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## Smiling

**D Messinger**, University of Miami, Coral Gables, FL, USA

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### Glossary

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**Anticipatory smile** – A pattern in which a young child smiles at an object and then gazes at another person while continuing to smile, sharing positive emotion about the object.

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**Duchenne smile** – Smile involving eye constriction (caused by orbicularis oculi, the Duchenne marker) involved in the communication of intensely positive emotion. Cheek-raise smile.

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**Joy** – An emotional process characterized by pleasurable feelings of engagement, a desire for the engagement to continue, and action tendencies, such as smiling, that tend to continue the engagement.

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**Open-mouth smile** – A smile involving a dropped jaw typically occurring during arousing play. Play smile.

g0025

**Secure attachment** – A categorization of infants and toddlers who are able to explore the environment, confident in their caregivers' emotional and physical availability should the need arise.

g0030

**Simple smile** – A typically weak smile that involves neither the Duchenne marker nor mouth opening.

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**Smile** – The sideways raising of the lip corners caused by contraction of the zygomatic major.

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**Strong smile** – Smile involving stronger contraction of the zygomatic major.

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### Introduction

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Early smiles are a prototypical expression of joy and a window on the development of positive emotion. Smiles elicit positive emotion and engagement in others, a process that contributes to the development of joy and social competence in the young child. Infants express different intensities and qualities of positive emotion through alterations in the temporal and facial dynamics of their smiling and through the incorporation of other expressive actions such as laughter and jumping up and down. Through the first two years of life, infant smiles and laughter become increasingly social and affectively intense, and increasingly used in referential communications about objects; between 2 and 4 years, smiles reflect the social structure of peer interactions. Difficulties

with smiling in early interactions reflect a variety of risk conditions, while emotionally positive and responsive interactions can index optimal developmental trajectories.

### Historical Interest in the Study of Smiling

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Early smiling is the quintessential physical expression of positive emotional engagement. Infant smiles appear to be direct behavioral expressions of joyful feelings (see **Figure 1**). This apparent link between behavior and meaning has motivated over a century of research on the emotional significance, causes, behavioral correlates, and developmental consequences of early smiling. Seminal figures in child development have concerned themselves with the meaning and causes of infant smiles. Freud regarded infant smiling as a signal of sensory pleasure and contentment, while Piaget considered the smile of mastery an index of pleasurable accomplishment. In his work on the expression of emotion, Darwin observed his own infants to determine whether their first smiles were expressions of joy.

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This article begins with a review of contemporary theoretical perspectives on the emotional significance of smiling. It continues with an overview of the neurophysiology of smiling and common methods for measuring smiling in infants, toddlers, and preschoolers. The article continues with a discussion of smiling as a joyful process involving arousal regulation, a discussion which includes definitions of different types of smiling. A central section concerns the development of smiling from the neonatal to the preschool period. The penultimate section considers how smiling reveals deficits and competencies in infants with various disabilities. The final section documents the developmental continuity of smiling and its links with emerging social competencies.

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### Theoretical Perspectives on Early Smiling

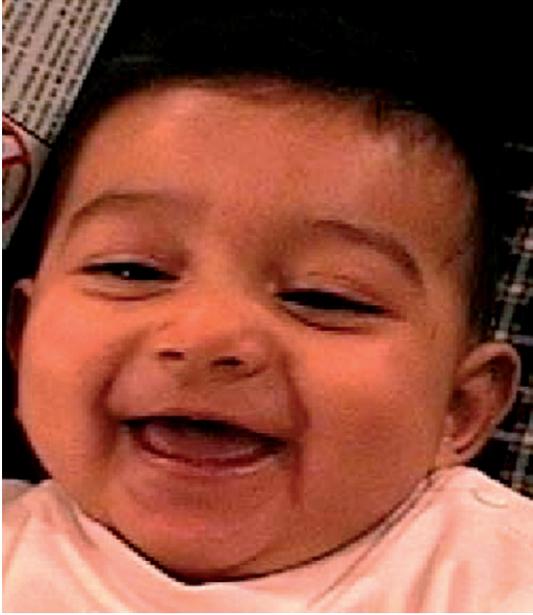
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#### Behaviorist Approaches

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Social learning and behaviorist approaches suggest that the caregiver's contingent responsivity to the infant's actions produces increases in smiling. Smiling can, in fact, be reinforced. If an examiner contingently responds to an infant's smiling with standardized periods of smiling, talking, and tickling, the infant will initially smile at an increased rate. Infants, however, soon habituate to these

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**Figure 1** This 6-month-old infant's strong smile involves the Duchenne marker (eye constriction) and mouth opening.

reinforcers and smiling then declines precipitously. Behaviorism is one of the only theoretical approaches to divorce smiling from emotion. Behaviorist approaches to understanding smiling have been largely abandoned in favor of approaches that focus on the dynamic relationship of smiling to the infant's emotional engagement with the changing environment.

### Cognitive Differentiation Theory

Cognitive differentiation theory maintains that joy is located in the meaning of the environment to the infant and young child. Infants' active cognitive understanding of events, and maybe even early awareness of their own pleasure, is thought to be necessary for the emergence of joy. Cognitive differentiation theory holds that joy and other emotions develop out of more diffuse states such as pleasurable positive valence. Early smiling, such as that triggered when recognition of a visual stimulus elicits a relaxation in tension, is held to index pleasure but not joy. Joy is thought to develop around 9 months of age and involve pronounced drops in cognitively mediated arousal and to be accompanied by particularly intense infant smiling and laughing.

### Discrete Emotion Theory

In contrast to a cognitive differentiation perspective, discrete emotion theory proposes that infant joy is expressed in the infant's first waking smiles. Discrete emotion theory emphasizes the role of brain-based affect

programs such as joy in organizing the output of multiple expressive systems in the infant. Smiles and other infant facial expressions are thought to directly express emotions produced by these discrete affect programs. By this account, smiles index an irreducible joyful feeling state throughout infancy, early childhood, and, indeed, the entire lifespan. Like other approaches, discrete emotion theory suggests that joy motivates infants to approach and interact in an affiliative fashion with caregivers and other social partners.

### Functionalist Theory

While discrete theories locate joy within the infant, functionalist and dynamic theories locate joy in the relationship of the young child and his or her often social environment. Functionalist theoretical perspectives emphasize the adaptive role of emotions such as joy in the creation and maintenance of relationships with the environment, especially the infant's social partners. The infant's smiles and the infant's comprehension of the smiles of others are seen as part of the process of pursuing and attaining goals in the social world.

The functionalist emphasis on pursuing goals in relationships is not limited to human beings. Extensive ethological research, guided by a functionalist perspective, has painstakingly documented the communicative functions of smiles and similar expressions in young monkeys and chimpanzees. Attachment theory also borrows from functionalist theory to describe the function of smiles from an evolutionary perspective. From the ethological and functionalist perspective represented by attachment theory, early smiles are attachment behaviors that maintain the proximity of caregivers to the infant.

### Dynamic Systems Theory

Dynamic systems theory conceptualizes smiles and other expressive configurations as constituents of infant emotional processes. The process of smiling is part of the infant's experience of joy as well as an element in the infant's emotional communication with others. Dynamic systems theory focuses on the bottom-up interrelationship between smiles and other constituents of social interactions. The theoretical approach focuses on the temporal dynamics of smiles and positive emotional processes. The idea is that the formation of smiles during social interaction can provide insights into the emergence of smiling developmentally.

### Summary and Overview

These diverse theoretical perspectives offer different definitions of positive emotion and different arguments for the association between positive emotions and smiling.

Despite their differences, there are clear areas of overlap between different theoretical perspectives. Cognitive differentiation theory's emphasis on engagement in the emergence of smiling, for example, exemplifies the dynamic systems emphasis on the bottom-up emergence of emotional expressions out of multiple interfacing constituents. Each perspective provides overlapping insights that will illuminate the presentation of the meaning and development of smiling in this article. Below, we review the anatomical and neurophysiological basis of early smiling, and methods used to measure smiling.

networks of activation. This possibility is congruent with a wide range of theoretical perspectives such as cognitive differentiation and dynamic systems approaches.

### Measurement of Smiling

Researchers typically measure the frequency and duration of infant smiling from videotaped records. Smiles and other emotional expressions are coded either with well-validated infant-specific coding systems, or according to study-specific criteria. These coding systems are also used to measure a set of smile-related actions such as eye constriction (the Duchenne marker) and other communicative actions such as changes in infant gaze direction. Researchers may also code vocal, gestural, and whole-body expressions of infant emotion, such as jumping up and down in joy, as well as the facial and other expressive actions of the caregivers and testers with whom the infant may be interacting.

Neonatal smiling is typically observed in hospital nurseries, laboratories, and homes where early infant smiling in response to experimentally controlled visual and vocal stimuli such as the static image of a human face and high-pitched tones has been carefully documented. Social smiling between 2 and 6 months of age is often studied during playful face-to-face interactions with a parent (see Figure 2). These interactions are typically videotaped in either the home or in a laboratory playroom and are usually between 2 and 5 min in length. Individual infants typically show a range of relatively stable levels of smiling in these face-to-face interactions. Level of smiling during these interactions is also associated with more general ratings of infant emotional valence over 2–3 h home observations.

Smiling is also measured during experimental procedures involving a period of parental nonresponsivity. The face-to-face/still-face (FFSF), for example, is an experimental procedure in which a period of face-to-face play is followed by a period in which the parent is asked to hold a still-face and not respond to the infant; this is followed by a reunion episode in which the parent is asked to renew play with the infant. Smiling typically declines precipitously in the still-face and rises in the reunion episode, though not quite to initial face-to-face levels.

Through 48 months of age, smiling is often observed during observations in the home, daycare settings, and preschools, and observations in laboratory playrooms. Naturalistic observations may be supplemented or supplanted with structured protocols carried out by a tester or parent such as tickling, peek-a-boo, and the presentation of standardized stimuli such as a jack-in-the-box used to document the development of positive emotion. These protocols have been incorporated into structured assessments which, along with parental reports of positive emotion expression, are also used to assess individual differences in infant temperament.

## The Neurophysiology of Smiling

### Definition of Smiling

Physiologically, the contraction of the zygomatic major muscle creates a smile by pulling the corners of the lips upward and laterally (see Figure 1). The zygomatic is innervated by the seventh cranial nerve, the facial nerve. The facial nerve emanates from the facial nucleus, a group of motor neurons located at the level of the pons in the brainstem.

### Neurophysiology of Smiling

The facial nucleus receives inputs from two pathways. One pathway controls deliberate smiling and the other controls spontaneous expressive smiling. More deliberate facial actions may occur when a young child is asked to smile and involve pathways from the cortical motor strip through the pyramidal system. Spontaneous smiling predominates in infancy and early childhood. Spontaneous facial expressions involve an 'extrapyramidal' pathway that involves subcortical structures such as the basal ganglia and amygdala.

Although spontaneous smiling is linked to joyful emotions, contemporary neuroimaging studies have not unambiguously identified structures that are activated by positive emotions. Candidate structures include portions of the anterior cingulate cortex as well as subcortical structures mentioned above such as the basal ganglia. The degree to which neurophysiological studies identify localized structures involved in positive emotion is of central importance to discrete emotion theory. This theory's hypothesized modular affect program for joy rests on the eventual identification of specific structures and pathways.

Robust evidence has been found for the association of joy with laterality differences in cerebral activation. Emotions involving an orientation or motivation to approach, particularly joy, are associated with greater left frontal cerebral activation than right. Laterality differences suggest a distributed cerebral basis for positive emotional processes and processing, one involving multiple

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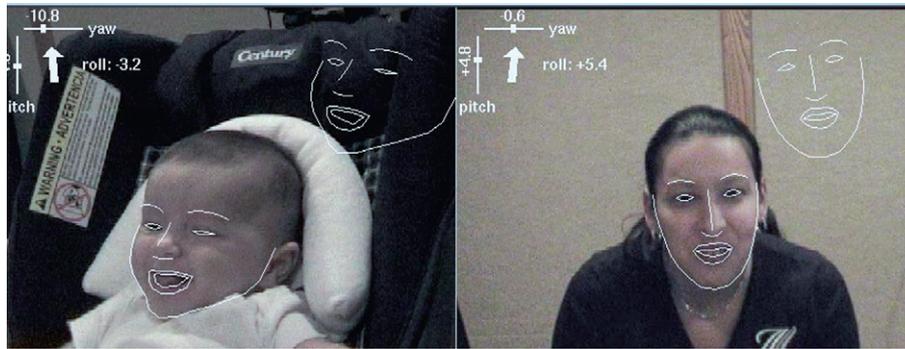
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FO010 **Figure 2** Four-month-old infant and mother smiling interaction as captured by Automated Face Analysis at the Carnegie Mellon University, Robotics Institute, compliments of Jeffrey Cohn, PhD. The infant and mother's faces are outlined to illustrate lip movement, mouth opening, and eye constriction.

### S0070 **Smiling, Joyful Positive Emotion, and Arousal**

P0095 Smiles are simultaneously expressions of joy and indices of arousal modulation. Early discrete emotion theories held that the basis of positive emotion is a sharp reduction in neurally based arousal. Cognitive theories held that positive emotions involve active engagement with a challenging feature of the environment followed first by recognition and then by smiling. In support, infant heart rate—an index of arousal—is more rapid during smiling than during neutral expressions. Infants also accompany smiling with a variety of tension-reducing activities. Infants are likely to put their hands in their mouths while smiling and, after 3 months of age, tend to avert their gaze before ending a smile. Smiles may, in fact, be a mechanism for infants to maintain visual contact with arousing features of the environment for as long as possible.

P0100 The general role of arousal in smiling is also relevant to links between smiles and negative emotional expressions. When a period of engagement yields an experience that the environment is safe and interesting, positive emotion and smiling results. When engagement yields an experience of the environment as overwhelming and unsafe, negative affect results. This might occur, for example, when an interaction with a caregiver or parent becomes temporarily overstimulating for the infant.

P0105 Although related to the management of arousal, the smiles of infants and young children are also expressions of joy. Smiles, for example, are perceived as more emotionally positive than neutral expressions, even among infants with serious facial deformities. The smiles of infants and young children are part and parcel of a process of positive engagement with the environment. They occur during periods of interaction likely to elicit positive emotion and tend to elicit positive emotion on the part of others. Smiles, then, can signal a desire for arousing

interaction even as they are part of a process or arousal modulation. We now turn to a discussion of different types of smiles and their role in the expression of positive emotion.

### S0075 **Different Types of Smiles**

P0110 The smiles of young children have different forms. Some appear to be tentative, others appear to communicate a sense of personal connection, and yet other smiles appear to be part of hilarious outbursts. Infant smiles differ along a variety of dimensions. They can be stronger and weaker and can involve different degrees of eye constriction (the Duchenne marker) and mouth opening. In this section, we explore evidence suggesting that different types of smiling express different degrees and types of positive emotion.

### S0080 **Simple smiles**

P0115 Smiles that are not particularly strong, and do not involve the Duchenne marker or mouth opening, are known as simple smiles. The types of situations in which infants produce simple smiles and ratings of those simple smiles indicate that even these smiles are more emotionally positive than neutral expressions. A functionalist view of facial expressions in non-human primates offers additional clues to the meaning of simple smiles. Chimpanzees (*Pan troglodyte*) possess a zygomatic major muscle active in producing a bared teeth display that is similar to simple human smiling. The bared teeth display was originally a signal of submission (I accept your dominance). It has come to be a signal of affiliation (I mean you no harm), which is frequently followed by behaviors such as holding out a hand. Likewise, simple infant smiles may signify a positive affiliation with others that may be a stepping stone for more positive engagement. Infant simple smiles

occur, for example, during the warm-up phases of games and when infants are approached by an impassive stranger.

While simple infant smiles are emotionally positive, smiles involving stronger zygomatic contraction, eye constriction and/or mouth opening are more emotionally positive than simple smiles. Below, we review evidence that strong smiles, and smiles involving eye constriction and mouth opening are more likely to occur during periods of interaction likely to elicit positive emotion than are simple smiles and are perceived as more emotionally positive than other smiles.

### **Smiles involving mouth opening (play smiles) and smiles involving vocalizations**

Infant smiles involving mouth opening caused by jaw dropping have a specifically social and excited quality. They tend to occur while infants gaze at their mothers' faces and are typically perceived as reflecting more positive emotion and arousal than closed-mouth smiles.

The open-mouth human smile is also morphologically similar to the relaxed open-mouth display of nonhuman primates. These displays develop in infant chimpanzee in the context of mock biting play with mothers. Like the open-mouth smiles of human infants, these displays communicate playful, aroused engagement. Relaxed open-mouth displays and infant open-mouth smiles are also related to laughter. Laughter is a rhythmic, smile-linked vocalization that appears to index intense positive emotion. More generally, infant vocalizations tend to be embedded within the time course of ongoing smiles such that the smiles are punctuated by the vocalizations. The vocalizations may serve both to recruit attention to the smile and to intensify the expression of joy.

### **Duchenne smiles**

The Duchenne marker – eye constriction caused by orbicularis oculi, pars lateralis, which raises the cheeks toward the eyes – is perhaps the best known index of smiling intensity in infants. Infants tend to produce Duchenne smiles when their mothers are smiling and when they are approached by their smiling mothers. Infants also produce more syllabic sounds when Duchenne smiling, a potential marker of emotional intensity. Duchenne smiling is also associated with greater relative activation of the left than right frontal cerebral hemispheres, a pattern which suggests greater approach orientation and joy. Although smiles involving the Duchenne marker are often regarded as the only index of strong joyful emotion in adults, this distinction does not appear to be absolute in infants. In infants, smiles with and without the Duchenne marker often follow one another directly in time, suggesting that infant Duchenne smiles are more intense indices of positive emotion than smiles without the Duchenne marker.

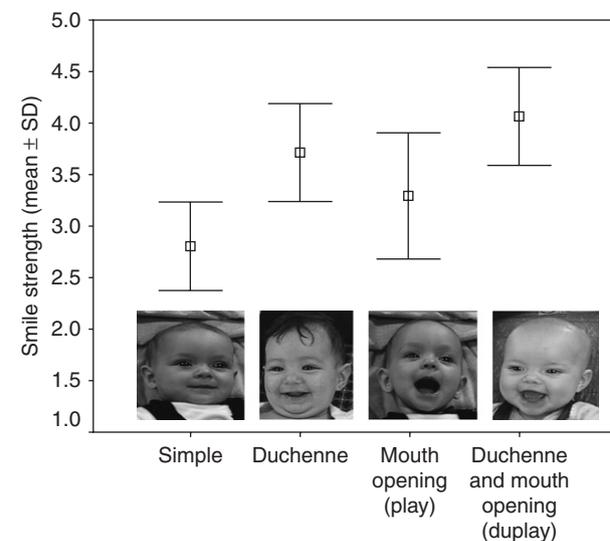
### **Strong smiles**

Smiles are continuous muscular processes in which the degree of zygomatic contraction determines the strength of the smile, the degree of lip corner movement. Strong smiles index more intensely positive emotion, the infant's positive emotional engagement with ongoing activities. More exciting parts of games elicit stronger smiling than the preparatory phase of the games. Tickling, for example, is accompanied by stronger smiling than getting ready to tickle or pretending to tickle. Smiles involving stronger zygomatic contraction are also perceived as more positive and joyful than weaker smiles.

Stronger smiling – involving greater zygomatic contraction – tends to be associated with eye constriction and mouth opening. Simple smiles without these features are the weakest while smiles involving both eye constriction and mouth opening are the strongest (see **Figure 3**). These intensity parameters vary together in time over the course of an infant smile. As the strength of an infant's smiles increase and decrease, the degree of eye constriction and mouth opening involved in the smile, also increase and decrease.

### **Combined strong, open-mouth Duchenne smiles**

Infant smiles involving the Duchenne marker tend to involve mouth opening (and vice versa) (see **Figure 1**). These combined smiles – sometimes called duplay smiles – tend to occur during unambiguously positive period of interaction such as when young infants are gazing at their smiling mothers. Strong smiles involving mouth opening and eye constrictions are perceived as the most joyful of infant smiles. They occur in circumstances – such as while being tickled – which appear likely to elicit the strongest and most engaged positive emotion.



**Figure 3** Mean smile strength of different smile types.

s0105 **Conclusion: The meaning of different types of smiles**

p0155 It is possible that Duchenne smiles are involved in reciprocating another's positive emotion, while open-mouth smiles involve a more aroused, playful quality of positive emotion. If different types of smiles have qualitatively different meanings, this would challenge the discrete emotion theory proposition that there is single affect program for joy. An alternate possibility – that different types of smiles express different degrees of a single dimension of positive emotion or joy – is consonant with a wide range of theoretical perspectives. Discrete emotion and cognitive theories are congruent with this dimensional perspective, although the dimensional perspective's emphasis on real-time changes in smiling intensity have been a more central concern of functional and dynamic systems approaches.

s0110 **The Development of Smiling**

s0115 **Developmental Overview**

p0160 The development of smiling reflects the emerging cognitive, social, and emotional competencies of the young child. Smiles first emerge during sleep during the neonatal period and rapidly become a centerpiece of face-to-face social interactions in the first half year of postnatal life. Between 6 and 12 months, infants begin to intentionally communicate desires and experiences about objects and events in the world to their communicative partners. Between 12 and 48 months, smiling and laughter within the parent-child dyad becomes more sophisticated and intricate. At the same time, the smiles of young children become essential features of their social interactions with peers. We review these developments below.

s0120 **Neonatal and Early Smiling: 0–2 Months**

s0125 **Neonatal smiling: 0–1 month**

p0165 Neonatal smiles are an emotional puzzle. They are referred to as endogenous or spontaneous smiles because they are prompted by internal stimuli, suggesting they have no emotional content. Neonatal smiles occur more frequently in sleeping and drowsy states of rapid eye movement (REM) – about one smile every 5 min – than in other states. These smiles, however, do occur in other behavioral states, including states of alertness, suggesting the possibility that they are related to positive emotion.

p0170 The form of neonatal smiles suggests an association with positive emotion. Neonatal smiles can have a relatively mature form that involves strong muscular contractions and the Duchenne marker. These smiles occur against a backdrop of frequent lip and mouthing movements. Nevertheless, approximately one-third of these neonatal

smiles are recognized by untrained observers, suggesting their potential signal value.

Neonatal smiling is unrelated to 'gas' as its frequency is unaffected by time since last feeding. Instead, neonatal smiling appears to have a subcortical origin, as evidenced by the observation of neonatal smiling in an infant with microcephaly. Infants born prematurely show more neonatal smiling than full-term newborns and the quantity of their endogenous smiling declines with age. These factors also suggest a subcortical origin for neonatal smiling, which may limit the emotional meaning of these smiles.

Theoretical perspectives differ on the meaning of neonatal smiles. While discrete emotion theory suggests that neonatal smiles – at least those occurring during waking states – are expressions of joy, a cognitive differentiation perspective regards them as physiological responses to internal or environmental stimuli. Neonatal smiles illustrate the dynamic systems emphasis on heterochronicity; that is, the neonatal smile appears to develop physically before it is integrated into patterns of cognitive engagement and social interaction that provide evidence for joyful emotion.

**Early smiling and the transition to social smiling: 1–2 months**

Over the first 2 months of life, smiling becomes gradually linked to environmental stimulation, which sets the stage for the emergence of social smiling. Infants first smile in response to auditory stimuli, and then respond to auditory plus visual stimuli, and finally smile in response to visual stimuli alone. Specifically, through 1 month of age, infant smiles often occur during states of drowsiness or even sleep when they are elicited by high-pitched tones including the human voice. After 1 month, smiles during alert states are increasingly elicited by visual stimuli such as gazing at a face or an upright image of a face. Infants become increasingly likely to smile to high-pitched auditory stimuli (such as the human voice) or visual displays (particularly static images of the human face) until about 3 months of age.

Cognitive differentiation theory maintains that while neonatal smiles involve a reduction in physiological arousal, the smiling of young infants involves a reduction in psychological or cognitively modulated tension. It is the emerging psychological meaningfulness of visual stimuli rather than their physical/perceptual properties that occasions smiling. In support of this proposal, as infants become more capable of rapidly recognizing more complex stimuli in the first months of life, latencies to smile decrease. This cognitive differentiation perspective is also relevant to the emergence of social smiling, to which we now turn.

Social smiling develops in a developmental period when infants are spending less time asleep and more time in periods of alert inactivity, awake but not fussing

or crying. These states facilitate social interaction as infants spend increasing amounts of time gazing at the caregiver's face. The period in which social smiles emerge is also marked by the development of new patterns of visual attention between 1 and 2 months of age. One-month-olds gaze alternately at the edge of the head and the eyes. Two-month-olds gaze between the edge of the head, the eyes, and the mouth. This more integrative pattern of gazing suggests attention to the facial expression of others which may also facilitate social smiling.

p0200 Social smiles typically first occur while gazing at the parent in the 4–6 weeks after birth. Age of social smiling appears to be contingent on a certain level of neurological maturity. For infants born prematurely, age of social smiling must be adjusted to account for the number of weeks the infant was born before due date. Maternal reports of the first social smile precede tester's first elicitation of social smiles by several weeks. Parents may experience infant's first social smiles as providing a sense of connection, fulfillment, and even reward ('my baby recognizes me') after the hard, sometimes sleep-depriving work of caring for a neonate.

p0205 In the first month of postnatal life, infants gaze at and away from mother's face without smiling. In the second month, the social smile emerges, heralded by periods of concentration. Several seconds of brow knitting and visual fixation of the mother's face are followed by relaxation of the brows, indexing apparent cognitive recognition, and a smile. This pattern links processes elucidated by cognitive differentiation perspectives to the emergence of social smiling. Dynamic systems approaches indicate – in complementary fashion – that the real-time occurrence of this attention-related smiling pattern may provide a window into the first developmental emergence of smiling.

### s0135 **The Development of Social Smiling in Face-to-Face Interaction: 2–6 months**

p0210 Social smiles develop during interaction. The period between 2 and 6 months is one of intense social interaction and rapid emotional development. During this period, infants become both increasingly responsive to the smiles of others and increasingly likely to initiate smiles to others. We begin this section with a discussion of general features of smiling in face-to-face interaction and then turn to the development of interactive smiling between 2 and 6 months.

#### s0140 **General features of face-to-face interactive smiling**

##### s0145 **Overview of infant and parental activities during interactive smiling**

p0215 Overall, infants smile for about one-fifth of face-to-face interactions and smiling typically occurs in bursts of smiles separated by periods without smiling. Infant interactive

smiling is strongly linked to gazing at the parent's face and smiling tends to be associated with vocalizations that are also used to express positive emotion.

During face-to-face interactions, infant smiles are a high point of play with both mothers and fathers. Fathers tend to employ a more physical style of play with their infants (e.g., bouncing games) whereas mothers rely more on visual and vocal expressivity to elicit smiles. Although the term mother is often used in this article because of the preponderance of research findings on mothers, mothers and fathers are equally adept at eliciting smiles from their infants.

During interaction, parents both stimulate and entertain their infants, attempting to elicit engagement and expressions of positive emotion while at the same time attempting to prevent and modulate their infants' fussing and crying. In addition to smiling, parents hold, touch, and tickle their infants, move toward and away from the infant, and engage in high-pitched infant-directed speech. These rhythmic multimodal displays increase and decrease in emotional intensity over the space of several seconds in concert with and in reaction to infant smiles and other expressive actions.

#### **Infant and mother responsivity to smiling**

A key feature of interaction is the degree to which each partner influences and is responsive to the other. Mothers' smiles and vocalizations are typically necessary to elicit infants' smiles but may not be sufficient to elicit infant smiles. Mothers are optimally successful at eliciting infant smiles when they combine different communicative modalities with smiling such as vocalizing, leaning toward the infant, and smiling simultaneously.

Infant smiles are more likely to elicit mother smiles than mother smiles are to elicit an infant smile. An infant smile is typically sufficient to elicit a mother smile, usually within a relatively brief two second time interval. In fact, an infant neutral gaze at mother's face is often sufficient to elicit a mother smile, and mothers frequently initiate smiles in the absence of discrete infant behaviors. Infants, then, may experience parental contingency in the midst of a wide array of parental expressive behaviors.

#### **Patterns of infant and mother smiling**

As suggested by a dynamic systems perspective, infant and parent individual propensities toward smiling combine to create more complex dyadic patterns of interaction in time. Infant smiles typically occur when the infant gazes at the mother and the mother smiles. Once infants are smiling, parents will rarely cease smiling, which would break off a bout of mutual smiling. The young infant's experience of smiling, then, is, prototypically, smiling with a smiling parent.

Infant and mother also impact one another continuously in time. Stronger smiling on the part of the infant is

likely to lead to stronger mother smiling. Stronger mother smiling may be mirrored by the infant or the infant may disengage, gazing away to regulate their levels of arousal. These levels of interactive influence vary among different infant–parent dyads. Generally, however, infant expressions of joy are mirrored and intensified by the parent. The infant responds to this intensification with either intensified engagement and positive emotional expression or disengagement, gazing away, and terminating smiling.

p0250 The exchange of smiling is a nonverbal dialogue whose topic is the shared experience of joy and the regulation of emotion. Prototypically, infants' experience of positive emotion as they smile is mirrored back in intensified form by the smiling parent. The infant perceives this increase in the parent's smile and simultaneously perceives his or her own increase in positive emotion that the parent's smile engenders. Sources of the infant's positive responsiveness to the parent's smile may be mirror neurons or related neurophysiological processes that produce feelings of sympathetic joy in the infant who perceives the smile of another.

p0255 Whatever the source, infants' awareness of their own changing feelings occurs in concert with their experience of their impact on the parent. The dynamic interplay that results suggests that one path to the development of joy involves experiencing the joy of another. The infant's simultaneous awareness of their own feelings and those of the parent is known as primary intersubjectivity. We now turn to the development of primary intersubjectivity and interactive smiling between 2 and 6 months.

### s0160 **Developments in interactive smiling between 2 and 6 months**

p0260 As infants develop and increase their smiling around 2 months, there is a related increase in positive maternal expressions such as smiling. Infants appear to become accustomed to specific levels of positive responsivity such that 2-month-olds smile less at a stranger who is either more or less contingently responsive to the infant than the infant's mother. Early on, then, infants appear to show dyad-specific levels of interactive contingency that affect smiling levels. This may be one mechanism through which infants between 2 and 6 months increasingly differentiate between adults and come to reserve their smiling to a familiar attachment figure.

p0265 The development of smiling in face-to-face interaction occurs concurrently with changing patterns of infant attention to the caregiver's face. Between 2 and 6 months, infants spend decreasing periods of time gazing at their mothers' faces but become increasingly likely to smile when they are gazing at the mother's face. As infant smiles become more strongly coordinated with gazes at mothers' faces, patterns of gazing and smiling change. At 3 months, infants tend to begin and end their smiles within gazes at the parent's face; that is, infants' early expressions of

positive emotion are dependent on visual contact with the parent. At 6 months, infants tend to gaze at mother's face, smile, gaze away, and only then end the smile.

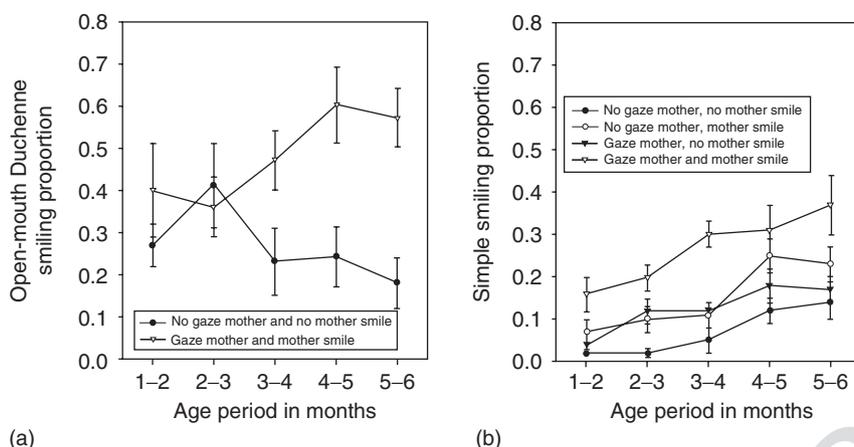
Gazing away from the parent during smiling appears to be an early mechanism of emotion and arousal regulation. Five-month-old infants playing peek-a-boo tend to avert their gaze from the mother's face more frequently and for longer periods of time during stronger smiles and during longer-lasting smiles. This suggests that stronger and longer-lasting smiles involve more intense affectively positive arousal which infants regulate by gazing away from their parents' faces. In addition, smiles in which infants gaze away before the peak of the smile is reached may have a 'coy' quality which leads naïve observers to perceive some of these smiles as communicating shyness. These developmental patterns of gazing at and away from the parent's face are the context in which smiling develops during face-to-face interactions.

As infant smiling increases between 2 and 6 months, infants also become more active participants in smiling dialogues. Infants' tendency to smile in response to mothers' smiles increases with age as does infants' propensity to initiate smiles – even in the absence of a previous maternal smile. The age at which infants become reliably responsive to their mother's smiles and the range of responsivity between different infants and mothers is a topic of active research.

### **The development of different types of smiling**

Considered as a whole, infant smiling during face-to-face interaction increases between 2 and 6 months. Different types of smiling, however, show different patterns of development. Simple smiles that involve neither eye constriction nor mouth opening show a nonspecific rise in different interactive periods (see **Figure 4**). By contrast, the more emotionally positive open-mouth smiles involving eye constriction show a specific developmental pattern. Between 2 and 6 months, infants become increasingly likely to use open-mouth Duchenne smiling to respond to their smiling mothers. These combination smiles decline in periods when mothers are not smiling and infants are gazing elsewhere. In sum, highly positive types of smiling become selectively associated with more positive periods of interaction. Infants' increasing tendency to engage their smiling mothers with open-mouth cheek-raise smiling appears to index their emerging capacity to fully participate in intensely joyful interactions.

The period approaching 6 months is one in which infants also become increasingly likely to gaze away from mother during the course of a smile in order to control their own arousal levels. As infants, then, become more capable of using very intense smiles to participate in highly arousing social situations they also begin to exercise more control over the direction in which they smile.



**Figure 4** (a) Open-mouth Duchenne smiling increases when infants are gazing at their mothers' faces while their mothers are smiling. It decreases when infants are not gazing at their mothers while their mothers are not smiling. (b) By contrast, simple smiling with neither characteristic tends to increase irrespective of where the infant is gazing and whether or not the mother is smiling. All smiles are positive, but some smiles are more positive than others. All smiles are positive, but some smiles are more positive than others. From Messinger D, Fogel A, and Dickson KL (2001) All smiles are positive, but some smiles are more positive than others. *Developmental Psychology* 37(5): 642–653.

Infants are increasingly controlling their own positive emotion by exercising control over their involvement in the interchanges that lead to this positive emotion.

Another clue to the emotional meaning of infant smiles is the infants' perceptions of the smiles of others. By 4 months of age, infants can visually match their mothers' smiles with a matching vocalization and, by 5 months, recognize the smile–vocalization pair posed by an experimenter. These abilities suggest the infant's appreciation of the affective meaning of the smiles of others is blossoming in the same period in which the infant is able to more flexibly engage in his or her own intensely positive emotional expressions.

### Smiling between 6 and 12 Months: The Development of Referential Smiling

In the first half year of life, infant emotional expression during face-to-face interactions reflects a primary, non-reflective communication of immediate experience. In the second half of the first year of life, infant smiling takes on a qualitatively new form as smiling is integrated into intentional communications. We begin by reviewing the form of infant smiling and laughter during this period, examine smiles associated with walking, mastery smiles, and then turn to the development of smiling in intentional communications.

#### The development of different types of smiling, laughter, and mastery smiles

Between 6 and 12 months of age, strong smiles combining the Duchenne marker and mouth opening occur in the midst of positive and exciting periods of interaction such as physical play with a parent. Simple smiling without

these features predominates both during the preparatory phases of active games (e.g., getting ready to tickle) and during slower-paced activities (e.g., book reading). While games such as tickle become more potent elicitor of smiles between 6 and 12 months, it is not clear if the relative frequency of different types of smiling – or their association with different types of elicitors – changes in this period. The conditions that elicit laughter, however, change developmentally.

Laughter is a smile-linked vocalization indexing intense positive emotion and arousal that becomes more common between 6 and 12 months. During this period, physical stimulation such as pat-a-cake remains potent elicitors of laughter even as infants become more likely to laugh in response to social games such as peek-a-boo. One factor in this development is that infants are becoming increasingly active agents in social games (e.g., moving the parent's hands in peek-a-boo and eventually hiding the parent) and eventually become full partners in producing their own smile- and laugh-inducing experiences.

Cognitive differentiation theory holds that mastery of a challenging task is intrinsically rewarding. In support, infants approaching 1 year of age engage in more smiling and laughing when engaging in newly acquired capacities such as pulling to stand than when engaging in more practiced tasks such as pulling to sit.

Smiling is linked to the developmental achievements of the toddler and young child. For early walkers (before 12 months), the onset of walking is associated with an increase in infant positive emotional expressions such as smiling. Walking onset is also, however, associated with a decrease in maternal expressions of positive affect to the early walker and increases in interpersonal struggles. This 'testing of the wills' may reflect the toddler's delight in the

experience of increased mobility and the mother's work to ensure that the young toddler stays safe despite their increased mobility. The mischievous smile may develop around this age as toddlers gaze back at a parent from a distance while smiling to ascertain the level of prohibition or acceptance associated with a potential path of action. Such actions would reflect the toddler's developing secondary intersubjectivity, a topic to which we now turn.

### Smiling in referential communication

#### Overview

In the period between 6 and 12 months, infants and parents increasingly integrate objects into their play. Smiles tend to occur in the context of coordinated joint engagement in which the infant actively shifts attention between a toy and a social partner. When initiating joint attention, infants use gestures and gaze to refer to objects and events outside the infant-partner dyad. Infant smiles are related to the communicative meaning of these gestures and gazes. Infants are more likely to smile during communications that show or share an object than they are to smile during communications that request an object or action. In sum, infants begin to smile at others with reference to particular objects or events in what is known as triadic communication.

#### The development of referential communications involving smiles

Between 6 and 9 months, infant initiation of joint attention by gazing between a toy and a responsive adult increases. Yet even among infants who gaze between the toy and an adult, the percentage who accompany this gaze with a smile rises between 6 and 9 months. This suggests that integrating a smile into a gaze at a responsive adult indexes a more complex communicative message than gazing alone. Such smiles index the infant's secondary intersubjectivity, the infant's awareness of the relationship between the adult and toy. An additional index of the infant's secondary intersubjectivity involves the sequence of smiling and gazing. The infant is aware not only of the parent, but increasingly aware of the parent's attentional state with respect to an object or event.

Anticipatory smiles involve a specific sequence of smiling and then gazing at a partner that appears to index the

infant's secondary intersubjectivity (see **Figure 5**). Infants engage in anticipatory smiles when they smile at a toy or event and then turn to gaze at an adult while continuing to smile. The infant's smile anticipates social contact and communicates pre-existing positive affect with another person. It seems to communicate something like, "that was funny, wasn't it."

Infant anticipatory smiles increase between 8 and 12 months. An infant's likelihood of engaging in anticipatory smiling is associated with the infant's general capacity to engage in intentional communications and to understand means-end relationships. This suggests that anticipatory smiles index infants' emerging ability to understand and refer to the relationship of an adult and an object. From a dynamic systems perspective, the real-time process of smiling and then referencing an object to another suggests how positive emotion may motivate the development of early triadic communications.

### Smiling between 12–48 Months: Smiling among Toddlers and Preschoolers

As toddlers become more mobile and young children become more involved in play with peers, many researchers have neglected the observation of smiling, focusing instead on other dimensions of social competence. From 1 to 2 years of age, however, smiling and laughter remain revealing elements of play with parents during a period in which toddlers become increasingly aware of the social meaning of the parents' smiles. Between 1 and 4 years, smiling is also an essential feature of the young child's developing peer play where it reveals emerging patterns of social affiliation. These two topics – smiling with parents and smiling with peers – are the focus of this section.

#### Toddler smiling and laughter with the parent

Infant comprehension of the smiles of others in social referencing paradigms provides evidence for the development of secondary intersubjectivity. In social referencing paradigms, infants are confronted with an ambiguous stimulus such as a moving mechanical object that might be interpreted as interesting or as threatening. Between 12 and 18 months of age, infants respond differentially to



**Figure 5** Anticipatory smile. A 12-month-old infant gazes at an object (left), smiles at the object (middle), and gazes at the experimenter while continuing to smile (right).

adult smiles (and associated vocalizations) than to fear and neutral expressions. Infants interpret these adult smiles not as direct expressions of joy (primary intersubjectivity), but as referential signals that the ambiguous situation is nonthreatening (secondary intersubjectivity).

p0350 The toddler's developing understanding of pretense is also related to maternal smiling. Mothers smile more when engaging in pretense activities with their 18-month-olds (e.g., pretending vs. really eating a snack). Toddlers also give more clues that they understand that the activities are pretend – they participate more and smile more themselves – when mothers smile more. The 12–24-month period also involves developments in dyadic laughter. When engaged in play during this period, infants and mothers begin and end their laughs increasingly closer together in time. The members of the dyad appear to become increasingly responsive to the onset and offset of one another's positive communications, leading to the emergence of dyad-specific patterns of positive communication. Thus infant understanding of smiling as a social signal ('this is a pretend activity') develops at the same time as infants and mothers continue to evolve complex patterns of dyadic responsivity to each other's positive emotion expressions.

### s0205 **Smiling in peer play**

p0355 Peer play is an increasingly important context for social development and smiling after 1 year. By 18 months, level of smiling is linked to increased interaction with peers, particularly when there is a relative absence of peer conflict. Additional evidence for the importance of peers involves three types of smiling identified among preschoolers.

p0360 A closed smile in which the teeth are covered that is likely related to simple smiling has been identified in preschoolers. Closed smiling predominates in solitary contexts and levels of closed smiling change little between 2 and 4 years of age. Upper smiles and broad smiles and open-mouth smiles show different patterns of occurrence and development. Upper smiles display the upper teeth and may include Duchenne smiles; broad smiles display both the upper and lower teeth and are likely to include open-mouth smiles. Upper and broad smiles occur in social situations and are increasingly used with same-sex peers between 2 and 4 years. Male children, in particular, are increasingly selective in directing broad smiles toward male peers and not to female peers. Different types of smiling may, then, reflect and reinforce developing patterns of social affiliation such as the increasing sex segregation of young preschoolers.

p0365 With respect to more recent typologies of smiles among preschoolers, by 3.5 years of age, stronger smiles are likely than weaker smiles to accompany success in a game. By 4.5 years, children tend to produce Duchenne smiles in games in which they produce – rather than simply being shown – an interesting display. Mastery,

success, and failure during a given trial of a game are not, however, always accurate predictors of smiling. Gaze at the examiner – or whomever the child is playing with – remains a prepotent elicitor of smiling, whether the child has failed or succeeded at the game. In the preschool period, then, smiling continues to serve multiple masters. It expresses both joy at success and the happiness associated with interacting with a cooperative adult or peer.

### s0210 **Smiling as an Index of Developmental Risk and Disability**

p0370 Individual differences in smiling are meaningfully related to concurrent risk factors. Levels of smiling differ between infants at risk for disturbed developmental outcomes and typically developing infants. We review evidence for differences in smiling associated with prematurity, maternal depression, and infants who are blind, infants with Down syndrome, and infants with 'autism spectrum disorders' – emphasizing how such differences shed light on the disorders and conditions in question.

### s0215 **Smiling in Premature Infants and the Infants of Depressed Mothers**

p0375 Infants born prematurely spend less time than full-term infants engaging in relatively strong open-mouth smiles during face-to-face interactions and exhibit fewer strong smiles during peek-a-boo games with an experimenter. This likely reflects the difficulties of many premature infants in coping with high levels of even positive emotional arousal. Maternal depression and maternal depressive symptomatology, particularly when long-lasting or chronic, tend to be associated with a reduction in infant smiling, at least during interactions with mother. This is likely to reflect a lack of positive emotional responsivity to the infant on the part of mothers with depressive symptomatology.

### s0220 **Smiling in Blind Infants and Children**

p0380 The impact of environmental influences is evident in the development of smiling in blind infants. Blind infants demonstrate social smiling in response to social events such as hearing a familiar voice and their smiling typically elicits a parental response. The frequency of these social smiles increases between 4 and 12 months. However, the smiles of blind infants are less regularly elicited and more fleeting than those of sighted infants. Blind infants, of course, cannot enter into mutually reinforcing visually mediated smiling exchanges with others, which may limit the duration of their smiling. Lack of contingent visual feedback to smiles is also likely to play a role in the decrement in smiling observed in blind infants after 2 or 3 years of age.

### s0225 Smiling in Infants with Down Syndrome

p0385 Infants with Down syndrome – trisomy – show delayed development of positive emotional expressivity with the most substantial delays evident among the most cognitively delayed infants and the infants with the most flaccid muscle tone. Although levels of smiling are typically low in infants with Down syndrome, these infants do show mastery smiles consonant with their cognitive level. They also show the typical developmental pattern of smiling – first to auditory, then to visual and tactile, and then to social stimuli and activities.

p0390 Infants with Down syndrome show patterns of indiscriminate smiling whose cognitive and affective bases have not been adequately specified. Infants with Down syndrome direct open-mouth Duchenne smiles both to their mothers and to toys, whereas typically developing infants direct these smiles only to mother. Infants with Down syndrome also do not show decrements in smiling when their mothers adopt a still-face as dramatic as the decrements of typically developing infants. It remains to be seen whether such indiscriminate smiling is associated with the level of cognitive functioning of individual infants with Down syndrome.

### s0230 Smiling in Children with Autism Spectrum Disorders

p0395 While children with Down syndrome show indiscriminate smiling, children with autism spectrum disorders (ASD) show deficits in facial expressivity frequently including low levels of smiling. Low levels of smiling are associated with deficits in initiating joint attention and are particularly salient when children with ASDs are oriented toward an adult. These effects are evident as early as 12 months among infants who will later be diagnosed with an ASD. Even among infants at risk for autistic symptomatology because they are siblings of children with an ASD, levels of neutral affect are higher in early face-to-face interactions than among other infants. Smiling in children with ASDs reflects a deficit in the degree to which face-to-face contact with others is rewarding that may have cascading repercussions for the social development of affected children.

### s0235 Developmental Continuity in Smiling: Predicting Social Competence

p0400 Individual differences in smiling are meaningfully related to subsequent developmental outcomes. This section is concerned with the continuity of early expressions of positive emotion and the association between early smiling and later indices of social competence. We begin

with a discussion of smiling and security of attachment and other indices of social competence, turn to genetic and environmental influences on smiling, and end with a discussion of interactive smiling and its impact on socialization.

### Smiling and Attachment

s0240  
p0405 Infants who smile when their parent adopts a nonresponsive still-face have a tendency to develop socially appropriate relationships. They are perceived by their parents as having fewer externalizing behaviors (such as being loud and rough) 1 year later than infants who do not smile during the still-face, and may be more likely to develop secure attachments.

p0410 Infants whose level of smiling during face-to-face play with the parent rises between 2 and 8 months are more likely to be classified as securely attached than other infants. Similarly, smiling with the parent in play sessions around 18 months of age is associated with concurrent attachment security. It may be that regular smiling interactions in which the parent helps the infant modulate their level of positive arousal are a route to the development of a secure attachment relationship. This modulation involves not only responding positively to the infants' smiles but being responsive to the infant's need to look away after intense smiling bouts. This allows infants to calm themselves and then look back (and perhaps smile) at the parent.

### Face-to-Face Smiling, Joint Attention Smiling, and Social Competence

s0245  
p0415 Early social smiling in face-to-face interaction with a parent positively predicts 'anticipatory smiling', a tendency to communicate positive affect about an object to an adult tester. In addition, highly sensitive maternal caregiving predicts a more general measure of infant smiling at any point during an infant joint attention episode. It appears that infants' experience with early-rewarding social stimuli contributes to a later predilection to initiate positive communicative referencing with others.

p0420 Anticipatory smiling toward 1 year of age predicts parent-reported social expressivity and social competence scores at 30 months. Positive affect sharing indexed by anticipatory smiling may be a developmentally focal activity that is predicted by early social smiling and predicts subsequent social expressivity and competence. Likewise, infant Duchenne smiling during reunions with mother in the Strange Situation predicts parent ratings of extraversion and openness to experience when children are 3.5 years of age. In sum, positive emotion expression elicits positive responses from social partners that foster later sociability and social competence.

s0250 **Smiling: Genetic and Environmental Effects**

p0425 Parent reports on dimensions of infant temperament involving questions about infant smiling and laughter reveal the influence of both genetic and environmental effects. This contrasts with negative emotion expression, which shows higher genetic and lower environmental effects. Shared environmental effects in positive emotion expression point to possible socialization effects in factors that determine parent perceptions of level of smiling. This may mean that more emotionally positive infant–parent interactions influence future levels of infant smiling and positive emotional expression.

s0255 **Developmental Continuity in Smiling**

p0430 Infant reaction to standardized elicitors of smiling and other positive emotional expressions such as a puppet show and jack-in-the-box show moderate developmental stability between 1 and 3 years of age. Infants who engage in extremely high levels of smiling, positive vocalizations, and motor movement at 4 months in response to a mobile and auditory stimuli show different developmental patterns than infants who are nonresponsive or show more emotionally negative reactions. The infants who display earlier smiling are less behaviorally inhibited in unfamiliar situations over the first 2 years of life than the other infants. They continue to show a more exuberant temperamental style at 4 years when they are more likely to talk and engage with peers.

s0260 **Concurrent Validity of Smiling to Social Stimuli**

p0435 Infant smiles to social stimuli such as peek-a-boo games with examiners and infant smiles to nonsocial stimuli such as a jack-in-the-box appear to have different meanings. Only infant smiles to social stimuli are associated with infant positive emotion expression in the parent–child relationship and with parent ratings of their children’s day-to-day positive emotion. Infant smiling in the parent–child relationship is in turn associated with later social competence.

s0265 **Predictive Validity of Interactive Smiling**

p0440 Through smiling in face-to-face interactions infants come to engage in simultaneous, reciprocal, and mutually enjoyable exchanges. Affecting and being affected by the positive emotional expression of the parent may lead infants to experience the happiness of others as essential to their own happiness. In support, shared infant–mother positive emotional expressions such as smiles – when they occur in conjunction with maternal responsivity to infant – are

associated with two indices of social competence: children’s internalization of social norms (obeying the rules) and committed compliance to maternal directives (cleaning up without reminders). In this way, experiences of affectively positive responsivity emerge from social interaction and shape the infant’s developing social competence into childhood.

See also: Attachment (00012); Autism Spectrum Disorders (00016); Emotion Regulation (00055); Imitation and Modeling (00082); Newborns (00112); Self Knowledge (00139); Humor (00078); Intermodal Perception (00086).

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**Relevant Websites**

- <http://face-and-emotion.com> – A site devoted to the human face, Dataface (contains information on the anatomically based Facial Action Coding System for the measurement of smiles and other expression).
- <http://www.psych.utah.edu> – Alan Fogel’s website.
- <http://www-2.cs.cmu.edu> – Automated Face Analysis at the Carnegie Mellon University, Robotics Institute.
- <http://www.psy.miami.edu> – Daniel Messinger’s website.

## Non-Print Items

### Abstract:

Early smiles are a prototypical expression of joy and a window on the development of positive emotion. Smiles elicit positive emotion and engagement in others, a process that contributes to the development of joy and social competence in the young child. Infants express different intensities and qualities of positive emotion through alterations in the temporal and facial dynamics of their smiling and through the incorporation of other expressive actions such as laughter and jumping up and down. Through the first two years of life, infant smiles and laughter become increasingly social and affectively intense, and increasingly used in referential communications about objects; between 2 and 4 years, smiles reflect the social structure of peer interactions. Difficulties with smiling in early interactions reflect a variety of risk conditions, while emotionally positive and responsive interactions can index optimal developmental trajectories.

**Keywords:** Affect; Arousal; Attachment; Development; Emotion; Face-to-face; Infant; Interaction; Joy; Mastery; Toddler

### Author and Co-author Contact Information:

D Messinger  
Flipse Psychology Annex, PO Box 249229  
Coral Gables,  
FL 33124-0721  
USA  
+1 305-284-8443  
+1 305-284-4795  
dmessinger@miami.edu

### Biographical Sketch for Online Version



Daniel S. Messinger was born in El Reno, Oklahoma, earned his Masters at the University of Chicago in 1989 and his PhD at the University of Utah in 1994, where he studied with Alan Fogel. He took a position at the University of Miami in Pediatrics in 1993 and a position in Psychology in 1999. Dr. Messinger investigates a range of basic and applied developmental questions. He is particularly interested in real-time emotional interaction and its role in development. His current work involves infants at-risk for autism and the measurement of emotional dynamics.