Routledge
Taylor & Francis Group

# Early attachment predicts emotion recognition at 6 and 11 years old

Howard Steele[a]*, Miriam Steele[a] and Carla Croft[b]

[a]*New School for Social Research, New York, USA;* [b]*Department of Health Psychology, Hillingdon Hospital, London, UK*

This paper reports on findings from a sample of 63 children at 6 years old, and 49 children at 11 years old, all from the same cohort who had been observed with mother in the Strange Situation at 1-year-old. At 6 and 11 years, the children responded to the task of providing verbal labels for line-drawn (caricatures of) emotion faces. The faces comprised the six basic emotions identified as such by Darwin (sadness, happiness, anger, fear, surprise, and disgust) as well as a neutral face and two more complex (blended) emotions (mischievousness and disappointment). Infant–mother attachment was linked significantly with children's emotion judgments 5 years and, to a lesser extent, 10 years after the Strange Situation assessment. Results are discussed in terms of the long-term but attenuating influence of early learning experiences in the relationship with mother, and implications for how we think about the functioning of internal working models of attachment.

**Keywords:** emotion recognition; emotion judgments; facial expressions of emotion; attachment; developmental neuroscience

## Introduction

Darwin (1872) first observed that children have an innate, universal capacity to express basic emotions and have intuitive knowledge of the meaning of facial expressions of emotion displayed by others. There has been much research on this phenomenon, including Ekman's (e.g., 1972, 2003) seminal work on the widely recognized six primary emotional signals (happiness, sadness, anger, fear, surprise, and disgust). Adults in diverse cultures, including those from environments largely unchanged for 40,000 years (New Guinea), quickly recognize, label, and display on request these basic emotions when presented with photographs (or line drawings) posing these emotions (Cuceloglu, 1970; Ekman, 1972; Izard, 1994). Ekman and Izard were each trained in the study of emotion by the grand theorist Sylvan Tomkins (1995). First published in the early 1960s, John Bowlby was familiar with Tomkins' approach, and aligned his own view of emotion with that of Tomkins that affects constitute the primary motivational system, suggesting that "feeling is a phase of an appraisal process, in a way analogous to that in which redness is a phase of iron when heated" (Bowlby, 1969, p. 116).

Arriving at a label or judgment of the emotion on the face of the other is tied to appraisal processes linked to anticipated behavior of the other based on memories of how the other behaved when looking this way or that. Such experiences of facial emotional

---

*Corresponding author. Email: steeleh@newschool.edu

exchanges lead to the formation of a mental "script" or "mental event representations" (MER) that have been suggested to serve as the rudiments or basic building blocks of more abstract and generalized internal working models of the self and attachment figures (Bretherton & Munholland, 1999; Nelson, 1999; Spangler & Zimmerman, 1999; Thompson, 1999). All the while, there is present in the human individual a core set of responses to the human face that are arguably pre-verbal or non-verbal, extremely fast, and automatic, leading to more-or-less accurate judgments of the probable emotion on the face of the other.

Long-term influences following from the experience of looking into the face of the mother as an infant has been widely speculated upon, and more recently has been the subject of empirical inquiry: the results reported in this paper being a gesture in this direction. It has been suggested that between the 3$^{rd}$ and 6$^{th}$ month of life infants are normatively exposed to 32,000 highly articulated contingent facial expressions of emotion (Malatesta, 1985). "Thus it is likely that internal working models include templates or images of the rewarding or punishing face of the other" (Magai, 1999, p. 796). Magai here is restating in attachment terms the working hypothesis of Tomkins from the early 1960s: "if parents unduly punish the facial expression of emotion or any particular facial affect, then this source of information may be lost to the individual as a guide to the perception of the same expression in others" (Tomkins, 1995, p. 227). The loss of perception for feelings, and the absence or diminishment of one's lexicon for feelings, according to Tomkins, would naturally follow from a typically disappointing, rejecting, or neglectful maternal response to infant facial expressions of emotion.

Facial affective exchanges between infant and caregiver are thought to be vital to the initial formation of the internal working model, with infants on a path toward a secure attachment showing (already by 4 months) more variable facial expressive behavior than babies on a path toward an insecure-avoidant attachment (Koulomzin, Beebe, Anderson, Jaffe, Feldstein, & Crown, 2002). However, there is controversy regarding the possible long-term effects of infant–mother attachment upon children's verbal understanding of emotion, as highlighted by social emotion researcher Paul Harris (1999). Harris aptly described longitudinal findings (Steele, Steele, Croft, & Fonagy, 1999), which are the focus of the current report, pointing out that two overlapping influences upon children's understanding of blended or mixed emotions at 6 years old are evident. That is, from our earlier report of how infant–mother attachment links up with mixed emotion under-standing at 6 years old, it was not possible to conclude with confidence that the child's (secure) internal working model of attachment *from infancy* had led to superior understanding of complex emotions at 6 years old. In those results (Steele et al., 1999), it could equally have been the case that a secure infant–mother attachment was simply a marker of a mother who at once both facilitated a secure attachment during infancy *and* engaged in more coherent psychological discourse concerning emotion in the years intervening between the 12-month and 6-year assessments. For Harris (1999), with his investment in the importance of coherent (and concurrent) psychological discourse from the mother as *the* social information required to account for a child's understanding of emotion and theory of mind, knowledge of the early attachment status of the infant is possibly superfluous.

This was a view we could not dispute based on our previously published findings from the 11-year follow-up of the London Parent–child Project (Steele, Steele, & Johansson, 2002). In that report from Steele et al. (2002), infant–mother attachment no longer had any discernible impact on individual differences in social cognition tapped by verbal responses (acknowledging distress and coping resourcefully) in response to line-drawn

cartoon sequences (depicting a dilemma and emotional hurt) known as the Affect Task previously shown these young people at 6 years old (Steele et al., 1999). With respect to this measure of social cognition at 11 years of age, the significant correlates were concurrent maternal warmth and their mother's narrative responses to the Adult Attachment Interview (AAI).

Yet, a further look at our Affect Task administered (at 6 and 11 years old) may reveal a discrete long-term independent influence of the children's earliest internal working models of attachment, inferred from their responses to the Strange Situation procedure (Ainsworth, Blehar, Waters, & Wall, 1978) as 1-year-olds. This further look is afforded by the fact that in addition to obtaining a considered verbal response to the feelings likely to be experienced by characters in the cartoon sequences comprising the core of the Affect Task, we first showed the children a set of line-drawn emotion faces including the six basic emotions of happiness, sadness, surprise, anger, fear, and disgust. There were also two basic blends of emotion: (1) angry eyes and a happy mouth comprising a typical mischief face; and (2) surprised eyes and a sad mouth comprising a disappointed face, and a basic neutral face. Thus, children were shown nine line-drawn faces with characteristic variations in the shape and positioning of the eyes and mouth. They were then asked to provide one or more words that tell what each face was saying. Much previous research indicates that line-drawn faces such as these are as easily discerned as photographs of faces and that by the adolescent years most individuals accurately classify the basic emotion faces (McClure, 2000). At 6 years of age, however, and also at 11 years of age, individual differences in accuracy of response rates were to be expected, and we hypothesized that these differences may be systematically related to individual differences in infant–mother attachment security, reflecting early pre-verbal emotional learning and the initial formulation of the internal working model of attachment. If such distal associations between emotional functioning were observed between 1 and 6 years, and between 1 and 11 years, even after taking into account maternal AAI responses, and other possibly competing (e.g., verbal or gender-related) accounts of the association, then novel evidence in support of the long-term influence of pre-verbal early experience would be suggested.

We anticipated an overall effect of early infant–mother security (as opposed to insecurity) being linked to heightened or superior accuracy in judging emotion faces. This hypothesis follows from the expansive literature (e.g., Laible & Thompson, 1998) on how mothers who facilitate a secure attachment in their children do so by way of freely exploring with them a wide range of emotions, sharing joyful emotions, while also showing how readily negative emotions (anger, sadness, fear, disappointment) can be experienced, acknowledged, and recovered from through reliable help available from an attachment figure. We hypothesized that such an infant is launched not only toward a secure infant–mother attachment, but also toward a fuller and more accurate capacity for arriving at judgments as to the emotion that is conveyed by a human face. We tested for such an effect at 6 and 11 years of age, expecting one in relation to the early *infant–mother* attachment. This seemed justified given the absence of an effect of the infant–father attachment in our previous reports on mixed emotion understanding at age 6 years (Steele et al., 1999), and social cognition at 11 years old (Steele et al., 2002), and the wider literature documenting the seemingly unique importance of mothers as influences upon children's emotional development (Thompson, 1999).

With respect to infants with an early insecure (avoidant or resistant) attachment to mother, we hypothesized that their expected heightened recognition skills would be most apparent for those emotions that typified their early strategies for dealing with their emotional experiences. For example, given the pressure upon avoidant infants to contain

distress and (defensively) ''put on a happy face,'' we anticipated accurate recognition skills of the happy emotional display, with diminished recognition skills for the negative emotions, especially the more subtle ones (e.g., blended emotions). By contrast, given the frequent experience of distress (that is not easily resolved) for children with a history of insecure resistance, we anticipated ''normal'' levels of recognition of the sad emotion face by these children. These predictions are partly informed by the work of Belsky, Spritz, and Crnic (1996), suggesting that insecure infants are biased toward recollection of negative memories, while secure infants are biased toward the recollection of positive memories. However, the outcome variable in the Belsky et al. (1996) study was recall following a puppet show where children's narrative responses were studied, in effect, for pessimism versus optimism. The focus of the current study is more perceptual than cognitive, insofar as the outcome variable is immediate responses to displays of facial emotion. Given that children with a history of disorganized attachments may be primed for hyper-vigilance to negative emotion, as suggested from the study of neglected and maltreated children (Pollak, Cicchetti, Hornung, & Reed, 2000), it was expected that children with a history of disorganization may show selective enhanced skills for one or other negative emotion.

## Method

### Sample

The 6-year follow-up included 63 children from the original cohort of 96 infants (Fonagy, Steele, & Steele, 1991). Twenty-nine (46%) of the children were girls, and 34 (54%) were boys. Forty of these children, seen at 6 years old, and nine others from the original cohort, participated in an 11-year follow-up including the emotion judgment task. Thus, at the 11-year follow-up, 49 children responded to the emotion judgment task, 25 (51%) of them girls and 24 (49%) were boys. The sample at both time points was 95% White and middle-class, with 70% of the parents possessing university degrees.

### Verbal skills (control) measures

Both mothers and fathers had been administered the short form of the Mill Hill Vocabulary Scale (Raven, Court, & Raven, 1986) early in the child's life. Parents' vocabulary scores were observed to be moderate to high in relation to published norms in response to this previously validated test of verbal intelligence. Children's vocabulary skills were assessed when they were 5 years old with the Bus Story Test established as a valid measure of receptive and productive vocabulary that is predictive of language delays in school-aged children (Renfrew, 1991; Templin, 1987).

### Attachment measures

#### Adult Attachment Interview (AAI)

From prior observations of the sample, two core measures of attachment were available for comparison with the children's accuracy in assigning a label to the emotion faces. First, there were the Adult Attachment Interviews (George, Kaplan, & Main, 1985), obtained from the children's mothers and fathers (Steele, Steele, & Fonagy, 1996), and scored reliably according to the well-known rating and classification system (Main, Goldwyn, & Hesse, 2003; Main, Hesse, & Goldwyn, 2008). The pregnancy AAIs provided by each of

the parents from the current sample was rated and classified independently by four trained coders. In over 90% of cases, all four coders agreed as to which to the four major classifications (autonomous-secure, insecure-dismissing, insecure-preoccupied, or unre-solved with respect to past loss or trauma) best fit the interview transcript. Majority agreement (3/4) decided the classification in 5% of cases, while conferencing aloud settled the matter in the remaining 5% of split (2/2) decisions. Further inter-rater reliability details are provided in Steele et al. (1996). AAIs from parents of the children responding to the affect-judgment task at 6 and 11 years old were distributed normally (>60% secure) and similarly to that observed for the fuller sample of 90 couples reported on previously (Steele et al., 1996).

*Strange Situation procedure*

A unique strength of the present investigation was the longitudinal design with the Strange Situation procedure (Ainsworth et al., 1978), conducted in infancy to observe the infant–mother attachment at 12 months, and the infant–father attachment at 18 months, when highly reliable classification assignments were assigned by trained raters (median kappa for inter-rater agreement was .89 [range .83–.92] as reported in Steele et al., 1996). In terms of the previously observed infant–mother and infant–father attachment groups, the follow-up samples at both age 6 and 11 years were highly representative of the initial cohort, as well as the wider population of low-risk respondents. For example, the 6-year-old participants had previously as infants shown the following infant–mother patterns: avoidant = 29%, resistant = 6%, secure = 57%, disorganized = 8%, and at 11 years the previous infant–mother patterns were: avoidant = 25%, resistant = 8%, secure = 58%, disorganized = 8%. These proportions reflect those commonly observed in low-risk community samples across cultures (De Wolff & van IJzendoorn, 1997; van IJzendoorn & Kroonenberg, 1988).

**Emotion judgment task**

The emotion judgment task comprised nine simple line drawings of facial expressions, with distinct emotions achieved by varying the eyes and eyebrows, and mouth muscles (after Cuceloglu, 1970), with a resulting set of simple, clear, posed emotions. Six of the nine faces portrayed the basic emotion faces of fear, anger, sadness, disgust, happiness, and surprise. Two of the faces expressed a "complex" or "mixed" emotion: mischief (a happy mouth and angry eyes) and disappointment (a sad mouth and surprised eyes). The remaining facial expression was of no emotion, a "neutral" face. In order to confirm the likelihood of this set of line-drawn faces being identified accurately, we surveyed 82 undergraduate university students. More than 95% of the students correctly identified all but two of the faces. These were the "disgust" face (correctly identified by only 10% of adults) and the "disappointed" face with sad mouth and surprised eyes (correctly identified by 50% of the adult college sample).

At 6 years old, children were asked to say a word or more that described the face. Their descriptions were audio-recorded and transcribed for subsequent coding. At 11 years old, children were asked to write down a word or phrase that described the face. There was a high level of agreement between independent raters on whether a child's spontaneous label of a face was accurate or inaccurate: 92% agreement on the responses at 6 years old, and 94% agreement at 11 years old. Disagreements were conferenced. Table 1 shows the extent of accuracy for each of the nine faces at 6 and 11 years old.

Table 1. Number and percent of children at 6 and 11 years old correctly identifying the facial expressions of emotion.

|  | 6-year-olds | 11-year-olds |
| --- | --- | --- |
| Fear | 8 (13%) | 30 (60%) |
| Disgust | 1 (2%) | 0 (0%) |
| Anger | 52 (83%) | 39 (80%) |
| Sad | 46 (73%) | 37 (77%) |
| Happy | 51 (81%) | 45 (92%) |
| Surprise | 25 (40%) | 46 (93%) |
| Mischievous | 21 (33%) | 46 (93%) |
| Disappointment | 2 (3%) | 5 (10%) |
| Neutral/plain face | 15 (24%) | 33 (67%) |

Table 1 reveals that at 6 years of age, there were only three emotions accurately identified by the vast majority of children, namely, anger, sadness, and happiness. Only one child correctly identified the disgust face at 6 years old, and no child identified the disgust face at 11 years old. This deficit in identifying the disgust face, also noted in the responses of the pilot sample of university students, was attributed to the need for a photograph to depict this emotion, one that would include tongue-protrusion from a contorted face feeling revulsion. A simple two-dimensional line drawing, such as the one we used, cannot capture this. By 11 years of age, a majority of children identified all but the line-dawn disgust face and the disappointed face, pointing to the subtle quality to this blended emotion. At 6 years of age, mean accuracy score was 3.51 ($SD = 1.64$, range $= 0–8$), while at 11 years of age, mean accuracy score was 5.72 ($SD = 1.09$, range $= 2–8$).

## Results

Results are presented in three parts: (1) correlations between emotion accuracy scores and all other measures; (2) emotion accuracy scores grouped by infant–mother attachment classifications in one-way ANOVAs (with Bonferroni pair-wise comparisons). This permits identification of any overall effect of infant–mother attachment upon later emotion judgment skills, while also allowing for inspection of the sources of any overall effect in particular contrasts among the four attachment groups; and (3) a further set of results providing an exploratory look, via cross-tabulations and chi-square tests, aimed at observing how specific emotion faces were judged differently by 6-year-old children from different infant–mother attachment groups.

### Correlational analyses

In order to investigate questions having to do with both discriminant and predictive validity of the emotion judgment task, we correlated children's emotion accuracy scores at 6 and 11 years old, with previously validated assessments of their own and their parents' verbal skills, child gender (boy/girl), as well as all previously assessed attachment variables rendered in binary form (insecure/secure). The resulting correlations are shown in Table 2.

Table 2. Correlations between verbal skills of parents, child, and child gender and emotional accuracy scores at 6 and 11 years old.

|  | Emotion accuracy | |
|  | 6-year-olds | 11-year-olds |
| --- | --- | --- |
| Vocabulary skills of: |  |  |
| Mother | −.21 | .02 |
| Father | −.05 | −.01 |
| Child | .10 | .10 |
| Gender of child | .16 | .14 |
| Attachment security of: |  |  |
| Mother | .20 | .07 |
| Father | −.13 | −.03 |
| Infant–mother | .41*** | .25+ |
| Infant–father | −.03 | .19 |

$+p < .10$; $***p < .001$; these are two-tailed probabilities.
Note: Gender is scored boy/girl and attachment is scores insecure/secure based on AAIs from parents and Strange Situation results for infant–parent attachment.

Correlational results in the upper half of Table 2 reveal that neither parents' nor children's verbal skills were significantly correlated with emotion judgment skills shown by the children at 6 or 11 years old. Notably, the upper set of correlations appearing in Table 2 reveal that, at both 6 and 11 years old, emotion recognition was positively correlated with children's gender (being a girl). The sample would have to be many times larger for this gender effect to be significant, where it would be possible to suggest that 2% of the variance in emotion judgment skills may be accounted for by gender.

The correlations in the lower half of Table 2 address the central hypothesis of this report that infant–mother attachment, and not infant–father attachment, nor maternal AAI or paternal AAI security, would be linked to emotion judgments. Table 2 reveals that, indeed, infant–mother attachment security is correlated positively and significantly with accuracy in emotion judgments at 6 years old, with the magnitude of the correlation suggesting that 16% of the variance in emotion recognition at 6 years old may be attributed to infant–mother attachment security. The strength of this correlation is reduced somewhat when we consider emotion judgments at 11 years old, but still it appears from the correlation that more than 6% of the variance in emotion recognition skills at 11 years old may be attributed to the long-term influence of infant–mother attachment security.

### Accuracy in emotion judgments at 6 and 11 years old as a function of infant–mother attachment

Table 3 below shows the mean number of faces accurately identified at 6 years old grouped by infant–mother attachment at 12 months in the four well-known groups (avoidant, resistant, secure, and disorganized). This one-way ANOVA was aimed at identifying which of the insecure infant–mother attachment groups were scoring significantly lower on accuracy of emotion judgments at 6 years old. We exclude from this table details of the 11-year ANOVA results as no pair-wise differences were observable at this age, despite a

Table 3. Mean number of facial expressions of emotion correctly identified at age 6 years grouped by infant–mother attachment.

| 12-month infant–mother attachment groups | 6-year accuracy of emotion judgment scores Mean (SD) | Significant pair-wise comparisons |
|---|---|---|
| Avoidant (n = 18) | 2.89 (1.45) | A < B |
| Resistant (n = 4) | 1.50 (1.29) | C < B |
| Secure (n = 36) | 4.08 (1.59) | B > A, B > C |
| Disorganized (n = 5) | 3.20 (0.84) | N.S. |

Note: $F = 5.26$, $df = 3.59$, $p < .005$; reported pair-wise comparisons rely on the Bonferroni test, $p < .05$, two-tailed.
A = Avoidant, B = Secure, C = Resistant, D = Disorganized.

significant overall *F*-value mirroring the correlation result reported above in respect of Table 2.

Table 3 reveals that when levels of accuracy in emotion judgments at 6 years old were grouped according to infant–mother attachment from 5 years previously, the overall result was highly significant, as expected from the correlation results and core study hypothesis. Inspection of the Bonferroni pair-wise comparisons in Table 3 shows that this significance derives from the greater accuracy in judging emotion faces demonstrated by children with a history of a secure attachment to mother, as compared to the significantly less accurate emotion judgments shown by children with a history of an insecure (either avoidant or resistant) attachment to mother at 12 months. Table 3 also shows that the children with a history of disorganization in their infant–mother attachment were not distinguishable from those children with a history of security.

### *Exploratory look at specific emotion judgments at 6 years old as a function of infant–mother attachment*

In order to further identify the sources of significance in the 6-year findings, a series of post-hoc cross-tabulations were computed comparing correct/incorrect responses to specific faces with 3-way infant–mother attachment (avoidant = 19, resistant = 8, and secure = 36). The 3-way grouping was preferred for this set of analyses because children whose primary infant–mother attachment was disorganized performed on the emotion-recognition task in ways not significantly different from those children who had shown security with mother at 12 months.

A set of eight 3X2 cross-tabulations were computed, 3-way infant–mother attachment by incorrect/correct emotion recognition at 6 years old. The disgust face was excluded because there was no variation to possibly explain. Three of the eight cross-tabulations computed yielded significant chi-square results: (1) happy face (chi-square = 11.31, $df = 2$, $p < .005$); (2) mischief face (chi-square = 7.82, $df = 2$, $p < .02$); and (3) surprise face (chi-square = 8.36, $df = 2$, $p < .02$). The happy face was judged accurately by a large majority of those 6-year-olds who had been either secure (86%) or insecure-avoidant (85%) in their infant–mother attachments. By contrast, the happy face was judged accurately significantly less frequently at 6 years old by those who had been insecure-resistant (38%) in their infant–mother attachments. All eight children in this group of 6-year-olds with a resistant attachment to mother at one

year uniformly (100%) missed the surprise face, whereas only 47% of 6-year-olds with a secure history did so, and 68% of those with an avoidant history. The mischief face (the blend of angry eyes and a happy mouth) was correctly judged by 47% of 6-year-olds with a secure history, but only 25% of those with a resistant history, and 11% of those with an avoidant history.

### Discussion

We observed a long-term significant link between infant–mother (not infant–father) attachment security and accuracy in recognizing or judging emotion faces at 6 years of age, with some lingering benefits even at 11 years of age for those children who had been securely attached to their mothers as infants. Attention is to be given to the difficulties 6-year-old children showed with judging accurately particular emotion faces when their infant–mother attachment history included having been insecure-avoidant or insecure-resistant. The apparent non-significant differences between children with a secure as opposed to disorganized infant–mother attachment history are also to be considered. The central concerns of this discussion concerns implications for our understanding of internal working models of attachment during infancy and their potential long-term influence upon children's emotion judgments at 6 or 11 years old, above and beyond the influence of child gender, or verbal skills of either child or parent, including psychological discourse skills. Potential links to the developmental neuroscience literature are also considered.

### *Emotion recognition skills as a pre-verbal learning phenomenon uniquely linked to the infant–mother relationship*

The currently reported results suggest that accuracy in emotion judgments of the human face is unrelated to verbal skills, and only weakly linked to child gender, with girls having a slight (non-significant) advantage in the current study. Across a large number of independent studies, this ''small'' gender effect has been confirmed as significant (McClure, 2000) with the suggestion that on a given emotion judgment task, girls should score above average 53% or 54% of the time, while boys should score above average only 46% of time. McClure (2000), drawing on much previous literature, attributes this advantage to inherently more organized or precocious development of right brain processes (responsible for emotion processing) in girls, linked to preferential stimulation from the maternal environment. Interestingly, in the current study girls scored above the mean 55% of the time, and boys did so 45% of the time, at both 6 and 11 years old, in accord with McClure's (2000) conclusions. Notably, in the current report, at 6 years of age, when a child had been securely attached to mother as an infant, they scored above the mean 74% of the time, relative to children who had been insecurely attached to mother who scored above the mean only 26% of the time. This suggests that when maternal sensitivity is optimal in the first year of life, boys *and* girls derive benefits that are likely to include significantly enhanced accuracy in facial emotion processing through 6 years of age. By 11 years old, in the current study, this benefit was lessened to that of only marginal significance, with 65% of those who had been securely attached as infants scoring above the mean. McClure's (2000) speculations in the direction of neurological advantages conferred upon girls have been the focus of much recent writing suggestive of how infant–mother attunement may be the mechanism of advantage to an extent far more important than the gender of the child. And, to the extent that fathers are the primary caregivers of

their infants, the gender of parent may not matter as much as it did in the current study where almost all the mothers played this role, and the infant–mother relationship was singled out as a uniquely important domain of learning about facial emotion processing.

In this respect, the current results offer fresh support for the decades-old suggestion of Tomkins that a loss of perception for feelings, and the absence or diminishment of one's lexicon for feelings, may follow from restrictions upon the emotional exchanges between infant and mother. Drawing on Tomkins' ideas articulated in the 1960s, and Magai's (1999) reframing of those ideas in terms of internal working models, the current results provide important empirical support. They suggest that the first organization of an infant's internal working model of attachment, assumed to take shape in the final quarter of the first year (Bowlby, 1969), includes templates of the emotion faces infants have seen (and felt) regularly (on their mother's face) together with linked messages as to what these faces portend for the self and other(s). This learning is preverbal from the first year of life, yet powerful enough to show itself 6 years and 11 years later in emotion recognition tasks.

### Developmental neuroscience, faces, and emotion

Contemporary reasons for thinking that there is a long-term discrete influence of infant–mother attachment upon accuracy in judging facial expressions of emotion comes from recent neuroscientific speculation (Schore, 2000) and investigation (Grossmann, Johnson, Farroni, & Csibra, 2007; Le Grand, Mondloch, Maurer, & Brent, 2003; Otsuka, Nakato, Kanazawa, Yamaguchi, Watanabe, & Kakigi, 2007). Schore (e.g., 2000, 2001) has posited that attachment theory is fundamentally a regulatory theory, and the affect-recognition and affect-regulatory lessons learned by the infant are stored in the internal working model of attachment located in brain processes of the orbitofrontal cortex, mainly in the right hemisphere.

The salience of the right hemisphere in these processes, and their potential long-term effects, has been established in a number of well-controlled neuroscientific studies. Le Grand et al. (2003) looked at levels of competence in expert face processing (detecting variations in the spacing of the eyes and between the eyes and the mouth) in visually normal individuals and in 20 patients treated for unilateral congenital cataract that blocked all patterned input to the either the left eye ($n = 10$), or the right eye ($n = 10$), ranging in age from 8–29 years, where correction of the cataract occurred for all in the second, or later, year of life. This is of particular interest to the method applied in the current study because, with line drawings of faces (as applied) and in photographs, variations in emotion correspond closely to configurations in the spacing and shape of the eyes and eyebrows, and mouth. Le Grand et al. (2003) showed that deprivation of input to the right hemisphere severely impairs the development of expert face processing, whereas deprivation restricted mainly to the left hemisphere does not, indicating that early visual experience is required for the neural circuitry responsible for adults' face expertise. The two hemispheres are not equipotent: only the right hemisphere is capable of using input to develop expertise at face processing. Otsuka et al. (2007) measured levels of cerebral oxygenation in infants aged 5–8 months as they looked at either upright or inverted faces (long known to be a less preferred stimulus than upright faces). They observed significantly elevated activation of the right hemisphere, specifically in the temporal region and probably in the right temporal sulcus (STS) when looking at

upright as opposed to inverted faces. This would seem to underline the importance for infants of being exposed to non-threatening comforting *and* vertically presented faces (the normal orientation of the caregiver's face) for normal brain development to follow.

The vital specific relevance of experience looking at vertically presented faces showing direct (and averted) gaze in the first months of life was underlined by the research of Grossmann et al. (2007). Direct gaze from photographic images of upright female faces directed at 4-month-old infants elicited increased and early evoked gamma activity at occipital channels, while averted gaze induced gamma burst over right posterior regions. The capacity of the sensitive and responsive caregiver to achieve repair following such a disruptive "burst of activity" is now well documented (Beebe & Lachmann, 1994; Sroufe, 1996; Tronick, 1989). Schore (2001, p. 20) has described the likely interactive process as follows: "the 'good-enough' caregiver who induces a stress response in her infant through a misattunement, reinvokes in a timely fashion her psychobiologically attuned regulation of the infant's negative affect state that she has triggered. The reattuning, comforting mother and infant thus dyadically negotiate a stressful state transition of affect, cognition, and behavior."

### Emotion recognition skills of 6-year-olds with a history of attachment disorganization

In the current report, 6-year-olds with a history of disorganization scored on the emotion judgment task in a way not significantly different from those 6-year-olds with a history of security in the early infant–mother relationship. This puzzling similarity of performance is made comprehensible by considering that a child who is neglected, abused, or otherwise threatened is likely to become skilled (defensively) in reading emotions on the face of other people. Rather than leading to a retreat from the perception of emotions per se, harsh and unpredictable experiences provide training in how to be hyper-vigilant to feelings, especially anger (Pollak et al., 2000), as a child living in fearful circumstances knows well what harm an angry face portends (Rieder & Cicchetti, 1989). From this perspective, Rieder and Cicchetti's (1989) comments on hyper-vigilance help explain what is likely to be the significantly different origins to the similarly high levels of accuracy in judging facial emotions at 6 years of age seen in the current study for children with a history of secure and disorganized infant–mother attachments. We speculate that in the one case (of security) it is because of a rich, diverse, and consistent history of attuned interactions with the mother, while in the other case (i.e., disorganization) it is precisely because of the serious lack in such consistency. That is, an unpredictable history of interactions, occasioning fear in the child, may teach such a child to accurately forecast the emotion on the face of the other which may be seen as a most reasonable step toward self-protection.

### Emotion recognition difficulties for 6-year-olds with a history of attachment insecurity (avoidance or resistance)

With respect to the specific strengths and difficulties in emotion recognition shown by children at 6 years old with a history of insecure-avoidance or insecure-resistance, a different set of explanations seems warranted. The specifically enhanced skills at identifying the happy face observed in 6-year-old children with a history of insecure-avoidance are suggestive of pressure (upon the child with an avoidant history) to recognize

and present an optimistic outlook, even if it is not genuinely and deeply felt as in the case of the child with a secure history. Yet these same children with an avoidant history had difficulty with the "surprise" face and the "mischievous" (playful) face, as did those with an insecure-resistant history. It would appear that this shared impoverished accuracy, relative to those children with a secure history, suggests a restriction in the range of playful and manageably surprising emotional exchanges experienced in the first years of life. For children with an insecure-resistant history, this restriction extended to the "happy face" that they had difficulty identifying correctly.

### Conclusions

To build on the current study, further rigorous empirical investigations of these potential individual differences stemming from differences in infant–mother attachment should be undertaken. They will add to the literature compiled in recent years representing a shift in the focus of emotion-recognition research away from the pioneering attention given to basic universal processes (Darwin, 1872; Ekman, 1972; Izard, 1994) to the sources of individual differences. Individual differences have been looked at in terms of accuracy and bias in the operation of this basic human capacity as a possible function of early adversity (e.g., Colvert et al., 2008; Pollak et al., 2000) and clinical diagnostic status (e.g., Ellis et al., 1997; Magai, 1999; Rich, Grimley, Schmajuk, Blair, Blair, & Leibenluft, 2008; Zabel, 1979). Taken together, these studies of individual differences in the recognition of facial expressions of emotion among children with a history of neglect or abuse, or current disturbance, offer confirmation both of the diminished lexicon for emotion hypothesis, and the hyper-vigilance hypothesis; all consistent with attachment theory and the influential role that early experiences may play in shaping one's initial internal working model, and subsequent process of emotional information with face-reading being a privileged mode of perception dating, as it does, from the preverbal period of development.

Finally, with respect to the emphasis Harris (1999) places upon the influence of parent–child psychological discourse in contributing to children's understanding of emotion, the current results are *not* in dispute with this claim because the outcome we have considered *precedes* rational psychological discourse. We have taken as our focus in this paper accuracy in judging emotional expressions on the face, based on rapid verbal and *largely unconsidered* first responses. Such responses, at 6 years of age, if not also long after, we have argued, are likely to reflect the child's initial organization of his or her internal working model. This would have been achieved in the latter quarter of the first year of life, and would have initially been organized along preverbal lines to do with what it looks like and feels like to be with mother (Bowlby, 1969; Stern, 1985). Over time, the internal working model is updated and reorganized into verbal forms so that it is eventually available, at least in part, to conscious inspection, reflection, and further (psychological) updating (Grossmann, 1999; Steele & Steele, 2008). In this respect, accuracy in judging facial expressions of emotion may come to be influenced by much further learning outside the domain of the infant–mother relationship (and thus we saw a diminishment of the infant–mother effect at 11 years old). Also, it is to be expected that enhanced emotion judgment skills will be linked to advances at the verbal level in the understanding of emotion, and in social cognition more generally (Steele et al., 2002). This is coming to be a widely accepted perspective (Elfenbein, Marsh, & Ambaday, 2002), that a core feature of emotional intelligence is the ability to judge accurately emotion in facial expressions. In turn, further research may come to document how security of attachment (to mother or

other attachment figures) in infancy, underpinned by an organized and hopeful internal working model (of self and attachment figures), is the normative beginning of emotional intelligence.

## Acknowledgements

## References

Ainsworth, M.S., Blehar, M.C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the strange situation*. Oxford: Erlbaum.

Beebe, B., & Lachmann, F.M. (1994). Representations and internalization in infancy: Three principles of salience. *Psychoanalytic Psychology*, *11*, 127–165.

Belsky, J., Spritz, B., & Crnic, K. (1996). Infant attachment security and affective-cognitive information processing at age 3. *Psychological Science*, *7*, 111–114.

Bowlby, J. (1969). *Attachment and loss. Vol. 1: Attachment*. New York: Basic Books.

Bretherton, I., & Munholland, K.A. (1999). Internal working models in attachment relationships: A construct revisited. In J. Cassidy & P.R. Shaver (Eds.), *Handbook of attachment: Theory, research and clinical applications* (pp. 89–111). New York: Guilford Press.

Colvert, E., Rutter, M., Beckett, J.C., Groothues, C., Hawkins, A., Kreppner, J., et al. (2008). Emotional difficulties in early adolescence following severe deprivation: Findings from the English and Romanian adoptees study. *Development and Psychopathology*, *20*, 547–567.

Cuceloglu, D. (1970). Perception of facial expressions in three cultures. *Ergonomics*, *13*, 93–100.

Darwin, C. (1872). *The expression of the emotions in man and animals*. London: Harper Collins.

De Wolff, M.S., & van IJzendoorn, M.H. (1997). Sensitivity and attachment: A meta-analysis on parental antecedents of infant attachment. *Child Development*, *68*, 571–591.

Ekman, P. (1972). Universals and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska symposium on motivation* (pp. 207–283). Lincoln: University of Nebraska Press.

Ekman, P. (2003). *Emotions revealed: Recognizing faces and feelings to improve communication and emotional life*. New York: Henry Holt & Co.

Elfenbein, H.A., Marsh, A.A., & Ambaday, N. (2002). Emotional intelligence and the recognition of emotion from facial expressions. In L.F. Barrett & P. Salovey (Eds.), *The wisdom in feeling: Psychological processes in emotional intelligence* (pp. 37–59). New York: Guilford.

Ellis, C.R., Lindstrom, K.L., Villani, T.M., Singh, N.N., Best, A.M., Winton, A.S.W., et al. (1997). Recognition of facial expressions of emotion by children with emotional and behavioral disorders. *Journal of Child and Family Studies*, *6*, 453–470.

Fonagy, P., Steele, H., & Steele, M. (1991). Maternal representations of attachment during pregnancy predict the organization of infant–mother attachment at one year of age. *Child Development*, *62*, 891–905.

George, C., Kaplan, N., & Main, M. (1985). *The Adult Attachment Interview*. Unpublished manuscript, University of California, Berkeley.

Grossmann, K.E. (1999). Old and new internal working models of attachment: The organization of feelings and language. *Attachment & Human Development*, *1*, 253–269.

Grossmann, T., Johnson, M.H., Farroni, T., & Csibra, G. (2007). Social perception in the infant brain: Gamma oscillatory activity in response to eye gaze. *Social Cognitive and Affective Neuroscience (SCAN)*, *2*, 284–291.

Harris, P. (1999). Individual differences in understanding emotion: the role of attachment status and psychological discourse. *Attachment & Human Development*, *1*, 307–324.

Izard, C.E. (1994). Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin*, *115*, 288–299.

Koulomzin, M., Beebe, B., Anderson, S., Jaffe, J., Feldstein, S., & Crown, C. (2002). Infant gaze, head, face, and self-touch at 4 months differentiate secure vs. avoidant attachment at 1 year: A microanalytic approach. *Attachment & Human Development*, *4*, 3–24.

Laible, D.J., & Thompson, R.A. (1998). Attachment and emotional understanding in preschool children. *Developmental Psychology*, *34*, 1038–1045.

Le Grand, R., Mondloch, C.J., Maurer, D., & Brent, H.P. (2003). Expert face processing requires visual input to the right hemisphere during pregnancy. *Nature Neuroscience*, *6*, 1108–1112.

Magai, C. (1999). Affect, imagery and attachment: Working models of interpersonal affect and socialization. In J. Cassidy & P.R. Shaver (Eds.), *Handbook of attachment: Theory, research and clinical applications* (pp. 787–802). New York: Guilford Press.

Main, M., Goldwyn, R., & Hesse, E. (2003). *Adult Attachment Classification system Version 7.2*. Unpublished manuscript, University of California, Berkeley.

Main, M., Hesse, E., & Goldwyn, R. (2008). Studying differences in language use in recounting attachment history. In H. Steele & M. Steele (Eds.), *Clinical applications of the Adult Attachment Interview* (pp. 31–68). New York: Guilford Press.

Malatesta, C. (1985). The developmental course of emotion expression in the human infant. In G. Zivin (Ed.), *Expressive development: Biological and environmental interactions* (pp. 183–220). New York: Academic Press.

McClure, E. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin*, *126*, 424–523.

Nelson, K. (1999). Event representations, narrative development and internal working models. *Attachment & Human Development*, *1*, 239–252.

Otsuka, Y., Nakato, E., Kanazawa, S., Yamaguchi, M.K., Watanabe, S., & Kakigi, R. (2007). Neural activation to upright and inverted faces in infants measured by near infrared spectroscopy. *NeuroImage*, *34*, 399–406.

Pollak, S.D., Cicchetti, D., Hornung, K., & Reed, A. (2000). Recognizing emotion in faces: Developmental effects of child abuse and neglect. *Developmental Psychology*, *36*, 679–688.

Raven, J.C., Court, J.H., & Raven, J. (1986). *Manual for Raven's progressive matrices and vocabulary scales*. London: H.K. Lewis & Co.

Renfrew, C.E. (1991). *The bus story: a test of continuous speech* (2nd ed.). Oxford: C.E. Renfrew.

Rich, B., Grimley, M.E., Schmajuk, M., Blair, K.S., Blair, R.J.R., & Leibenluft, E. (2008). Face emotion labeling deficits in children with bipolar disorder and severe mood dysregulation. *Development and Psychopathology*, *20*, 529–546.

Rieder, C., & Cicchetti, D. (1989). Organizational perspective on cognitive control functioning and cognitive affective balance in maltreated children. *Developmental Psychology*, *25*, 382–393.

Schore, A.N. (2000). Attachment and the regulation of the right brain. *Attachment & Human Development*, *2*, 23–47.

Schore, A.N. (2001). Effects of a secure attachment relationship on right brain development, affect regulation, and infant mental health. *Infant Mental Health Journal*, *22*, 7–86.

Spangler, G., & Zimmerman, P. (1999). Attachment representation and emotion regulation in adolescents: A psychobiological perspective on internal working models. *Attachment & Human Development*, *1*, 270–290.

Sroufe, L.A. (1996). *Emotional development: The organization of emotional life in the early years*. New York: Cambridge University Press.

Steele, H., & Steele, M. (2008). On the origins of reflective functioning. In F. Busch (Ed.), *Mentalization: Theoretical considerations, research findings, and clinical implications* (pp. 133–158). New York: The Analytic Press.

Steele, H., Steele, M., Croft, C., & Fonagy, P. (1999). Infant–mother attachment at one year predicts children's understanding of mixed emotions at six years. *Social Development*, *8*, 161–178.

Steele, H., Steele, M., & Fonagy, P. (1996). Associations among attachment classifications of mothers, fathers, and their infants. *Child Development*, *67*, 541–555.

Steele, M., Steele, H., & Johansson, M. (2002). Maternal predictors of children's social cognition: An attachment perspective. *Journal of Child Psychology & Psychiatry & Allied Disciplines*, *43*, 861–872.

Stern, D. (1985). *The interpersonal world of the infant*. New York: Basic Books.

Templin, M.C. (1987). *Certain language skills in children: Their development and interrelationships*. Minneapolis: University of Minnesota Press.

Thompson, R.A. (1999). Early attachment and later development. In J. Cassidy & P.R. Shaver (Eds.), *Handbook of attachment: Theory, research and clinical applications* (pp. 265–286). New York: Guilford Press.

Tomkins, S.S. (1995). *Exploring affect: The selected writings of Sylvan S. Tomkins*. In (E.V. Demos, Ed.). New York: Cambridge University Press.

Tronick, E.Z. (1989). Emotions and emotional communication in infants. *American Psychologist*, *44*, 112–119.

van IJzendoorn, M.H., & Kroonenberg, P.M. (1988). Cross-cultural patterns of attachment. A meta-analysis of the Strange Situation. *Child Development*, *59*, 147–156.

Zabel, R.H. (1979). Recognition of emotions in facial expressions by emotionally disturbed and nondisturbed children. *Psychology in the Schools*, *16*, 119–126.