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Different emergence of fear expressions in infant boys and girls

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Abstract

This study examined the emergence of fear expressions, based on survey reports from a quasi-representative sample of 957 Hungarian mothers. Infant girls showed fear expressions significantly earlier (3.48 weeks) than boys (4.28 weeks). Results indicate a possible gender-related development of facial expressions of fear in human infants.

Keywords: Emotion development; Infant development; Fear; Maternal perception

1. Introduction

Defensive behaviors, including facial expressions of fear, are prewired in the brain, and provide an evolutionary social signaling mechanism for survival in threatening situations. Both human and nonhuman responses to threatening situations change with development (Bronson, 1972), and these changes probably follow the maturation of fear-related circuits in the brain.

A century of research on facial expression of animals and humans has supported the hypothesis that basic emotions are invariant (Darwin, 1872; Ekman & Friesen, 1971,

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Eibl-Eibesfeldt, 1994) and therefore probably inborn (Field, Woodson, Greenberg & Cohen, 1982). Research with monkeys indicates that from earliest development, the occurrence of different defense response patterns such as anger or fear is determined by different neurochemical systems in the brain (Kalin, Shelton & Takahashi, 1991). However, there is little known about the emergence of fear expressions in human neonates.

2. Method

In 1999, 957 Hungarian women 18 years and older, who had given birth 1–20 weeks earlier, were asked to complete an anonymous questionnaire regarding the developmental timing of their infants' facial expressions of emotion. Mothers were asked to state the age of appearance of fear expressions in weeks and to describe the circumstances in which the first fear expression appeared. They were also asked to state the age at which the social smile first appeared.

Trained nurses from all over Hungary volunteered to distribute the questionnaires during their visits to new mothers' homes. Every county of Hungary was represented in this sample. The Ethical Committee of the Albert Szent-Györgyi Medical University, the Debrecen Medical University, and the National Preventive Medicine Office approved the study and provided the volunteering nurses.

2.1. Subjects

Participating mothers were required to have healthy, mature neonates born at 38 weeks gestational age or later. Of the 957 eligible mothers who agreed to participate, 708 responded to the questions concerning appearance of fear expressions (mothers of 389 boys and 319 girls), and 458 of these also described the circumstances of the first observed fear (mothers of 201 girls and 257 boys).

The mean age of the infants ($N = 708$) at the time of data collection did not differ between genders (boys: Mean age:11.77 weeks, (3.88), girls 11.49 weeks (3.93), $t = 1.11$, n.s.).

3. Results

Data were analyzed using the SPSS 10.0. statistical program. An alpha level of 0.05 was accepted throughout. Nonpaired *t* tests showed that there was a significant effect of gender on the first appearance of fear, as perceived by mothers in the larger sample, ($N = 708$). Girls showed fear expressions about 6 days earlier than boys (Girls: $m = 3.48$ weeks (SD 4.02), Boys: $m = 4.28$ weeks (SD 4.22), $t = 2.57$, $p = 0.01$). A smaller difference, which did not reach significance, was recorded for the appearance of the social smile (girls $m = 4.31$ weeks (SD 2.58), boys $m = 4.48$ weeks (SD 2.50), $t = 1.04$, n.s.). Of the 458 mothers who answered the question about the circumstances of the first fear expression, 114 reported the first fear occurred during a bath situation; 227 reported it was related to a loud noise or sudden movement; and 117 reported it was related to novelty or to social stimuli, such the approach

of a stranger. As a comparison, the age of the first appearance of fear expressions was also examined in this smaller sample ($N = 458$). Again, boys showed fear significantly later than girls (boys: $m = 5.69$ weeks (SD 4.07), girls: $m = 4.83$ weeks (SD 3.93), $t = 2.24$, $p = .026$).

We examined the circumstances of the first fear expression by age of first appearance for the boys and girls compared in this sample. On average, fear related to the bath appeared the earliest ($m = 2.70$ weeks (SD 2.36)), fear related to noise came next ($m = 5.84$ weeks (SD 3.78)), and fear related to novelty and social stimuli appeared latest ($m = 6.87$ weeks (SD 4.57). Mean ages of first appearance were significantly different for the bath and noise ($t = -7.96$, $p < .001$); bath and social fears ($t = -8.55$, $p < .001$); and also for noise and social fears ($t = -2.19$, $p = .029$). When boys and girls were examined separately, the same ordering of fear types was found, but age differences did not reach significance.

4. Discussion

If the facial expression of fear is a behavioral response to threatening situations, one might expect that it would show development as the infant matures cognitively. Hiatt, Campos and Emde (1979) when eliciting happiness, surprise and fear, found that infants did not consistently show fear facial expressions to fear-eliciting stimuli, even at 10–12 months of age, although they showed happiness and recognizable surprise with appropriate stimuli. This result might be interpreted to indicate a delayed development of fear in human infants, relative to other emotions. Caldji, Tannenbaum, Sharma, Francis, Plotsky & Meaney (1998) demonstrated that in rats, fearful behavioral responses to stress in the offspring are 'programmed' by maternal care. This means that behavioral fear responses –including facial expressions of fear–are not closed genetic programs for response to the eliciting stimuli but reactions that undergo development in consequence of interaction with the social environment in a species specific way.

Recent research on brain development offers reasons why development of fear-related neural circuits might be modulated by social experience. Defensive behaviors are accompanied by elevated glucocorticoid levels in the brain. The emergence of freezing behavior in rats is accompanied by a rapid increase in plasma glucocorticoids (Takahashi, 1996). However, glucocorticoids potentiate hippocampal damage induced by various noxious stimuli (Hortnagl, Berger, Havalec & Hornykiewicz, 1993). The developing brain in an early sensitive period is especially vulnerable to the potentially damaging effects of glucocorticoids (Takahashi, 1998).

Both infant rhesus monkeys (Kalin et al., 1991) and rats (Takahashi, 1996) are known to show age-related development of defensive behaviors. In the rat (Takahashi, 1996) freezing appears only at the end of the second postnatal week. Similarly, our results with infants indicate that the facial expression of fear is probably not elicited in a recognizable form right after birth, and that it develops around the end of the first month. The timing of emergence of certain fear-related behaviors in several species may be delayed according to the length of a critical period of postnatal brain maturation in that species, during which physiological changes that accompany defensive behaviors have the potential to damage the developing brain.

There is not accepted neurobehavioral taxonomy of different types of fears; however, based on the mothers' descriptions, different categories of stimuli can elicit fear at different times in development. Fear expressions related to the bath were reported to be earliest, followed significantly later by those related to sudden stimuli such as noise or vestibular stimulation. Fear expressions as a reaction to social and nonsocial novel stimuli appear still later in the age range we examined. It may be that not only the timing, but facial characteristics of these expressions are different, and that they form part of a complex, continuously developing repertoire of expressions for fear-defensive behaviors.

Fear expressions developed significantly later in boys than girls. Sex-related differences in emotion recognition have been shown in numerous studies, with female subjects tending to outperform male subjects at a given age, especially in emotion recognition from facial expressions (Hall, 1978; McClure, 2000). Taylor (1969) and Richardson (1975) proposed that cerebral maturation is more rapid in girls. Delayed emergence of fear behaviors may be protective of the developing brain, especially in male infants, who remain longer in a sensitive, critical stage of brain development. Geschwind and Galaburda (1985) suggested that differential maturity in male and female brains entails differential vulnerability and that it is a consequence of the higher testosterone levels to which male brains are exposed during their pre- and early postnatal development. Bachevalier, Hagger and Bercu (1987) have associated slower maturation of temporal cortex with high levels of androgens found in male monkeys before birth and during the first 6 months of life. Bachevalier, Brickson, Hagger and Mishkin (1989) suggested that high levels of circulating testosterone may slow the maturation of males' temporal cortex, but the mechanism of such an effect is still unclear. If the apparently delayed appearance of facial expressions of fear in male infants represents delayed development of defensive behaviors, it will not only support the theory of gender-dependent cerebral immaturity, but it may also provide a means of linking these phenomena in a coherent way.

A potential source of bias in this study is the possible tendency for mothers to have different expectations for male and female infants. For this reason we included the question about the first social smile. We reasoned that if mothers reported the same gender-related difference in both emotional expressions, it might reflect not only sex-related differences in facial expression development, but also a general, gender-related bias in mothers' reports. Previous studies have found that newborns are preferentially labeled as boys by adults (Hildebrandt & Fitzgerald, 1979; Nagy, Nemeth & Molnar, 2000), but that this male-bias disappears if the newborns are smiling (Nagy et al., 2000). Based on this result, we predicted that if girls were reported to show both smile and fear expressions earlier than boys, it could reflect a tendency by mothers to expect greater emotional expressiveness by girls than boys. However, our results showed that while the appearance of the fear expression was significantly gender-dependent in mothers' reports, the appearance of the social smile was not. This suggests that a gender-related bias in maternal perceptions is not responsible for the results, and that the reported age at the first appearance of facial expression of fear is dependent on intrinsic processes linked to the infants' sex.

The conclusions that can be drawn from this study are limited by our epidemiologic approach to investigating emotional expression development. The judgments of mothers concerning the timing of the appearance of emotional expressions could be rendered unre-

liable or invalid due to differences in maternal memory, observational skill or criteria for judging fear. However, the consistency found in the mothers' reporting of circumstances in which the first fear expression occurred suggests that mothers may have been making judgments in similar ways. Although the reliability of maternal reports is not comparable to that of individual and controlled observations, this study nonetheless provided the opportunity to examine this phenomenon in very large sample, which has not been done before. Further controlled studies will be needed to classify and to describe the sex-related timing of the development of fear behavior development in human infants.

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