



## Emotional expression and heart rate in high-risk infants during the face-to-face/still-face

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### ARTICLE INFO

#### Article history:

Received 2 May 2012

Received in revised form 19 October 2012

Accepted 26 November 2012

Available online 2 October 2013

#### Keywords:

Facial expression

Affect

Heart rate

Prenatal cocaine exposure

Still-face

Facial Action Coding System

### ABSTRACT

In infants, eye constriction—the Duchenne marker—and mouth opening appear to index the intensity of both positive and negative facial expressions. We combined eye constriction and mouth opening that co-occurred with smiles and cry-faces (respectively, the prototypic expressions of infant joy and distress) to measure emotional expression intensity. Expression intensity and heart rate were measured throughout the face-to-face/still-face (FFSF) in a sample of infants with prenatal cocaine exposure who were at risk for developmental difficulties. Smiles declined and cry-faces increased in the still-face episode, but the distribution of eye constriction and mouth opening in smiles and cry-faces did not differ across episodes of the FFSF. As time elapsed in the still face episode potential indices of intensity increased, cry-faces were more likely to be accompanied by eye constriction and mouth opening. During cry-faces there were also moderately stable individual differences in the quantity of eye constriction and mouth opening. Infant heart rate was higher during cry-faces and lower during smiles, but did not vary with intensity of expression or by episode. In sum, infants express more intense negative affect as the still-face progresses, but do not show clear differences in expressive intensity between episodes of the FFSF.

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### 1. Introduction

Smiles and cry-faces are the prototypic expressions of positive and negative affect in infants. However, both smiles and cry-faces occur at a range of intensities, which may offer a window into emotion regulation processes in at-risk infants. Indices of the intensity of both positive and negative affect in infants include eye constriction (produced by cheek raising) and mouth opening (Dinehart et al., 2005; Messinger, 2002; Messinger, Mahoor, Chow, & Cohn, 2009; Messinger, Mattson, Mahoor, & Cohn, 2012). These hypothesized indices are salient, readily observable, and associated with expressions of both positive and negative affect. In the current study, we examined how these putative intensity indices occurred with smiles and cry-faces during an age-appropriate stressor, the face-to-face/still-face (FFSF) paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1978). We also investigated whether heart rate varied with the intensity of smiles and cry-faces. Finally, we compared smile and cry-face intensity of infants with and without prenatal cocaine exposure, a risk factor for regulatory difficulties (Schuetz & Eiden, 2006; Schuetz, Eiden, & Edwards, 2009).

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### 1.1. Smile and cry-face intensity

Infant smiles are an index of positive affect and a social signal of readiness to begin or continue a pleasurable activity (Fogel, Nelson-Goens, Hsu, & Shapiro, 2000). Smiles with eye constriction, often referred to as Duchenne smiles (Darwin, 1877; Duchenne, 1990/1862), are exhibited in adults when they report happiness (Frank, Ekman, & Friesen, 1993). When infants experience events thought to elicit joy (e.g., the approach of a familiar caregiver), they also tend to exhibit smiles with eye constriction as well as left hemisphere activation, previously associated with positive affect in adults (Fox & Davidson, 1988). Open-mouthed smiles tend to predominate when infants are engaged in playful behavior, such as social games (Dedo, 1991). In infants, both eye constriction and mouth opening index stronger positive affect during smiles, and frequently co-occur (Messinger, Fogel, & Dickson, 1999; Messinger et al., 2012), suggesting they may both be indices of positive affect.

Infant cry-face expressions communicate distress to caregivers (Camras & Shutter, 2010; Oster, Hegley, & Nagel, 1992). While adults exhibit differentiated expressions of negative affect (e.g., anger and sadness), infants tend to express negative affect as undifferentiated distress (Camras & Shutter, 2010; Oster, 2003, 2009; Oster et al., 1992). Infant cry-faces, by definition, contain a degree of eye constriction (Izard, 1983; Oster, 2009). Oster (2009) suggested that the intensity of cry-faces vary with the degree of horizontal stretching of the lip corners and the degree of mouth opening involved.

Non-experts rate both smiles and cry-faces involving eye constriction and/or mouth opening as more affectively intense than expressions without these features (Dinehart et al., 2005; Messinger et al., 2012; Messinger et al., 2009). These findings suggest that infants' eye constriction and mouth opening both potentially index the intensity of cry-faces as well as smiles. The current study documents the distribution of these facial expression intensifiers in both smiles and cry-faces during the FFSF.

### 1.2. Facial expression intensifiers and the FFSF

The current study investigated eye constriction and mouth opening that occurred during both smiles and cry-faces in the FFSF. Within this protocol, the mother engages in play with her infant, the mother stops playing, and then the mother reengages in play. There is a well-documented decline in smile expressions from the face-to-face episode to the still-face episode. There is a parallel increase in infant cry-face expressions from the face-to-face episode to the still-face episode. There is also a moderate increase in smile expressions from the still-face episode to the reunion episode (Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009). Segal et al. (1995) found that both big smiles (strong smiling with mouth opening) and other smiles declined in the still-face episode of the FFSF. However, only big smiles increased between the still-face and reunion episodes. Based on this pattern of smiles and cry-faces in the FFSF, we expected a similar pattern of change in the occurrence of facial expression intensifiers. That is, we expected a greater number of facial expression intensifiers to occur during smiles in the face-to-face compared to smiles in the still-face and reunion episodes. We also expected a greater number of facial expression intensifiers to occur during cry-faces in the still-face compared to the face-to-face and reunion episodes.

In addition to differences at the mean level across episodes, there may be changes in the intensity of expressions within the still-face episode. Recent reports indicate that levels of smiling decline as time elapses over the course of the still-face (Ekas, Haltigan, & Messinger, 2012; Goldstein, Schwade, & Bornstein, 2009). These findings led us to anticipate a similar decline in the number of facial intensifiers during smiles in the still-face episode as infant smiling bids prove ineffective. A hypothesized increase in negative affect also led us to expect an increase in the number of facial intensifiers during cry-faces over the course of the still-face episode.

### 1.3. Cocaine-exposure and facial expression

There is some evidence that prenatal cocaine exposure is associated with a bias toward negative expressions of affect. Bendersky and Lewis (1998) found that a lower proportion of four-month-old infants with high levels of cocaine exposure displayed at least one smile during face-to-face interaction than nonexposed infants. A higher proportion of infants with high levels of cocaine exposure exhibited negative expressions during interaction after a period of no maternal response than did nonexposed infants. A previous report from the multi-site Maternal Lifestyle Study, found that heavily cocaine-exposed infants showed more passive and withdrawn engagement than nonexposed infants (Tronick et al., 2005). The modulated use of emotional expression is particularly important for at-risk infants, as inappropriate levels of intensity on the part of the infant may be readily misinterpreted by the caregiver (as in Eiden, Schuetze, & Coles, 2011). This is particularly important as mothers who used cocaine prenatally had lower sensitivity at 13 months. Given previous evidence of maternal sensitivity difficulties, appropriate levels of infant expression intensity may be particularly important in this population.

However, as argued by Lester (2006), and true of most cocaine studies, putative attribution of a group of infants as cocaine exposed should also be seen as an index of other kinds of exposures that typify such groups (e.g., alcohol, opiates, and other abused drugs). The current study examined whether infants with prenatal cocaine exposure showed less intense smiles and more intense cry-faces or a different profile of heart rate during these expressions, all potential indicators of deficits in emotion regulation.

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