emotion review

Emotion Review
Vol. 7, No. 2 (April 2015) 116–120

ISSN 1754-0739
DOI: 10.1177/1754073914554786
er.sagepub.com

About Face! Infant Facial Expression of Emotion

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Abstract

In honoring Carroll Izard's contributions to emotion research, we discuss infant facial activity and emotion expression. We consider the debated issue of whether infants are biologically prepared to express specific emotions. We offer a perspective that potentially integrates differing viewpoints on infant facial expression of emotion. Specifically, we suggest that evolution has prepared infants with innate action readiness patterns, which are crucial for early infant–caregiver social interaction, and in the course of social interaction specific facial configurations acquire functional significance, becoming associated with specific emotions. Research has not confirmed the presence of innate neurophysiological action patterns that map onto discrete emotions but evidence indicates that the possibility has not been ruled out.

Keywords
emotion expression, facial, infant

Carroll Izard's dissertation (1953) is the basis for his published finding that adults with paranoid schizophrenia reacted negatively and inconsistently to human faces (Izard, 1959). This finding is cited in contemporary studies of the neural underpinnings of schizophrenic emotional disturbances (e.g., Carter & Neufeld, 2007; Paradiso et al., 2003). Thus began Carroll Izard's lifelong interest in emotion and the face.

Influenced by emotion theorist, Silvan Tomkins (1962, 1963), Cal formulated differential emotions theory (DET; 1971). It postulates that infants are genetically endowed to express distress, interest, and enjoyment in their faces (Izard, 1971). Recognizing the dearth of evidence, Cal launched a research program on infant perception and production of facial expressions of emotion. This position contributed to debate regarding whether the face *expresses* emotion and whether this capacity is innate or an acquired cognitive schema (e.g., Russell, 2003). Committed to revising ideas based on evidence and argument, Cal reformulated his position, stating that "evolutionarily adapted neurobiological systems enable infants to experience and express … discrete emotions only as they become adaptive through growth of emotion–cognition–action connections" (Izard, Woodburn, & Finlon, 2010, p. 134).

In honor of Cal's significant contributions to emotion theory and infant development, we grappled with what is known and not known about infant emotion expression. This inspired us to posit that infants are biologically endowed with readiness for specific neuromuscular patterns, including in the face, which enable them to communicate changes in goals for well-being (Barrett & Campos, 1987). From the functional perspective this is critical to the relational process that defines emotion. When a particular readiness is potentiated as facial activity, infants signal changes in their goal states that others readily and consistently interpret. As with speech sounds, facial patterns are constrained by evolution and become specific emotion expressions as they become functionally linked with emotions through social interaction within varying cultural-relational contexts. We introduce the concept of facial babbling to reconcile DET with functional and dynamic systems views of emotion development (Camras, 2011).

Action Readiness as an Innate Capacity for Discrete Emotions

Evidence is consistent with the DET perspective that infants are biologically prepared to produce facial configurations that are interpretable as specific types of action readiness. First, there is evidence of specific forms of facial activity (a) in infant responses to standard emotion-relevant situations (Izard et al., 1995; Lewis, Ramsay, & Sullivan, 2006), and (b) in individuals from different cultural contexts (e.g., Ekman, Sorenson, & Friesen, 1969). Second, newborns' facial musculature is fully

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developed and capable of actions that are morphologically identical to adult expressions (Goldfield, 1995) and caregivers interpret these facial actions to guide appropriate care, which fosters the development of attachment relationships (Sroufe, 1996). Third, facial actions in fetuses during the third trimester (Hata et al., 2013; Reissland, Francis, & Mason, 2013; Yan et al., 2006) and nonhuman primates (de Waal, 2003) are homologous to discrete emotional expressions in children and adults. Fourth, congenitally blind people involuntarily produce facial configurations that are recognized as discrete emotion expressions (Cole, Jenkins, & Shott, 1989; Rinn, 1991). These disparate findings support the tenet that humans have biologically endowed neurophysiological readiness to communicate changes in goal states and infants are prepared to do so when they are born.

Common critiques of DET are that young infants often engage in facial activity that is ambiguous, unrelated to context, or rapidly changing, and that variations of prototypical expressions occur that could indicate the same emotional response (Camras, 2011). Dynamic systems perspectives (DS; Lewis & Granic, 2002) on emotion explain these observations in terms of coordinative motor structures; one motor component can engage another motor component without reflecting a change in goal state (e.g., opened mouth engages eye opening). However, DS models may not consider important ways that facial movements differ from other movements (e.g., arms move independently in space, faces do not). Faces are innervated by both cortical pathways that activate voluntary movement, and subcortical pathways associated with emotion that activate involuntary movement (Rinn, 1991). Involuntary motor behaviors typically involve fixed-action patterns or discrete configurations (Rinn, 1991). In adults, these can be generated involuntarily by emotion induction, even in individuals with damage to voluntary pathways, who cannot deliberately produce facial expressions (Rinn, 1991). Thus, it is unclear whether the DS concept of coordinative motor structures, originally based on biomechanical systems such as walking and reaching, applies to subcortically activated facial movements associated with an emergent, relational process like emotion.

We suggest that seemingly random or ambiguous infant facial activity is a form of "facial babbling." Just as infants can express all speech sounds without evident intention to communicate (Kuhl, 2007), they may engage in facial activity that is consistent with emotion expression (potentiated action readiness) without changes in appraisal (hence unemotional). Frequent, repetitive, and apparently nonfunctional motor movements are characteristic of newborns and young infants (Piaget, 1955; van der Meer, van der Weel, & Lee, 1995) and are precursors to later functional movements.

Facial babbling may be activated in various ways—by cortical pathways that result in seemingly random activity or by subcortical pathways that result in fixed-action facial configurations that may or may not be related to infant goal states or action readiness. As with vocal babbling, caregiver feedback may help to shape functional relations between babbling and infant communication of goal states (Barrett & Campos, 1987). Robotics research offers an analog (e.g., Saegusa, Metta, Sandini, & Sakka, 2009) that is consistent with a DS view. Programmed "motor-babbling" enables robots to learn prototypical human sensory-motor movements under myriad variations in environmental conditions and to create an internal map of "self" in relation to the environment. Facial babbling may function similarly, catalyzing infants' ability to develop such internal maps, through experience with others' facial activity. Interpersonal exchanges provide information about the significance of situations (Barrett & Campos, 1987). Thus, facial babbling, caregiver feedback, and decoding variability in others' facial activity may contribute to emotional development, linking facial expression with goal states.

Facial babbling could account for ambiguous or undifferentiated facial configurations when reconsidered in terms of temporal dynamics and efficient action readiness (Jack, Garrod, & Schyns, 2014). Moreover, infants, like adults, are capable of blends of emotion expressions in situations designed to evoke emotion (Izard, Huebner, Risser, & Dougherty, 1980), Facial activity can unfold iteratively. Initial activity may involve elements of different discrete emotions, involving both approach and avoidance readiness. The eyes and mouth open in fear and surprise, indicating appraisal of unexpected, potentially threatening change. As appraising continues, other facial activity may be potentiated, differentiating initially ambiguous expressions. Infant blends may be best understood in terms of temporal dynamics than static undifferentiated expressions. Functionally, initial facial configurations need not be discrete; for infants they need only effectively draw caregivers' attention. Once achieved, further differentiation in rapid succession or simultaneously may indicate multiple and specific infant needs.

Appraisal and the Social Construction of Functional Relation Between Faces and Emotion

Although infant facial activity does not always provide information about infant goal states, biological preparedness to enact specific types of facial activity is crucial to infants' survival. Young infants' facial activity can be variable, fleeting, hard to interpret, and only sometimes clearly indicative of goal states (Messinger, Fogel, & Dickson, 1997; Michel, Camras, & Sullivan, 1992). Yet being able to communicate to, engage with, and learn from caregivers ensures infants' survival and allows infants to be acculturated into the developmental niche. Biological preparedness for specific facial configurations aids communicative, socializing transactions between caregivers and children that create functional links between expressions and emotional significance. Each partner actively appraises and categorizes sensory information into percepts. Readiness for specific action patterns, including in the face, facilitates the communicative process.

Let us imagine a caregiver approaches a 2-month-old infant who just woke up. The caregiver sees the infant gazing at the crib wall and gently lifts and moves the baby's leg, inviting the infant's attention. If the leg motion happens to involve a movement that is regularly associated with other infant states, the nonemotional leg motion may stimulate associated facial activity. Let us say that the infant displays some combination of grimace and smile (Messinger et al., 1997). The caregiver has an expectation, is delighted for this psychological reunion with her baby, interprets the facial activity as a social smile, and smiles back. The infant's smile broadens.

Infants' facial and bodily movements and caregivers' recognition of these as signals of infant goal states likely coevolved to ensure infants' and caregivers' survival (Hrdy, 1999). Caregivers strive to interpret infant behavior and apply meaning to it, earnestly trying to understand their infants' condition, to repair distress, and to maintain calmness or happiness. Moreover, these communicative exchanges, whether shared enjoyment or empathic repair of infant distress, contribute to the dyad's mutual investment, supporting the development of attachment (Izard, Haynes, Chisholm, & Baak, 1991). In our example, the caregiver was inclined to interpret the infant's facial activity as a smile and thus responded with a smile and soft, pleasant vocalizations. The infant's facial activity may not have been random or intentional but a result of the stimulating neural pathways that trigger wider neuromuscular activity. Regardless, the caregiver construed it as an *expression* of happiness and responded accordingly. In so doing, caregivers organize infants' experience, providing sensory feedback very young infants can perceive (Barrett & Campos, 1987; Lavelli & Fogel, 2013; Tronick & Beeghly, 2011). These exchanges are building blocks of creating functional significance.

Infant knowledge at this tender age is not verbal or conceptual, but sensory-motor (Sroufe, 1996). The availability of biological preparedness for discrete action tendencies helps caregivers and infants find a common basis of communicating meaning within their developing relationship and the larger social-cultural context (Termine & Izard, 1988). Eventually, these meanings are conceptualized and verbalized in emotion words, display rules, and socioemotional concepts. Readiness to enact discrete emotion-related actions may include readiness to perceive discrete emotion categories. Before having differentiated emotion concepts, infants may be able to encode and respond to differences in emotion information that is provided in social exchanges.

Once infants have sufficient visual acuity, they can rely on the nervous system's design for categorizing sensory information into percepts, as shown by categorical perception of speech sounds at 1 month (Kuhl, 2007), colors by 4 months (Franklin & Davies, 2004), and facial expressions of emotion by 7 months (Kotsoni, de Haan, & Johnson, 2001; Leppanen, Richmond, Vogel-Farley, Moulson, & Nelson, 2009). Experience with faces contributes to infants' ability to process more and more facial information (Acerra, Burnod, & de Schonen, 2002; Oakes & Ellis, 2013). Thus, maturational processes must unfold before infants reach the transition around 2 to 3 months when sensory information can be organized into percepts that allow coordinated emotional interactions (Emde, Gaensbauer, & Harmon, 1976; Henning, Striano, & Lieven, 2005; Lavelli & Fogel, 2013; Rochat & Striano, 1999). Further development of neural networks permits infants to scan more of the face, which is needed to differentiate facial information into categories such as sad, angry, or disgusted (Oakes & Ellis, 2013). The maturation of these neural connections in concert with accumulating experience may explain the capacity of 7-month-olds to discern discrete emotional expression in faces. Their sensory-motor schemas may be based on specific biologically endowed action readiness patterns although by appearance they may seem undifferentiated. However, it remains to be determined whether emotionally specific action readiness patterns underlie infant emotional development. If caregivers routinely communicate facial configurations that were *not* associated with discrete emotions, would infants readily produce and extract meaning from such idiosyncratic "expressions?"

In emphasizing faces, we must remember that young infants produce and perceive other information that helps to appraise and categorize experience, including prosody, touch, smell, kinesthesis, and verbalizations (Henning et al., 2005). Moreover, sensation and perception are to some degree linked to action readiness. Aided by somatosensory mirror neurons, infants not only perceive changes in caregivers' faces but try to imitate them (Meltzoff, Williamson, & Marshall, 2013). In this way, even very young infants may be innately prepared to participate in the active cocreation of functional relations between experience and emotion.

Although *en face* mutually positive exchanges are now understood to be less common than once thought among Western mothers and to be culturally variable (Tronick & Beeghly, 2011), all young infants have a propensity to be first interested in and then smile at faces. What varies by culture is whether *en face* smiling exchanges are highly desirable. In many agrarian cultures, infants are swaddled on backs of caregivers, reducing face-to-face interaction. When agrarian Nso mothers from Cameroon viewed video of German mothers' *en face* interactions with their infants, they offered to help German mothers who appeared to work too hard to care for their infants (Keller, Völker, & Yovsi, 2005). Gusii mothers avert gaze when their infants smile (Tronick & Beeghly, 2011), perhaps due to a high rate of infant mortality that may influence caregiver bonding with infants (Kermoian & Leiderman, 1986). Just as infants cease vocalizing sounds that do not occur in their language environments (Kuhl, 2007), they may also cease facial activity that is not reinforced. In sum, evidence of cultural differences in how caregivers respond to infant facial activity does not preclude the capacity of young infants to engage in facial activity that is consistent with discrete emotions (Gratier, 2003; Keller, Otto, Lamm, Yovsi, & Kärtner, 2008; Richman, Miller, & LeVine, 1992).

The functional perspective challenges the view that discrete emotions reside within infants (Barrett & Campos, 1987). It focuses on biological dispositions and social exchanges that allow two individuals (e.g., caregiver and infant) to communicate and create shared meanings about goals for well-being (Barrett & Campos, 1987), which is also consistent with DET (Izard, 2011). A universal, innate readiness for certain neuromuscular patterns affords and constrains interpretations by caregivers, even when infant facial activity is variable, fleeting, partial rather than prototypical, or seemingly unrelated to the situation. These patterns are perhaps not as fixed as DET once asserted; they are flexible, open systems that nonetheless do not yield infinite variations (Beebe et al., 2010; Fogel, 2006). In this open system, emotions do not reside within infants (or anyone) but are relational processes that include how individuals communicate and share meanings (Barrett & Campos, 1987).

Nearly 50 years have passed since Cal Izard's (1971) initial work on emotion and the face. DET spawned fascinating research and Cal, ever the gentleman and scholar, continually revised his thinking (Izard, 2007, 2011). Yet many of DET's core tenets have survived the test of time and the weight of evidence that new tools (e.g., fMRI) and new paradigms (e.g., dynamic systems) have contributed. As we have discussed, the evidence continues to suggest (or at least not disprove) that infants enter the social world with innate neurobiological preparedness to communicate and create meaning with others, but with "some assembly required" (Thompson, 2011, p. 275). This conclusion may reconcile key elements of differential emotion theory, dynamical systems theories, and the functional perspective on emotional development, echoing Panksepp's (2007) assertion that seemingly competing models can coexist and advance emotion research.

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