

# Maternal Perceptual Sensitivity to Changes in Facial Expressions: A Comparison with Non-caregivers<sup>1</sup>

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**Abstract** : The present study examined perceptual sensitivity to changes in facial expressions as a function of care-giving experience. Measures of perceptual sensitivity were compared between the young mothers who had one or two children of 0 to 3 years, and female university students. It was found that the mothers were more sensitive to changes in facial expressions and more willing to respond to changes than female students. On the other hand, measures of Emotional Intelligence did not differ between the groups, whereas the empathy measure for Emotional-Warmth did. The results, despite some reservations, suggest that childcare experiences may play a role in increasing sensitivity at a perceptual level. The implications of these findings were discussed in light of individual differences and the development of empathy.

**Keywords** : perceptual sensitivity, signal detection theory, care-giving experiences, empathy, Emotional Quotient

## Introduction

Maternal sensitivity is an important factor that contributes to a child's healthy psychological development. Maternal sensitivity has been regarded as the concept of referring to maternal emotional and physical availability to respond to a child's signal in a timely manner. Maternal sensitivity is measured through the observations of mother and child interactions used in, for example, the Parent-Child Early Relational Assessment (Clark, 1999). The measurement of maternal sensitivity is largely based on the behaviours of mothers who are interacting with their children.

However, maternal sensitivity may not be limited to the behavioural level. To respond to the child's signal in a timely manner, mothers first need to identify the child's signal and then make a contingent response. Research into maternal sensi-

tivity suggests that maternal behaviours are associated with sensory sensitivity to changes in the baby's facial expressions (Donovan, Taylor, & Leavitt, 2007).

### *Perceptual sensitivity and maternal affects*

Donovan, Leavitt, Taylor, and Broder (2007) found that maternal sensory sensitivity to positive infant facial expression at 6 months of age predicted the maternal quality of responsive behaviours at 24 months, and sensory sensitivity to both the infants' positive and negative expressions was associated with later maternal affect. These findings indicate that sensory sensitivity influences interactions with other people. In the case of maternal sensory sensitivity, the implications of these findings could be huge, especially when their child is too young to influence or change a given social environment.

Previous studies have suggested that the sensitivity to facial expressions at the sensory level relates significantly to maternal affective behaviours, such as the ways in which caregivers interact with

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their child. Such sensitivity may also be related to maternal attachment style, whereby perceptual sensitivity facilitates or hinders how people interpret the attitudes of others. However, very little is known about whether such sensitivity is a part of a personal disposition or developed during the socialization processes from childhood to adulthood. A better understanding of the origin of maternal sensitivity could contribute to extending current understandings of maternal development and shed light on possibilities in programs for maternal education and intervention.

#### *Perceptual sensitivity in facial expressions and attachment*

Another line of research has investigated the sensitivity to social stimuli such as facial expression as a function of adult attachment. Niedenthal and colleagues (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Niedenthal, Brauer, Robin, & Innes-Ker, 2002; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000). They found that those who hold a representation of insecure attachment relationships tended to process emotional facial expressions differently from those who hold a representation of secure attachment relationships. They categorised the attachment orientations based on Bannan, Clarak, and Shaver (Bannan, Clarak, & Shaver, 1998), and compared these categorical groups in their ability to detect changes in emotional facial expressions. Amongst the four categories: fearful avoidant, preoccupied, dismissive avoidant, and secure, the fearful avoidant individuals identified the offset of changes in both happiness and anger expressions earlier, followed by securely attached individuals and the preoccupied and dismissive individuals identified these changes at later stages.

Following these studies, Dewitte and De Houwer (2008) not only confirmed the differences in processing facial expressions in relation to adult attachment styles but also suggested a possible explanation for finding such differences; people who are high in both anxiety and avoidance showed reduced attention to angry faces and tended to shift their attention away from happy faces. These

findings indicate that personal disposition can predict how people process and respond to social stimuli.

#### *Individual differences in empathy and face processing ability*

Face processing ability such as recognising emotions in facial expressions has been examined in relation to predispositions in empathy. Besel and Yuille (2010) found that accuracy of emotion recognition relates to Empathy Quotient, specifically a social skills factor. Similarly, Bate, Parris, Haslam, and Kay (Bate, Parris, Haslam, & Kay, 2010) examined the accuracy of facial expression recognition between the high and low groups for Empathy Quotient (Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004) and found that people who have higher socio-emotional functioning showed better recognition of newly learned facial expressions. These findings indicate that individual differences in facial processing ability seem to show variances as a function of empathy as well as the attachment styles, as reviewed above.

#### *Developmental changes in facial processing and empathy*

In terms of individual differences in facial processing, age and gender have been shown to have an effect (e.g. Hampson, van Anders, & Mullin, 2006; Thomas, De Bellis, Graham, & LaBar, 2007). These effects could help predict the development of facial processing and empathy. Although the sex difference may indicate categorical differences in these abilities, the age difference in facial processing ability suggest possible variability during intrapersonal development. In addition, a group of people who are on the autistic spectrum was reported to show severe difficulty in facial processing (Dawson, Meltzoff, Panagiotides, McPartland, Webb, 2002), and these people tended to have a low level of empathy (Baron-Cohen & Wheelwright, 2004). The findings from atypical development suggest that empathy is also a relatively stable predisposition from the beginning of life.

However, there have been recent reports suggesting that this predisposition can vary when the levels of hormone such as testosterone are changed

artificially or due to social environment - nurturing experience. Gettler, McDade, Feranil, & Kuzawa (2011) found in a prospective longitudinal study that those who become fathers showed a larger decline of testosterone than those who were non fathers in a 4.5 year follow-up study; this decline was also related to the amount of time that the fathers were involved in childcare. Another study extended the hormonal effect on empathy. Women who received a temporal spray of testosterone had a lower sensitivity to facial expressions than those who had not (van Honk, Schutter, Bos, Kruijt, Lentjes, Baron-Cohen, 2011).

Likewise, the hormonal effect for increasing sensitivity to face processing is also reported in females. Women who were pre-menopausal were more sensitive to judging the cuteness of baby faces than those who were post-menopausal, and a similar trend was found when comparing the groups with and without oral contraceptive pills (Sprengelmeyer et al., 2009). These findings suggest that facial processing ability and corresponding socio-emotional tendency are variable. Given the possibility of developmental changes in facial processing and empathy, it is likely that people, whether men or women who are involved in childcare would become better at judging human faces, especially for babies.

#### *Research questions*

There is an assumption that females who have had childcare experience are better at judging and responding to their child. However, to our knowledge, this assumption was not tested in psychological research. The present study examined sensitivity to facial expressions in relation to childcare experiences as well as to emotional competence. Given recent research findings, it was hypothesized that childcare experiences could make a difference in how individuals process information from facial expressions.

#### **Method**

The present study comprises the measurements of sensitivity to detect changes in facial expressions and two questionnaires: Emotional Quotient

Scale and Emotional Empathy Scale. Sensitivity to the detection of changes in facial expressions was measured by a PC-based experiment. The order of administering the questionnaires and experimental task was counterbalanced. All participants received a Book Voucher or were paid an equivalent amount for their time.

#### *Participants*

Twenty fourth-grade female university students and 18 mothers whose children were between 0 and 3 years of age participated in this study. The mean age for the students was 21.3 years (SD=0.4) and that of the mothers was 26.3 years (SD=1.9). None of the participants had reported any clinical emotional problems.

#### *Experimental stimuli and procedures*

The experiment was set-up to measure sensitivity for the detection of changes in facial expressions. In this experiment, each participant was asked to judge if two images of facial expressions were the same or different. The stimuli used for this experiment was made from facial expressions of a boy and a girl. Happy and sad images of each child were used to create 9 morphed images (Tiddeman, Burt, & Perrett, 2001). The middle variant of the morphed images for each child was used as a standard, which always appeared first for all trials in the tasks. In addition, five variants in either direction of happy or sad images and also the standard image for both children were presented as subsequent judgment stimuli<sup>2</sup> in the happy change detection and the sad change detection blocks, respectively. Each variant was presented twice and the standard was presented four times, comprising 28 trials in the task. The happy or sad versions of the task were administered in a counter-balanced way. For each participant, the sensitivity measure in the change detection task was derived

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2 Prior to the experiment, a pilot study was carried out to compute the proportion of correct responses. The proportion of same correct responses was 0.78 for the girl's image and 0.83 for the boy's image. The proportion of correct responses for the five variants of the boy (happy: 0.05~0.95; sad: 0.14~0.86) and of the girl (happy: 0.19~0.62; sad: 0.14~0.89).

from a total of 56 trials. The size of faces for the boy and girl were set to be approximately the same, which led to the image sizes of 850\*866 pixels and 944\*962 pixels, respectively. The viewing distance was about 50 cm.

A program, Super Lab 4, executed the stimuli presentation, which ran on a MacBook laptop computer with a 13-inch screen. The trial began with a blue screen cue that was presented for 1500 ms, which was followed by presenting the standard image for 2000 ms in a centre. This was followed by the presentation of a test stimulus at a horizontal distance of 200 pixels to the right and left from the centre. The participants responded by pressing one of the designated keys on the response box which was connected to the computer (4000 ms was set as a timeout for the test stimuli). Prior to this test session, there was a practice session of 8 trials, in which each baby-face stimuli was replaced with the shape of a triangle and square.

Subjects' judgments were recorded on to a computer program file. Based on the signal detection theory, subjects' responses for hit and false alarm were computed for sensitivity measures:  $d$ -prime, a measure of standard difference between the means of "hit" and "false alarm" and  $criterion$ , a measure of willingness to respond to "hit".

#### *Emotional Quotient Scale*

A version of the Emotional Quotient Scale: EQS, (Uchiyama, Sihimai, Utsuki, & Otake, 2001) was used as a control measure. This scale assesses a subject's emotional competence in three domains: Intrapersonal domain involves personal competence in emotion understanding, self-motivation, and self-control; Interpersonal domain involves social competence such as empathy and social skills; and the situational domain involves ability to control behaviours according to situations and social environments. The total scores for these domains were used to compare the Emotional Quotient Scale scores between the groups of mothers and female university students.

#### *Emotional Empathy Scale*

A modified version, which was adapted for the Japanese population (Kato & Takagi, 1980), was

used. This scale was developed originally by Mehrabian & Epstein (1972). This modified version comprised of three sub-scales: emotional-warmth, emotional-coolness, and emotional-susceptibility.

## Results

Emotional Quotient Scale scores across three domains are compared between the groups of mothers and female students to examine if one of the groups showed a greater degree of emotional intelligence that might affect their perceptual sensitivity. The means and standard deviations were computed and indicated in Table 1.

Table 1. The means and standard deviations for Emotional Quotient Scale scores

Emotional Intelligence	Group	Mean	S.D.
Intrapersonal	Students (n = 20)	45.6	14.9
	Mothers (n = 18)	44.2	12.7
Interpersonal	Students (n = 20)	54.4	12.2
	Mothers (n = 18)	54.7	11.8
Situational	Students (n = 20)	40.1	16.4
	Mothers (n = 18)	45.1	15.1

Emotional Quotient Scores for each domain were compared between the groups of mothers and female university students (Figure 1). Independent-samples t-tests were performed and the results showed no differences between the groups for all domains of the Emotional Quotient Scores:  $ts > .1$ ,  $ps > .1$ .

Emotional empathy scores for each of the subscales were compared between the groups. The means and standard deviations are given in Table 2.

Independent-samples t-tests were performed for each subscale (Figure 2). There was a significant difference in the subscale of emotional-warmth ( $t = 2.15$ ,  $p < .05$ ) but not in either the subscales of emotional-coolness or emotional-susceptibility ( $t = 1.16$ ,  $1.13$ ,  $ps > .1$ ).

Perceptual sensitivity measures were computed drawing on the signal detection theory. The means

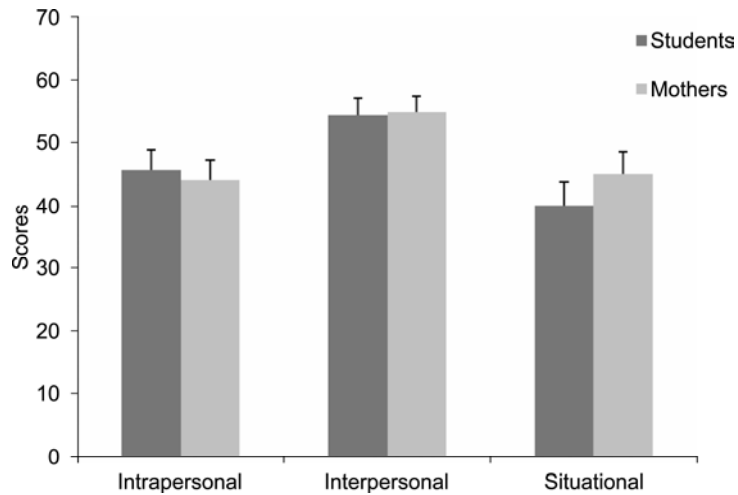


Figure 1. Comparisons between the groups of mothers and female university students across the three domains of the Emotional Quotient Scale. Each error bar indicates a standard error of the mean.

Table 2. The means and standard deviations for Emotional empathy scores

Emotional empathy	Group	Mean	S.D.
Emotional-warmth	Students (n = 20)	38.6	4.5
	Mothers (n = 18)	41.5	3.9
Emotional-coolness	Students (n = 20)	21.4	4.5
	Mothers (n = 18)	19.8	3.8
Emotional-susceptibility	Students (n = 20)	17.5	3.7
	Mothers (n = 18)	16.3	2.2

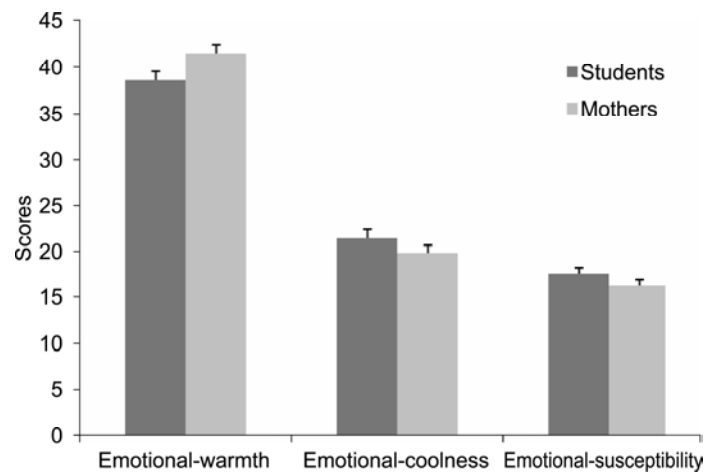


Figure 2. The comparisons between the groups of mothers and female university students for Emotional empathy scores. Each error bar indicates a standard error of the mean.

and standard deviations for each measure are given in Table 3.

Group differences in sensitivity measures, *d*-prime and criterion scores, were examined next (Figure 3). Independent-samples *t*-tests were

performed for *d*-prime and criterion scores, respectively. The results suggest that there was a difference in the *d*-prime score, approaching a significant level:  $t = 1.91, p = .06$ . The mothers were more sensitive to changes in facial expressions than the

Table 3. The means and standard deviations for sensitivity measures.

Sensitivity			
Measures	Group	Mean	S. D.
<i>d</i> -prime			
	Students (n = 20)	0.58	0.69
	Mothers (n = 18)	0.96	0.51
Criterion			
	Students (n = 20)	0.31	0.28
	Mothers (n = 18)	0.77	0.47

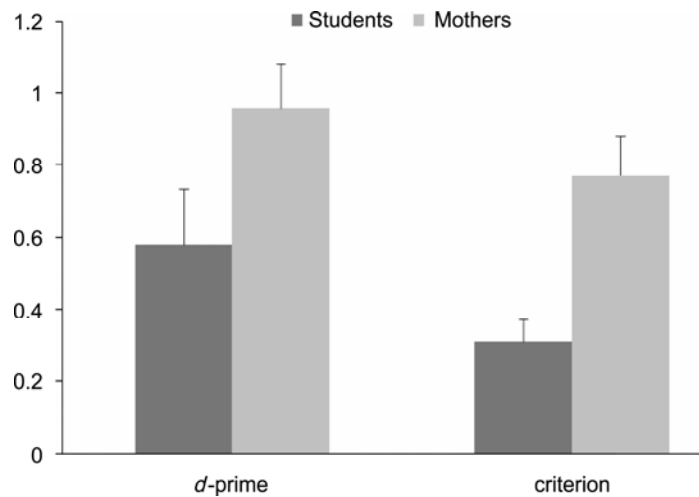


Figure 3. The comparisons between the groups of mothers and female university students for sensitivity measures (*d*-prime and criterion scores). Each error bar indicates a standard error of the mean.

female university students. There was a significant difference in criterion scores:  $t = 3.61$ ,  $p < .001$ . The mothers were significantly more willing to respond to changes in facial expressions than the female university students.

## Discussion

The present study investigated whether childcare experiences make a difference to maternal sensitivity at a sensory level.

As a control measure, the present study used the Emotional Quotient Scale to check if the mothers and female students were similar in terms of social ability in general. The results showed no difference in these groups for social aptitude. Despite no sign of aptitudinal difference, the two groups showed a difference in sensory sensitivity. The mothers were more sensitive to identifying the expression changes in baby faces than the female students. Also mothers were significantly more

willing to respond to changes in baby facial expressions. These findings suggest that having childcare experience increases the ability to process facial information.

Why does childcare experiences make a difference in facial processing ability? One possibility maybe due to the changing hormonal levels as was suggested by Gettler, McDade, Feranil, & Kuzawa (2011). However, the current study did not measure or control hormonal levels of the participants. Therefore this possibility remains. The hormonal changes during the course of childcare experiences may be one of the many reasons for explaining sensitivity increases.

Another possible explanation is that sensitivity to process facial information can be learned during the course of social interaction with their children. This possibility could be substantiated by the current results for the mothers' higher empathy scores compared to the female university

students, despite their Emotional Quotient being similar. Within the Empathy scales, only the emotional-warmth, but not emotional-coolness or emotional-susceptibility was shown to be higher in the mothers than the female university students. Emotionally warm responses shown by caregivers are necessary behaviours when interacting with young children so that they are emotionally full-filled.

That said, to examine the link between childcare experience and perceptual sensitivity further, studies controlling for age of participants and hormone levels are needed. The current study intended to minimize the age gap and recruited young mothers. However, there was a 5-year age gap between these groups and this difference may include compounds that cannot be eliminated by comparing the Emotional Intelligence.

Nevertheless, the current findings are in line with existing studies. The group of people who had higher scores in empathy was better at processing facial information (Besel & Yuille, 2010). The finding that the mothers were better at identifying changes in facial expressions and higher in emotional-warmth in comparison with female students suggests that childcare experience may be one of the factors that explain maternal sensitivity and empathy. Despite the reservations discussed above, the current study extended the previous studies. That is, not only gender and age but also the kind of experiences that the female population has could also make a difference in facial processing abilities.

The present findings could be scrutinized in the following two ways. To clarify the impact of childcare experience, female university students who have had no childcare experience could be compared with those who have had quasi-childcare experience. Although there is an issue as to whether university students who receive training as nursery teachers are experiencing genuine maternal childcare practices, direct comparisons could address the impact of some childcare experiences on perceptual sensitivity.

Another way is to find a link between the perceptual sensitivity in facial processing and attach-

ment styles. The studies suggest that the attachment style predicts facial processing abilities (Dewitte & De Houwer, 2008). Within female populations, in addition to empathy and childcare experiences, attachment style may mediate possible changes in a female's sensitivity to facial expressions. This line of study could provide a more comprehensive explanation for a developmental process of individual differences in maternal sensitivity.

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## 養育経験者の表情変化への敏感性－養育経験のない者との比較より－

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要 旨

本研究は、養育経験の有無によって表情変化への敏感性がどのように異なるか検討した。0歳から3歳までの子育てをしている母親と養育経験のない女子大学生の2つのグループに、乳児の表情変化を認識する課題を実施し、その認識における敏感性を測定した。統制測度として用いたEQは2グループ間に差異が見られなかったが、共感尺度における共感的温かさについては母親グループが有意に高かった。また表情処理課題においては、母親グループは、女子大学生グループに比べ、敏感性が高いことが示された。これらの養育経験による敏感性の違いを、個人差と共感性の発達との関係から考察した。

キーワード：知覚感度、信号検出理論、養育、共感性、こころの知能指数