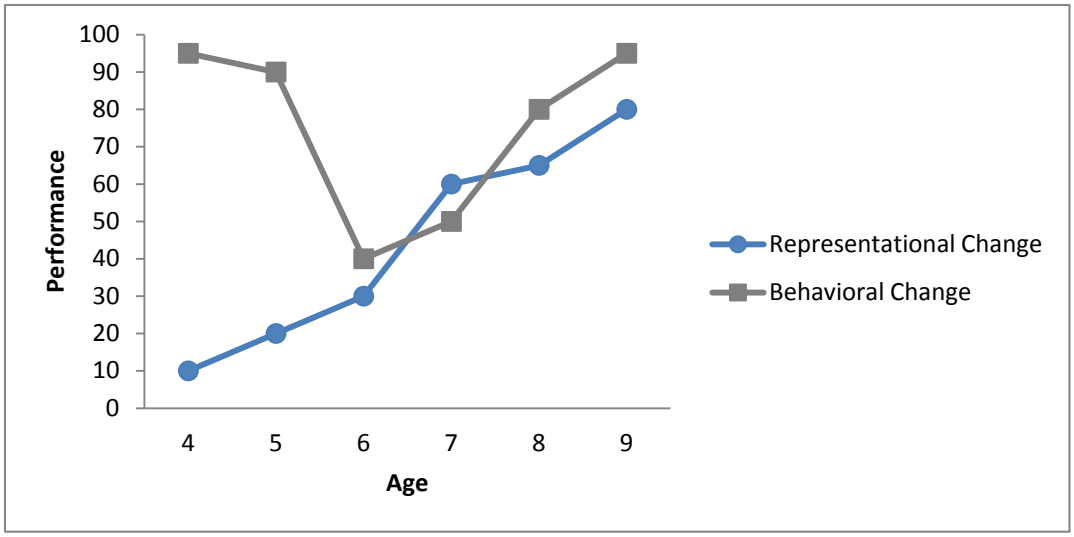

Figure 4.2 Representational Change vs. Behavioral Change (from Karmiloff.Smith, 1992). Behavioral changes show an U-shaped developmental trend in which younger children's performance is equivalent to adults' with a downturn during the development. Conversely, Representation Change' trend displays a progressive improvement during the development. So, an adult-like performance does not imply an adult representation.

Three phases described by Karmiloff-Smith are linked to "at least 4 levels at which knowledge is represented and re-represented" (Karmiloff-Smith, 1992), i.e. one implicit level and three explicit levels, (children's verbal access to knowledge). The implicit level overlaps the first phase described. The rest of the development implies a continuous re-description of representations into increasingly explicit knowledge. An explicit verbal knowledge is not achieved until the final phase.

The RR model not only can be usefully employed as a general model of cognitive development, but also fits very well as interpretation of the observed U-shape developmental trend of the relation between identity recognition and facial emotional expression processing.

In our results, an adult-like pattern was observed in 3-month-olds: as in adults, positive and negative facial emotional expressions respectively facilitate and interfere with

infants' identity recognition. Differently, in pre-school aged children both positive and negative emotional expressions have an interfering effect on their ability to recognize facial identity. RR model can help to provide an interpretation of these results. It could be that older children, i.e. 4- and 5-year-olds, own a better representation of facial emotion expressions. Indeed, particularly in this range of age, the ability to recognize facial expressions is improving and have an important increase (Gao & Maurer, 2010). This more evolved representation can generate the observed tumble in performance, when children have to ignore information regarding emotional expressions in order to focus on identity recognition. In infants, a rawer representation of emotional expression, at a level that Karmiloff-Smith might call "implicit", allows to observe an adult-like performance. According with the RR model, infants might be at the first phase of an emotional expression representation and children might be at the second level. This representational change might explain observed different patterns.

Finally, it would be interesting to test infants and children aged between 3-months and 5 years, in order to trace a more accurate developmental path of the relation between identity recognition and facial emotional expression processing across development .

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