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BRIEF REPORT

Developmental Changes in Infants' Categorization of Anger and Disgust Facial Expressions

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For decades, scholars have examined how children first recognize emotional facial expressions. This research has found that infants younger than 10 months can discriminate negative, within-valence facial expressions in looking time tasks, and children older than 24 months struggle to categorize these expressions in labeling and free-sort tasks. Specifically, these older children, and even adults, consistently misidentify disgust expressions as anger. Although some scholars have hypothesized that young infants would also be unable to categorize anger and disgust expressions, this question has not been empirically tested. In addition, very little research has examined developmental changes in infants' perceptual categorization abilities with high arousal, within-valence emotions. For this reason, the current study tested 10- and 18-month-olds in a looking time task and found that both age groups could perceptually categorize anger and disgust facial expressions. Furthermore, 18-month-olds showed a heightened sensitivity to novel anger expressions, suggesting that, over the second year of life, infants' emotion categorization skills undergo developmental change. These findings are the first to demonstrate that young infants can categorize anger and disgust facial expressions and to document how this skill develops and changes over time.

Keywords: infant, categorization, emotional expressions, anger, disgust

Facial expressions are powerful social signals. With the arch of an eyebrow or curl of a lip, humans can quickly communicate their feelings and influence the behavior of others. Proficiency at recognizing and appropriately responding to others' facial expressions has notable benefits for relationship satisfaction and psychological well-being, as well as for academic, social-emotional, and occupational development (Grinspan, Hemphill, & Nowicki, 2003; Izard et al., 2001). Understanding how emotion recognition skills develop also has important implications for diagnosing and treating developmental disorders, such as autism (Golan et al., 2010) and for designing effective social-emotional interventions (Izard, 2002). Recent attention to emotions in popular press and children's media (e.g., Disney Pixar's *Inside Out*) has renewed interest in facilitating children's emotional recognition skills. However, many important questions pertaining to young children's early emotion recognition skills remain unanswered. In particular, less is known about the perceptual and cognitive skills in infancy that set the foundation for children's later emotion recognition and understanding.

Scholars have proposed two requisite perceptual skills for emotion recognition: discrimination and categorization (Kotsoni, de Haan, & Johnson, 2001; Walker-Andrews, 1997). *Discrimination* refers to the ability to perceive differences between facial expressions on the same person (e.g., happy v. sad), whereas *categorization* refers to the ability to perceive that multiple people are expressing the same emotion. Several studies have examined the first requisite skill (discrimination), illustrating that infants younger than 10 months can discriminate between particular facial expressions, like happiness and fear (e.g., Bornstein & Arterberry, 2003; for a review, see Quinn et al., 2011). However, infants' perceptual categorization of facial expressions remains understudied. In addition, important questions remain as to how these skills change over time and are influenced by emotional valence.

Only a few studies have examined how infants categorize facial expressions. For instance, Soken and Pick (1999) found that 7-month-olds are able to match emotional vocalizations to sadness and anger expressions. Kotsoni and colleagues (2001) extended this work demonstrating that 7-month-olds can also form perceptual categories of happy versus fearful expressions. However, it is unclear in these studies whether differences in valence (i.e., happiness = positive, fear = negative) or arousal (i.e., sadness = low, anger = high) influenced infants' categorization (Widen & Russell, 2008). As a result, questions remain

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as to whether emotional valence and/or arousal drove these results. Unfortunately, nearly every study on infants' discrimination and categorization abilities has examined facial expressions *across* valences (positive vs. negative). Only a few studies have explored infants' ability to discriminate within-valence, negative expressions such as fear and sadness (Parker & Nelson, 2005) or anger and sadness (Schwartz, Izard, & Ansul, 1985). These facial expressions are perceptually and conceptually similar, making discrimination and categorization tasks challenging (Leppänen, Richmond, Vogel-Farley, Moulson, & Nelson, 2009). A lack of empirical attention in this area is problematic, considering that four basic-level emotions (Ekman, 1972) are negatively valenced (i.e., sadness, anger, disgust, fear). Furthermore, research on negative facial expressions has contrasted sadness (a low arousal emotion) with anger or fear (high arousal emotions; i.e., Soken & Pick, 1999). Therefore, categorization in these studies could be attributable to arousal alone. To date, virtually no studies have examined how emotion discrimination and categorization skills develop and change over multiple ages, particularly around the second year of life after the onset of social referencing (Sorce, Emde, Campos, & Klinnert, 1985).

Although less research has been done on preverbal infants' categorization of within-valence facial expressions, a large body of work has examined emotion recognition abilities with verbal children (see Widen, 2013, for a review). It is interesting to note that children, ages two and older, have shown difficulties in emotion categorization tasks with the within-valence facial expressions of anger and disgust (Widen & Russell, 2008, 2010). For instance, Widen and Russell (2003, 2008) asked 2- to 7-year-olds to verbally identify facial expressions (e.g., "how do you think she feels?") or sort photographs of facial expressions into labeled boxes (e.g., "only *happy* people go in this box"). Findings revealed that young children reliably identified happy faces as "happy," yet identified anger, disgust, and fear faces as "anger." Additional studies confirmed that, with disgust in particular, children (3- to 9-years) and adults consistently misidentified disgust facial expressions as anger (e.g., Pochedly, Widen, & Russell, 2012; Widen & Russell, 2010). However, although children consistently misidentified disgust facial expressions as "anger", they did not similarly misidentify anger facial expressions as "disgust." More specifically, the vast majority of children, (a) included disgust faces in a "angry box," (b) freely labeled disgust faces as "angry", and (c) selected a disgust face from an array when asked to select the "angry faces" (for a review, see Widen & Russell, 2013).

Disgust expressions share perceptual and conceptual overlap with anger expressions, which may partially explain the confusion between the emotions. Perceptually, the anger expression is defined by a lowered brow, whereas the disgust facial expression is defined by a wrinkled nose (Ekman & Friesen, 1978). These expressions are perceptually similar enough that adults misidentify disgust faces as "anger" when a disgust facial expression is placed on an angry body expression (i.e., hands raised in a fist; Aviezer et al., 2008). Part of this overlap stems from the fact that anger and disgust are both negative valence, high arousal emotions (Widen & Russell, 2008). In addition, disgust is also a "social emotion," which can be displayed toward humans who exhibit socially and morally unacceptable behaviors (Harris & Fiske, 2006). This "complex" disgust elicits high levels of other negative emotions, particularly anger (Marzillier & Davey, 2004). Taken together, this perceptual and conceptual ambiguity might contribute to disgust's misrecognition as anger in children and adults (Widen & Russell, 2013). For this reason, some scholars have argued that young infants would also be unable to categorize anger and disgust, in addition to other within-valence facial expressions (Lindquist & Gendron, 2013; Widen, 2013).

Current Study

The current study fills in several gaps in the current literature by exploring 10- and 18-month-olds' ability to perceptually discriminate and categorize anger and disgust facial expressions in a looking-time task. First, this study is one of a few to explore how infants perceptually categorize facial expressions: a more difficult task than perceptual discrimination (Casasola & Cohen, 2002). In categorization tasks, infants must recognize the common emotion expression (e.g., anger) expressed across multiple individuals and generalize that expression to novel individuals. Second, this study addressed issues of valence and arousal by contrasting anger versus disgust expressions. These emotions were selected because both represent negative, high arousal emotions, minimizing the possibility that infants would form categories based solely on valence or arousal (e.g., Soken & Pick, 1999). Importantly, these emotions have not yet been contrasted in infant research. Although older children consistently misidentify anger expressions as disgust (Widen & Russell, 2013), it is unclear whether younger infants exhibit similar difficulties.

Finally, to explore developmental differences, the current study examined 10- and 18-month-olds. Few studies have explored multiple ages in facial expression discrimination or categorization tasks, and virtually all existing studies have examined either very young infants (<10 months) or older children (>24 months), leaving a large gap in the literature during the second year of life. During this period, infants achieve several motor and language milestones that may impact their emotion categorization abilities. Specifically, infants become more sensitive to anger expressions at the onset of crawling by 10 months (Campos et al., 2000; Grossmann, Striano, & Friederici, 2007). Further, the onset of the vocabulary spurt at 18 months may alter how emotional expressions are processed (Barrett, Lindquist, & Gendron, 2007). Developmental differences have also emerged between 10- and 18-month-olds in previous categorization tasks with spatial relations (Casasola & Cohen, 2002).

The current study utilized a habitation-categorization paradigm similar to Casasola and Cohen (2002). Infants were habituated to a set of four different faces displaying either anger (anger condition) or disgust (disgust condition). After meeting the habituation criteria, infants were shown four test events: (a) a familiarized (i.e., previously viewed) face displaying the familiar expression (e.g., anger), (b) another familiarized face displaying the alternate/novel expression (i.e., disgust), (c) a novel (i.e., never viewed) face displaying the familiar expression (i.e., anger), and (d) a novel face displaying the novel expression (i.e., disgust). If infants formed a category during habituation, they should look less at the familiarized face displaying the *familiar* expression than at the familiarized face displaying the *novel* expression. Likewise, infants should look less at the novel face displaying the *familiar* expression than to the novel face displaying the *novel* expression. Thus, to form a

category, infants must look less to the habitation emotion relative to the novel emotion regardless of the identity of the face.

We hypothesized that both 10- and 18-month-olds would form categories of the anger and disgust facial expressions. However, we anticipated that developmental differences would emerge between the two age groups. One possibility is that younger, 10-month-old infants would show less sophisticated categorization abilities compared with 18-month-olds. Previous research has found that although both 10- and 18-month-olds can form categories of containment spatial relations, only 18-month-olds appear sensitive to support and tight-fit relations (Casasola & Cohen, 2002). In the current study, 18-month-olds may show more sophisticated categorization abilities due to either (a) a heightened sensitivity and experience with anger facial expressions (Campos et al., 2000; Grossmann et al., 2007) or (b) increased experience with emotion language (Barrett et al., 2007; Ridgeway, Waters, & Kuczaj, 1985). Overall, determining how younger infants perceptually categorize anger and disgust facial expressions at these ages provides both theoretical and practical insights into the requisite skills that drive the development of children's emotion recognition abilities.

Method

Participants

The study was conducted following American Psychological Association (APA) ethical standards and with approval of the institutional review board at Duke University (Approval Number: B0181, Protocol Title: Early Language Learning: Labels for Emotional Expressions). Participants were recruited through public birth records and contacted when they reached the appropriate age. The final sample consisted of 26 10-month-olds (13 female, M = 9.95 months, SD = .26 months, range = 9.54 months–10.46 months) and 26 18-month-olds (13 female, M = 17.97 months, SD = .53 months, range = 17.10 months–18.88 months). Previous research with these methods (Casasola, 2005) has found medium effect sizes with this sample size. A power analysis confirmed that a sample size of 52 infants (26 for each age group) would be sufficient in detecting reliable differences, assuming a medium effect size (f = .25) at the .05 alpha level with a power of .80. All infants were healthy, full-term, and of normal birth weight. Twenty-nine additional infants (10 10-month-olds, 19 18-month-olds) were excluded from final analyses for the following reasons: failure to meet the habituation criteria, described below (n = 11; 2 10-month-olds, 9 18-month-olds), extreme looking times (± 2 SD) during the test trials, indicating a failure to meet the habituation criteria (n = 6; 3 10-month-olds, 3 18-month-olds, see Oakes, 2010), failure to complete the experiment due to fussiness (n = 10; 4 10-month-olds, 6 18-month-olds), and experimenter error (n = 2; 1 of each age). All infants were given a t-shirt and a certificate for their participation.

To assess the degree to which infants in this age range might rely on preexisting semantic representations (i.e., emotion labels) when forming categories of the anger and disgust facial expressions, we solicited parental reports of an independent sample of 12- to 24-month-olds (n = 43). Parents confirmed that none of these infants understood or verbally produced the words "angry," "mad," or "disgust." Therefore, it is unlikely that the current sample would rely on these particular semantic representations to form facial expression categories.

Stimuli

Dynamic events were created in iMovie, using static images from the Radbound Faces Database (Langner et al., 2010). Each event began with a young girl (hereafter, the "actor") displaying a neutral expression. After 1.5 s, the actor's expression shifted from neutral to either anger or disgust. This anger or disgust expression remained for 3.5 s before shifting to a black screen, which lasted for 1 s. These 6-s events were looped five times, without pause, to create a 30-s video, which comprised a single trial in the experiment.

Apparatus

Each infant was tested in a 3-m × 3-m room with a 19-inch color computer monitor and audio speakers. Infants sat on their parent's lap approximately 127 cm from the monitor. A camera located approximately 22 cm below the monitor was connected to a computer and digital video recorder (DVR) in an adjoining control room, which allowed the experimenter to observe and record infants' looking during each trial. The experimenter used the Habit 2000 software program (Cohen, Atkinson, & Chaput, 2000) to present the stimuli, record infants' looking, and calculate the habituation criteria (described below).

Procedure

Participants were tested using a habituation-categorization task (Casasola & Cohen, 2002; Casasola, 2005). After obtaining parental consent, infants were seated on their parent's lap in the testing room. During the session, parents were asked not to speak to their infant or point to the screen. Before each trial, an "attention-getter" (i.e., chiming, expanding circle) directed infants' attention to the monitor. The experimenter began each trial when the infant was looking at the monitor and recorded the duration of the infant's looking behavior during that trial. For a look to be counted, infants had to look continuously for at least 2 s. Each trial played until infants looked away for more than 2 continuous seconds or until the 30-s trial ended.

Participants first saw a pretest trial (i.e., plush pig toy rocking back and forth) designed to acclimate infants to the task and direct their attention to the screen. During habituation, infants saw either anger or disgust facial expressions modeled by four different actors. Habituation trials continued until infants' looking time across the last three trials decreased 50% or more from their looking time during the first three consecutive habituation trials or until all 20 habituation trials were presented (Oakes, 2010). Infants were then presented with four test trials. The *familiarized-face–familiar-emotion* trial was identical to one of the events (e.g., anger) viewed during habituation. The *familiarized-face–novel-emotion* trial depicted another one of the actors viewed during habituation expressing the novel emotion (e.g., disgust). The *novel-face–familiar-emotion* trial depicted a new actor, who was not seen during habituation, expressing the habituation emotion (e.g., anger). Finally, the *novel-face–novel-emotion* trial was of another actor not seen during habituation expressing the novel

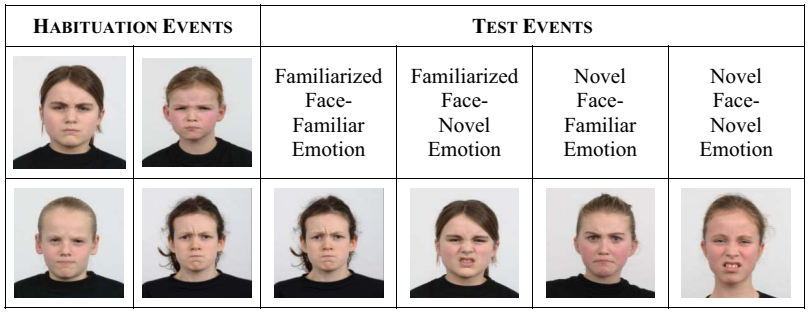

Figure 1. Select habituation and test stimuli for the anger habituation condition. Pictures reprinted with permission from the creators of the Radboud Face Database. For more details, please see "Presentation and Validation of the Radboud Faces Database," by O. Langner, R. Dotsch, G. Bijlstra, D. H. J. Wigboldus, S. T. Hawk, and A. van Knippenberg, 2010 *Cognition & Emotion*, *24*, 1377–1388., Copyright 2010 by Psychology Press. Reprinted with permission. See the online article for the color version of this figure.

emotion (e.g., disgust, See Figure 1). The habituation facial expression (anger or disgust), actors, and presentation order of the test trials were counterbalanced across participants.

After the testing session, parents completed the MacArthur–Bates Communicative Development Inventory (Fenson et al., 2000) to assess infants' vocabularies.

Results

Habituation Phase

To ensure that infants' looking times sufficiently decreased from habituation to test, we conducted a 2 (gender: male vs. female) × 2 (age: 10 months vs. 18 months) × 2 (habituation condition: anger vs. disgust) × 2 (trials: average of first three habituation trials vs. *familiarized-face–familiar-emotion* test trial) mixed-model analysis of variance (ANOVA). This analysis yielded a significant main effect of trials, $F(1, 44) = 58.28$, $p < .001$, $\eta_p^2 = .57$, confirming that infants looked significantly longer during habituation trials ($M = 22.27$ s, $SD = 13.86$ s) than during the *familiarized-face–familiar-emotion* test trial ($M = 7.93$ s, $SD = 4.41$ s). Hence, infants had not reached the habituation criteria by chance (Oakes, 2010). No other significant main effects or interactions emerged, all ps $> .10$.

Test Phase

Infants' looking times during the test trials were analyzed in a 2 (gender) × 2 (age) × 2 (habituation condition) × 2 (expression: familiarized vs. novel) × 2 (face: familiarized vs. novel) mixed-model ANOVA. This analysis yielded a significant Age × Habituation Condition × Face × Expression interaction, $F(1, 44) = 7.24$, $p = .010$, $\eta_p^2 = .14$. Step-down analyses by age were conducted.[1]

10-month-olds. A significant main effect of expression, $F(1, 24) = 12.87$, $p = .001$, $\eta_p^2 = .35$, revealed that 10-month-olds looked significantly longer to novel expressions relative to familiar expressions (see Figure 2). However, a nonsignificant main effect of face, $F(1, 24) = .01$, $p = .918$, suggests that these younger infants did *not* discriminate between the identities (i.e., faces) that displayed these expressions. No other significant main effects or interactions emerged, all ps $> .10$.

18-month-olds. Significant main effects of expression, $F(1, 24) = 18.77$, $p < .001$, $\eta_p^2 = .439$, and face, $F(1, 24) = 7.08$, $p = .014$, $\eta_p^2 = .23$, revealed that 18-month-old infants looked significantly longer at novel expressions compared with familiar expressions *and* at novel faces compared with familiarized faces (see Figure 3). However, a significant Habituation Condition × Expression × Face interaction, $F(1, 24) = 13.19$, $p = .001$, $\eta_p^2 = .36$, suggested that infants' facial expression processing varied as a function of habituation condition.

Simple effect analyses revealed that 18-month-olds who were habituated to disgust expressions (i.e., disgust condition) looked significantly longer at the novel expression (i.e., anger) relative to the familiar expression (i.e., disgust), $F(1, 12) = 12.46$, $p = .004$, $\eta_p^2 = .51$, and at novel faces relative to the familiarized faces, $F(1, 12) = 6.79$, $p = .023$, $\eta_p^2 = .36$. Conversely, although 18-month-olds who were habituated to anger expressions (i.e., anger condition) also looked significantly longer to novel expressions (i.e., disgust) compared with familiar expressions (i.e., anger), $F(1, 12) = 6.42$, $p = .026$, $\eta_p^2 = .35$, they *did not* look significantly longer to novel faces relative to familiarized faces, $F(1, 12) = 1.59$, $p = .232$, $\eta_p^2 = .12$.

In addition, in the anger condition, a significant Expression × Face interaction emerged, $F(1, 12) = 15.46$, $p = .002$, $\eta_p^2 = .56$. Post hoc comparisons revealed that 18-month-olds in this condition discriminated between anger and disgust expressions with the familiarized faces, $t(12) = 4.10$, $p = .001$, yet did not provide evidence of discriminating between the anger and disgust expressions with novel faces, $t(12) = 1.90$, $p = .081$. It is surprising that these looking times were in the *opposite* direction as predicted (see Figure 3). Although infants in this condition were habituated to anger expressions, they attended longer to novel faces expressing familiarized anger expressions than to novel faces expressing novel disgust expressions.

[1] The results remain the same when infant vocabulary, as measured by the MacArthur–Bates Inventory, is entered as a covariate.

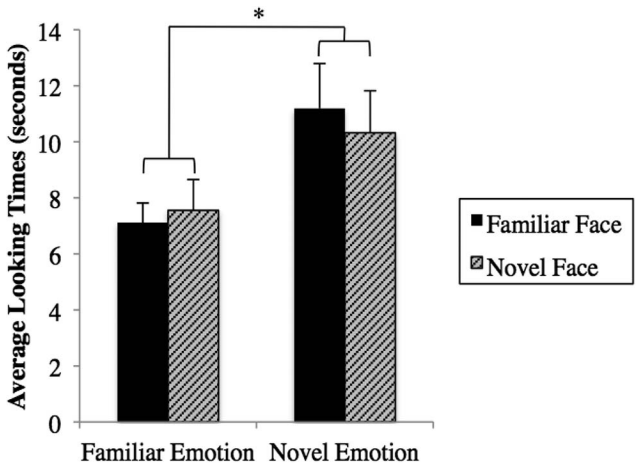

Figure 2. Ten-month-old infants' average looking times (in seconds) and standard errors during test trials. * $p < .05$.

To determine whether a heightened sensitivity to anger expressions may account for these findings (Campos et al., 2000), infants' looking times to *anger expressions* during the test trials were analyzed in a one-way (habitation condition) between-subjects ANOVA. If 18-month-olds were highly sensitive to anger expressions, looking times to anger expressions should not differ significantly across conditions. A nonsignificant main effect of habituation condition, $F(1, 24) = .16$, $p = .690$, $\eta_p^2 = .01$, confirmed this prediction. Infants' looking times to anger expressions did not vary across conditions, suggesting that infants remained highly sensitive to anger expressions regardless of whether they had been habituated to them. This was not the case with disgust expressions. An identical analysis of infants' looking times to disgust expressions yielded a significant main effect of habituation condition, $F(1, 24) = 12.06$, $p = .002$, $\eta_p^2 = .33$, confirming that 18-month-olds who had been habituated to disgust expressions looked significantly less at disgust expressions during the test trials than infants who had been habituated to anger expressions.

Discussion

The current study examined 10- and 18-month-olds' categorization of anger and disgust facial expressions in a looking-time task. If infants formed a category of the habituation emotion (e.g., disgust), they should look longer to the novel emotion (i.e., anger) relative to the habituated/familiarized emotion regardless of the identity of the face. The findings revealed that both age groups formed perceptual categories of anger and disgust facial expressions. However, developmental changes between the groups emerged.

Specifically, 10-month-olds dishabituated to changes in the emotional expression, but did not dishabituate to changes in faces/identity. In contrast, 18-month-olds dishabituated to changes in both expression and identity. These results are similar to Casasola and Cohen's (2002) developmental findings. In their study, although both 10-month-olds and 18-month-olds responded to changes in the familiar versus novel objects, only 18-month-olds responded to changes in familiar versus novel spatial relations. Taken together, it appears that simultaneously tracking multiple pieces of information (e.g., objects + spatial relations/identities + expressions) can be particularly challenging for 10-month-olds. Casasola and Cohen (2002) propose that infants first learn to recognize the objects in an abstract relation, and then learn to recognize the abstract relations *between* the objects. However, in the current study, 10-month-olds demonstrated the opposite pattern, by tracking the abstract emotion (i.e., expression) first, rather than the person's identity (i.e., face).

It is possible that 10-month-olds were unable to discriminate between the identities presented in the experiment. However, this is extremely unlikely given that infants younger than 10 months are sensitive to identity and emotion information with across-valence expressions (e.g., Kahana-Kalman & Walker-Andrews, 2001; Schwarzer & Jovanovic, 2010). An alternative possibility is that within-valence expressions, such as anger and disgust, require additional cognitive resources to process (Leppänen et al., 2009) because they carry additional informational value (Peeters & Czapinski, 1990). For infants, this additional information may elicit greater attention and increase cognitive demands (Vaish, Grossmann, & Woodward, 2008). Ultimately, these demands may have pushed 10-month-olds to selectively attend to the negative, emotional information over identity information. This prioritization of emotion over identify information seems to disappear by 18 months.

In contrast to the 10-month-olds, the 18-month-olds dishabituated to changes in both emotion and identity information. However, this responsiveness to both pieces of information was dependent upon the emotion to which they were habituated. Infants habituated to disgust expressions detected changes in both expression and identity information. In contrast, infants habituated to anger expressions only provided evidence of detecting changes to the novel expression (i.e., disgust) on familiarized faces. One possibility is that these infants did not form emotion categories when habituated to anger expressions. Similiar habituation asymmetries have been reported in the facial expression discrimination literature, particularly with fearful expressions (e.g., Kotsoni et al., 2001; Parker & Nelson, 2005). Specifically, infants tend to show a persistent attentiveness to fearful expressions when habituated to these expressions. For this reason, we suspect that the 18-month-

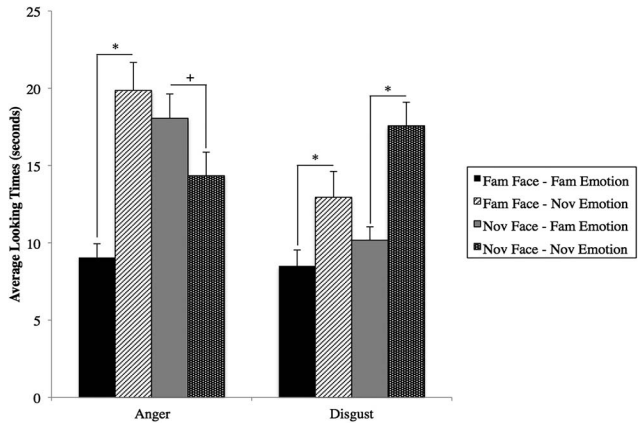

Figure 3. Eighteen-month-old infants' average looking times (in seconds) and standard errors during test trials as a function of habituation condition. + $p = .08$. * $p < .05$.

olds habituated to anger expressions were not insensitive to disgust expressions on novel faces, but rather were *overly* sensitive to anger expressions on novel faces. This interpretation is supported by subsequent analyses confirming that 18-month-olds remained highly attentive to anger expressions across habituation conditions.

These results suggest that anger facial expressions become more salient between 10- and 18 months. Advances in locomotion (e.g., crawling/walking) may help explain why 18-month-olds in the current study maintained a heightened sensitivity to anger expressions. For instance, mothers of locomoting (e.g., crawling) infants report expressing more anger toward their infants than mothers of prelocomoting infants (Campos, Kermoian, & Zumbahlen, 1992). Although many infants begin to crawl before 10 months (e.g., Adolph, Bertenthal, Boker, Goldfield, & Gibson, 1997), they likely have less experience with anger expressions related to their locomotion relative to 18-month-olds, who have already begun to walk. Consequently, this social-emotional experience may have contributed to 18-month-olds' heightened attunement to anger expressions (Grossmann et al., 2007).

Although the current study suggests that 10- and 18-month-old infants form perceptual categories of anger and disgust facial expressions, previous research has found that older, verbal children struggle to categorize anger and disgust expressions (Widen & Russell, 2013). One possible explanation for these developmental differences lies in the task demands across age groups. For infants, emotion categorization abilities have often been tested with looking-time paradigms, where infants must simply determine whether expressions are perceptually "similar" or "different." Alternatively, for older children, emotion categorization is often tested via sorting tasks where children must produce and/or match labels (e.g., "disgust") to facial expressions (Widen & Russell, 2013). As a result, these tasks measure emotion recognition, a more sophisticated ability than the perceptual categorization skills tested in infancy (Walker-Andrews, 1997). A related, albeit speculative, explanation is that younger, preverbal infants can recruit lower-level perceptual skills in these looking-time tasks (Caron, Caron, & Myers, 1985; Quinn et al., 2011), whereas older, verbal children must recruit higher-level conceptual and linguistic skills in labeling and sorting tasks (Widen & Russell, 2008). Future research is needed to pinpoint the type of information used to categorize facial expressions at different stages in development.

The current study is the first to demonstrate that infants as young as 10 months can categorize anger and disgust facial expressions. In addition, by examining two different age groups, these findings provide valuable insights into both how and when infants learn to categorize within-valence, negative emotions in the second year of life. In contrast to previous research on within-valence facial expressions (e.g., anger v. sadness; Soken & Pick, 1999), the current results cannot be attributed solely to differences in arousal, because both anger and disgust are high arousal emotions (Widen & Russell, 2008).

Given the nature of looking-time tasks, the current study cannot determine whether infants conceptually understand/recognize these facial expressions. Future research must determine at what age infants begin to *conceptually* understand within-valence facial expressions. This information could help explain the apparent developmental discontinuity between preverbal infants' and older children's categorization of anger and disgust expressions. Understanding how emotion recognition develops over time is essential, considering that children must know learn to respond appropriately to emotions to have successful social interactions (e.g., Izard et al., 2001; Kennedy & Adolphs, 2012). To truly understand the building blocks of emotion recognition, we need more research at different stages of children's social, cognitive, and linguistic development. In turn, this research has the potential to markedly improve children's emotional recognition skills and their social-emotional outcomes.

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