Emotion

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Infant Differential Behavioral Responding to Discrete Emotions

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Emotional communication regulates the behaviors of social partners. Research on individuals' responding to others' emotions typically compares responses to a single negative emotion compared with responses to a neutral or positive emotion. Furthermore, coding of such responses routinely measure surface level features of the behavior (e.g., approach vs. avoidance) rather than its underlying function (e.g., the goal of the approach or avoidant behavior). This investigation examined infants' responding to others' emotional displays across 5 discrete emotions: joy, sadness, fear, anger, and disgust. Specifically, 16-, 19-, and 24-month-old infants observed an adult communicate a discrete emotion toward a stimulus during a naturalistic interaction. Infants' responses were coded to capture the function of their behaviors (e.g., exploration, prosocial behavior, and security seeking). The results revealed a number of instances indicating that infants use different functional behaviors in response to discrete emotions. Differences in behaviors across emotions were clearest in the 24-month-old infants, though younger infants also demonstrated some differential use of behaviors in response to discrete emotions. This is the first comprehensive study to identify differences in how infants respond with goal-directed behaviors to discrete emotions. Additionally, the inclusion of a function-based coding scheme and interpersonal paradigms may be informative for future emotion research with children and adults. Possible developmental accounts for the observed behaviors and the benefits of coding techniques emphasizing the function of social behavior over their form are discussed.

Keywords: emotional development, emotion responding, functionalist theory

Appreciating and coordinating adaptive behavioral responses to others' emotional signals is crucial for navigating social interactions. For example, witnessing a sad individual may motivate one to attempt to alleviate the distress, whereas observing someone expressing fear may elicit vigilance and identification of the source of threat. Although such differentiated goal-directed responses across discrete emotions clearly occurs for adults, researchers have historically investigated infant emotional responding only from a valence-based perspective (i.e., comparing responses to positive vs. negative emotion). Though informative, this approach is limited. Specifically, one cannot conclude that the discrete *quality* of the positive or negative emotion regulates interpersonal behaviors. The present investigation examined how discrete emotion signals may differentially regulate the behavior of an observer, specifically infants' goal-directed responses.

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Emotion and Emotional Development

From a functionalist perspective, emotions are characterized as an individual's attempt to initiate, maintain, or terminate relations with the environment on matters of significance to the individual (see Barrett & Campos, 1987; Campos, Frankel, & Camras, 2004; Frijda, 1986; Lazarus, 1991). Descriptions of the specific functional relations of discrete emotions with an individual's goals and likely action tendencies exist in the literature (see Barrett & Campos, 1987, Table 9B.1).

Of equal, if not greater importance, emotions also serve as instigators and regulators of *others'* behavior (Klinnert, Campos, Sorce, Emde, & Svejda, 1983). This occurs within a social interaction when one person perceives and responds to the emotion signals of another. To do this effectively, infants must appreciate the quality of the specific emotion communication, termed *affect specificity* (see Montague & Walker-Andrews, 2001), and demonstrate behaviors appropriate and adaptive for that specific emotion given contextual factors (e.g., physical, interpersonal, and cultural), known as *functional affective responding* (Walle & Campos, 2012). While considerable research has investigated the former ability, far less has examined the latter.

Infant Discrimination of Emotion

Previous research has shown that infants can discriminate among different emotions in the sense that they perceive the morphological differences among emotional displays (for a review, see Saarni, Campos, & Witherington, 2006). Habituation and looking time paradigms have tracked infant discriminatory abilities of emotion in the first year of life, indicating that infants as young as 4 months discriminate discrete negative emotions that are presented multimodally through the face and voice (Flom & Bahrick, 2007). This ability continues to develop from 5–7 months of age (Flom & Bahrick, 2007; Walker-Andrews & Lennon, 1991). Furthermore, positive versus negative expressions presented multimodally have been shown to differentially regulate infant behavior by the end of the first half year. For example, Vaillant-Molina and Bahrick (2012) found that 5.5-month-old infants preferentially touched an object toward which an experimenter had directed bimodal (i.e., facial and vocal) expressions of positive emotion rather than negative emotion. However, prior research has not found that infants demonstrate different goal-directed behavioral responses to emotional expressions of the same valence (e.g., anger vs. fear) in the first year of life.

Infant Functional Responding to Emotion

Infants are capable of deploying organized behaviors in response to others' emotions in the second year of life. For example, infants' empathic concern and prosocial behavior to a distressed adult develops markedly between 15 and 24 months (Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992). However, few studies have compared infant responding to different emotions of the same valence in the same paradigm, and those that have often yielded mixed results. For example, Sorce, Emde, Campos, and Klinnert (1985) found that 12-month-old infants rarely crossed over the deep side of a visual cliff when the parent displayed fear or anger, but one-third crossed in response to sadness. However, additional laboratory studies involving infants as old as 15-months failed to identify differential behavioral responding to discrete negative emotions (Bingham, Campos, & Emde, 1987; Campos, Thein, & Owen, 2003).

Other research suggests that differential responding to discrete emotions may occur in some situational contexts by 16- to 19-month-old infants. A small-scale study by Anderson (1994) compared 18-month-old infants' responses to an experimenter's expression of joy, sadness, fear, anger or disgust toward a food item. Infants were more likely to look away from the food or give the experimenter the food when she displayed sadness and were more likely to push the food away when she expressed disgust. Martin, Witherington, and Edwards (2008) utilized a similar paradigm in which an experimenter expressed an emotion toward 1 of 2 toys. The researchers found that 17-month-old infants played less with a toy labeled with fear than a toy labeled with sadness, and showed more facial concern in response to the sad display than the fear display; 13-month-old infants showed no such differential responding between emotions. A follow-up study found similar age differences in responding, with older infants touching the target toy more than a distractor toy in the surprise and happy conditions, but touching the distractor toy more in the anger and fear conditions (Martin, Maza, McGrath, & Phelps, 2014).

Thus, it seems possible that infants are capable of differentially deploying organized behavioral responses to discrete emotions during the second year of life. However, previous research has been constrained by paradigmatic designs that limit the appropriateness of manipulating different emotions in a single context and that restrict the range of infant behaviors that could be elicited and coded. As such, the emergence of infant differential goal-directed responding to discrete emotions remains unclear.

Considerations for the Study of Differential Functional Behaviors

To systematically investigate infants' differential responding to expressions of different discrete emotions, it is necessary that research aimed at identifying differentiated behavioral responses include a range of emotions *and* afford the infant flexibility to deploy a range of organized behaviors (Walle & Campos, 2012). The present investigation emphasized three considerations to address these criteria.

Flexible Contexts

The manipulation of the emotion observed by the infant demands that the experimental context be plausible for each emotion to be studied. For example, although Sorce et al. (1985) included multiple discrete emotions in the visual cliff paradigm, the context in which the emotions were presented was not equally plausible for all conditions, particularly for the sadness condition. A more flexible context is evident in studies utilizing a broken toy (Bingham et al., 1987), in which one may be sad, but also angry or afraid, and possibly even disgusted if the broken toy made a mess. Likewise, paradigms in which one looks inside of a box at a novel object (e.g., Repacholi, 1998) are similarly ambiguous with regard to an a priori corresponding emotion. The present investigation utilized such flexible contexts (i.e., a broken toy, a box with novel contents) to manipulate the discrete emotion communicated by the experimenter and observed by the infant.

Flexible Coding

Previous research has often used paradigms that restrict the range of infant responding or has coded for a limited number of behavioral variables. For example, social referencing paradigms typically code infant behavior as "approach" or "avoidance" of the referent (e.g., crossing or not crossing on the visual cliff; time spent touching the stimulus). Paradigms in which the infant is seated in a highchair similarly restrict the range of behavioral coding afforded by the scenario (e.g., time spent looking to a screen, facial affect). Eliciting flexible goal-directed responses necessitates that researchers loosen control of the experimental setting and provide a more ecologically valid context. More important, implementation of paradigms that provide infants with flexible responding necessitates that similarly flexible coding strategies are adopted to validly measure such responses. Furthermore, while we agree that certain functional responses are likely to be more adaptive in some emotional contexts than in others (see Walle & Campos, 2014), it should *not* be expected that functional behaviors correspond solely with a single emotion.

Equifinality as Problem and Solution

The principle of equifinality is central to the present study given the above two considerations. Equifinality refers to the possibility that an emotion-related goal may be achieved through multiple, potentially distinct means. Consider observing an individual communicating sadness upon a toy breaking. One's response to the sad individual may take many forms (e.g., fixing the toy, providing a new toy, enlisting help from a third party, hugging the person). However, these distinct manifestations of behavior share the same underlying function (i.e., to alleviate the distress of the sad individual), and thus demonstrate multiple means to achieve the same end (i.e., equifinality). With this in mind, the present investigation utilized a coding system that focused on the overarching goal of the child's behavior rather than the specific behaviors used to achieve that goal.

Such an approach can be found in the seminal developmental research on infant attachment (for an excellent review, see Sroufe & Waters, 1977). Researchers of attachment reason that infants can maintain a sense of close contact with the secure base in a variety of ways (Bowlby, 1969), such as grasping tightly to the caregiver, moving toward the caregiver, looking to the caregiver from a distance, or vocalizing to the caregiver (e.g., Ainsworth & Bell, 1970; Ainsworth, Blehar, Waters, & Wall, 1978; Carr, Dabbs, & Carr, 1975). A similar emphasis on coding the function of interpersonal behaviors can be found in emotion research with adolescents (e.g., Hollenstein, Allen, & Sheeber, 2016; Main, Paxton, & Dale, 2016) and adults (e.g., Carstensen, Gottman, & Levenson, 1995; Gottman & Krokoff, 1989). Although functionally oriented coding systems could be considered to involve an undesirable degree of subjective judgment, a number of researchers have convincingly argued that it is both feasible and often preferable to utilize such a system because of its greater validity (e.g., for reviews, see Gottman, McCoy, Coan, & Collier, 1996; Sroufe & Waters, 1977; Walle & Campos, 2012). Additionally, whereas specific behaviors may be bound by affordances or constraints inherent in the context, functional coding is more likely to be applicable *across* contexts. For example, measuring security seeking in terms of the infant's physical proximity to the caregiver is inextricably linked with an experimental setting that affords such measure (e.g., a highchair, a testing room, a playground). However, coding the function of the behavior according to whether it was indicative of security seeking can allow the researcher to compare infant behaviors across multiple contexts. Based on these considerations, the present investigation sought to utilize a coding scheme that tapped into the function of infant behaviors rather than coding a set of particular concrete actions.

The Present Investigation

This study investigated infant behavioral responding to discrete emotions at three ages. Twenty-four-, 19-, and 16-month-old infants were observed responding to an experimenter's expression of emotion (joy, sadness, fear, anger, or disgust) in two separate, but similar, contexts. The infant age groups were selected based on prior research indicating that infants demonstrate clear responding to the valence of emotional displays early in the second year (e.g., Bingham et al., 1987), exhibit some coordinated behavioral responses in the middle of the second year (e.g., Martin et al., 2008; Zahn-Waxler et al., 1992), and may differentially respond to discrete emotions at the end of the second year (e.g., Denham, 1986; though, as noted above, research on this capacity is limited). The contexts were constructed to be plausible for the display of each emotion and allow maximal flexibility of infant responding, and were based on paradigms previously used to study infant responding to emotional communication in the second year of life (e.g., Bingham et al., 1987; Repacholi, 1998). Infant behavior was coded for the function of the response (i.e., the goal of the behavior). Additionally, the design of the paradigms and coding was intended to allow for the contexts to be collapsed for a more powerful analysis.

More important, it was distinctly *not* our prediction that a functional behavior would demonstrate a clear 1:1 matching with a discrete emotion. Rather, given the flexibility with which such behaviors can be deployed, we examined differences in the prevalence of functional behaviors across each emotional context. Elaboration of the functional behaviors measured in this study and specific emotion-related hypotheses for each are provided in the subsequent Coding section.

Additionally, although three separate age groups were tested, the primary aim of the study was to provide analysis of infant behavioral responding at each age, not to test how particular behaviors may emerge or change over time, for which a longitudinal design would be more appropriate. Thus, although we did not explicitly compare certain behaviors between age groups, we do provide descriptive age comparisons of the observed behaviors in each age group in the Discussion section.

Method

Participants

Participants were recruited from the San Francisco Bay and California Central Valley areas from a database of parents who had expressed interest in allowing their child to participate in research. Information regarding the ethnicity and racial composition of participants was missing for 69 out of the 296 infants in the final sample. Thus, the descriptions of these variables provided below reflect information for those participants who responded.

Twenty-Four-Month-Olds. The initial sample consisted of 120 24-month-old infants. All or part of the data for 49 additional infants (all = 14, part = 35) were not included in the final sample because of experimenter error ($n^1 = 15$), infant fussiness ($n = 4$; the infant refused to engage with the experimenter before the emotional display), infant inattention to the presentation of the emotional display[2] ($n = 38$), parental interference ($n = 4$), and infant physical disability ($n = 2$; the infant's leg was in a cast preventing mobility). The final sample consisted of 106 infants (54 female) with a mean age of 24.15 months ($SD = 0.67$ months, range = 23.08–25.25 months) who participated in the paradigms (see Table 1). The racial composition consisted of 3% Black, 3% Asian, 13% Hispanic, 53% White, and 28% "Other."

Nineteen-Month-Olds. The initial sample consisted of 109 19-month-old infants. All or part of the data for 47 additional infants (all = 7, part = 40) were not included in the final sample because of experimenter error ($n = 8$), infant fussiness ($n = 24$), infant inattention to the presentation of the emotional display ($n = 19$), parental interference ($n = 2$), and equipment failure ($n = 2$).

[1] Note: "n" refers to individual cases, not infants.

[2] Infants were excluded if they did not attend to the experimenter's emotional expression to ensure that observed behaviors were in response to the emotional communication.

Table 1
Participants Sorted by Age, Paradigm, and Emotion

	24-month-olds			19-month-olds			16-month-olds		
Condition	Box	Bunny	Total	Box	Bunny	Total	Box	Bunny	Total
Joy	15	18	33	18	16	34	15	15	30
Sadness	17	17	34	13	16	29	13	17	30
Fear	17	18	35	15	18	33	14	16	30
Anger	18	20	38	13	18	31	13	12	25
Disgust	17	20	37	21	17	38	11	13	24
Total	84	93	177	80	85	165	66	73	139

The final sample consisted of 102 infants (52 female) with a mean age of 19.15 months (SD = 0.61 months, range = 18.05–20.28 months) who participated in the paradigms (see Table 1). The racial composition was 4% Black, 22% Asian, 18% Hispanic, 28% White, and 28% "Other."

Sixteen-Month-Olds. The initial sample consisted of 103 16-month-old infants. All or part of the data for 51 additional infants (all = 15, part = 36) were not included in the final sample because of experimenter error (n = 13), infant fussiness (n = 22), infant inattention to the presentation of the emotional display (n = 22), parental interference (n = 6), equipment failure (n = 2), and infant physical disability (n = 2), The final sample consisted of 88 infants (46 female) with a mean age of 16.04 months (SD = 0.60 months, range = 14.96–17.29 months) who participated in the paradigms (see Table 1). The racial composition of the infants in the final sample consisted of 2% Black, 5% Asian, 7% Hispanic, 2% Native Hawaiian or Other Pacific Islander, 54% White, and 30% "Other."

Procedure

Infants were randomly assigned to an emotion condition for each of two paradigms, with the stipulation that the emotion was never the same for both paradigms. All infants followed a set order during their visit to the lab. The visit took place in two separate, but interconnected, rooms so as to allow the experimenters to move between the two rooms unbeknownst to the infant and parent. The infant and parent were always moved between the rooms through a series of hallways so as to suggest that the rooms were separate and distinct, and to help prevent carryover or transference from one testing room to another. Additionally, a unique female experimenter was used in each paradigm to express the emotion to minimize carryover effects.

Warm-Up. The infant was first brought to a comfortable room featuring a basket of toys and was encouraged to explore the warm-up space. A female experimenter (E1) played with the infant to help the infant to adapt to the new surroundings and to establish a friendly rapport. During this time a second experimenter (E2) explained all procedures to the parent and the parent completed consent forms and the demographic questionnaire.

Bunny familiarization phase. Once the infant appeared comfortable, E2 directed the infant's attention to a bin on a shelf, which she brought down to the floor in front of her. E2 then took out a plush bunny doll from the bin, showed it to the infant, and said, "This is my friend Mr. Bunny." E2 proceeded to play with the doll and verbally described its features, including its floppy ears, arms, and legs. This familiarization phase was intended to draw the infant's attention to the fact that the bunny doll was fully intact. After no more than 1 min of the infant attending to the bunny, E2 returned the bunny doll to the bin and placed the bin back on the shelf.

Mystery box paradigm. The first paradigm took place in a 10' × 15' room featuring a low table (2' × 6' × 2') positioned in the middle of the room. Behind the table in one corner was a chair for the parent and in the other corner was a basket of toys. Upon entering the room, E1 guided the infant to the low table, taking her position behind the table with the infant on the opposite side of the table facing E1. Meanwhile, E2 instructed the parent to sit in the chair diagonally behind the infant and complete a questionnaire so as to distract the parent from interfering with the experiment. E2 then appeared to leave the room through a false door, but was able to hear the session.

Next, E1 took out an opaque plastic box (6" × 6" × 6") that was covered with a lid and said, "Hmm, I wonder what's in this box . . ." E1 removed the lid, looked inside, and said, "[emotion noise], there's a fobble[3] in the box. I can't believe there's a fobble in the box," while communicating the emotion through her face, voice, and posture (for descriptions of each display, see Table 2). While emoting, the experimenter tilted the box toward the infant to show the infant its contents, but kept the box out of the infant's reach. The box contained a novel, pink and purple rubber toy with various nobs and protrusions emanating from the center. The toy was specifically selected to be slightly ambiguous in appearance and inherently neutral. E1 clearly directed her emotional communication toward the contents of the box, not the infant. E1's emotional communication lasted approximately 6 s, at which time she placed the lid back on the box and placed the box in the center of the table in front of and within reach of the infant. Infants had 40 s to freely respond to the emotional context, during which E1 continued to express the emotion both facially and posturally and repeated up to two shortened phrases of the emotional message, "there's a fobble in the box," if the infant looked to her. E2 kept time for the experiment beginning when E1 had completed the initial emotion script, and verbally signaled when the testing session was complete.

Ten-minute break. Following completion of the first paradigm, both experimenters guided the infant and parent back to the initial warm-up room and took a break of no less than 10 min.

[3] Note: The word "toma" was substituted for infants whose parents indicated that the infant was familiar with the word "fobble."

Table 2
Descriptions of Emotion Displays

Emotion	Face	Voice	Posture	Gesture
Joy	-Raised eyebrows -Eyes widened -Mouth turned upward in smile with no teeth showing	-High-pitched -Variable pitches -Elongated pronunciation -"Giggly" sound, "Oiuuuu!"	-Shoulders back and lowered -Chest slightly pushed out -Head raised up -Tall posture	-Steady point -Slight movement
Sadness	-Eyebrows raised -Eyes "glassy" looking downward -Lips downturned -Lips loosely together	-Low in tone -Slightly "sniffly" -"Whiny" sounding, "Awwww"	-Slumped -Diminutive	-Loose point -Slightly limp hand
Fear	-Eyebrows together, not lowered -Eye widened -Mouth open, tightened, and drawn back	-"Shaky" -Up and down intonation -"Whuaaaa"	-Shoulders drawn back at an angle	-Shaking point -Hand close to body
Anger	-Eyebrows furrowed, lowered, and brought together -Gaze stilling -Lip tightened -Clinched jaw	-Stern -Rigid -"Grunting sound"	-Tight -Tense -Still	-Index finger at constant distance -Forceful up and down pointing motion
Disgust	-Eyebrow furrowed -Eyes squinting -Nose scrunching -Mouth downturned -Slight pucker	-Orally rejected -Elongated syllables -Rough intonations, "Ewwwgh!"	-Head back	-Jabbing pointing -Hand not withdrawn from the body

During this time, the infant was again allowed to play on the floor with a basket of toys, this time playing with E2. Meanwhile, E1 interacted with the parent and explained the procedures for the second paradigm.

Broken bunny paradigm. The second paradigm took place in the warm-up room. E1 positioned the parent in a chair in one corner of the room and instructed the parent to complete a questionnaire. A toy basket was located in the other corner, similar to the positioning used in the first paradigm. E1 then left the space by moving behind a curtain that appeared to lead to another room.

E2 situated the infant near the bookcase where the bin was located, saying, "Do you remember my friend Mr. Bunny? Let's see Mr. Bunny . . ." Unbeknownst to the infant, the intact bunny had been switched with an identical bunny with its leg torn off and its stuffing spilling out. In clear view of the infant, E2 took down the bin, removed the bunny from the bin with a piece in each hand, and set the body and detached leg on the floor between the infant and E2 so that the pieces were clearly separate. E2 then said, "[emotion noise], look what happened to the bunny. I can't believe that this happened to the bunny," while communicating the emotion through her face, voice, and posture (see Table 2). E2 clearly directed her emotional communication toward the broken bunny, not the infant. E2's emotional communication lasted approximately 6 s. Infants were free to respond to the emotional context for 40 s, during which E2 continued to express the emotion facially and posturally and repeated up to two shortened phrases of the emotional message, "Look what happened to the bunny," if the infant looked to her. E1 kept time for the experiment beginning when E2 completed the initial emotion script, and verbally signaled when the testing session was complete.

Video recording. Three cameras recorded the entire experimental procedure for each paradigm. Cameras 1 (C1) and 2 (C2) were mounted on walls on opposite sides of the room (C1 near the parent, C2 in the toy area), and faced the experimenter. These camera angles were used to evaluate the experimenter's emotion display (see Manipulation check below) and to view the infant if she or he moved away from the experimenter. Camera 3 (C3) was positioned behind the experimenter facing the infant. C3 provided a clear view of the infant's behavioral response to the experimenter and stimulus. The three video angles were synchronized to provide a comprehensive view of the infant.

Manipulation check. Two research assistants, naïve to the experimental condition, viewed all videos to ensure that the experimenter effectively communicated the assigned emotion. Each coder first selected the emotion believed to have been communicated by the experimenter from a list of five emotions (joy, sadness, fear, anger, or disgust), which resulted in 100% agreement. Coders then rated the experimenter's emotional communication as expressed in the face, voice, and posture for the selected emotion using a 3-point scale. Ratings were based on their perceived similarity with the descriptions listed in Table 2. Ratings were as follows: 0 = unacceptable/break in character, 1 = dull, 2 = acceptably executed. Interrater agreement of the quality of the experimenter's emotional display was excellent (percent agreement = 94%). Trials in which the experimenter displayed the incorrect emotion ($n = 0$) or was rated as "unacceptable" or "dull" ($n = 36$) were excluded from the final sample because of experimenter error.

Coding

Functional coding scheme. A coding scheme categorizing the apparent goal of the infant's response was developed based on previous theoretical (e.g., Walle & Campos, 2012) and empirical work (e.g., Boccia & Campos, 1989; Sorce et al., 1985; Zahn-Waxler et al., 1992). Each code served to identify the underlying goal of the infant's behavior and did not necessitate that a specific criterial behavior be present. This approach is in contrast to one in which prespecified component indicators are used to identify the function of the response. Specifically, coders were instructed to code the gestalt of the behavior (e.g., whether the goal was to help the experimenter), as opposed to looking for specific indicators (e.g., whether the infant furrowed their eyebrows, had sadness in the eyes, and increased proximity to the experimenter; e.g., Vaish, Carpenter, & Tomasello, 2009).

Six functional codes were assigned: seek security, social avoidance, information seeking, prosocial responding, exploration of the stimulus, and relaxed play. Although it may have been possible to code additional functional behaviors, the selected codes were included because (a) previous evidence indicated that infants of the targeted ages could demonstrate each functional behavior, (b) the prevalence of each functional behavior was hypothesized to vary as a function of discrete emotion (described below), and (c) the codes were of a sufficient level of granularity so as to capture distinctions between infant behaviors while not but not be overly burdensome for coders.

Two raters naïve to the study's hypotheses and predictions independently reviewed videos of each infant response and assigned functional scores in the order that they occurred. The videos included both audio and visual information regarding the emotion communicated by the experimenter. Raters were allowed to rewatch each video as many times as necessary and could assign multiple functional codes for each trial. For example, an infant who first sought information from the experimenter, then sought security from the caregiver, and then again sought information would be scored as: Seek Information, Seek Security, Seek Information. As noted in the introduction, distinct behaviors can accomplish the same goal (e.g., one may alleviate distress by providing a comforting hug *or* ignoring the victim so as to not draw attention to their state), and a singular discrete behavior can potentially be in the service of different goals (e.g., the act of giving someone a toy can function to play with them *or* to provide them with a distraction). Thus, coders were explicitly instructed to infer the underlying goal of infants' behavior, not to code its surface-level manifestation.

Coders rated each functional behavior separately as present or absent during each 40-s trial. Coders overlapped in coding 21% of trials to provide sufficient reliability. Interrater reliability ranged from acceptable to excellent (Landis & Koch, 1977). Function codes, corresponding κ values, and specific hypotheses for each behavior were as follows.

Security seeking (κ = .88). Infant behavior in the service of seeking comfort or security from the caregiver. This often occurred when the infant (a) retreated to the caregiver's location with the intent to seek comfort, (b) asked the caregiver for comfort, or (c) demonstrated "checking in" behaviors (e.g., looks, vocalizations) toward the caregiver with the goal to feel safe. We hypothesized that infants would be more likely to demonstrate security seeking in the fear condition than in other emotion conditions (e.g., Klinnert, 1984).

Social avoidance (κ = .58). Infant behavior in the service of avoiding engagement with the experimenter, yet without seeking security from the caregiver. The avoidant infant often (a) retreated a distance away from the experimenter to avoid the situation, yet did not seek security from the caregiver, or (b) "froze" in a tense posture, and exhibited careful monitoring of the experimenter's behaviors, but in an inconspicuous manner so as to not draw attention to the self. We hypothesized that infants in the anger condition would be more likely to respond with social avoidance than in other emotion conditions (Camras, 1977; Denham, 1986; Strayer, 1980).

Information seeking (κ = .73). Infant behavior in the service of obtaining additional information about the context. This functional behavior typically involved (a) looking from the stimulus to the experimenter or vice versa to determine the source of the experimenter's emotional outburst, or (b) asking questions to disambiguate the situation (e.g., "What happened?"). Seeking of information, a behavior similar to social referencing, is likely an adaptive response for most emotional contexts (e.g., Sorce et al., 1985), and thus no a priori hypotheses were made regarding infants' information seeking across emotion conditions.

Prosocial responding (κ = .70). Infant behavior intended to help the experimenter or relieve her condition in some way. This goal-directed behavior took many different forms, including (a) sharing a different object or toy with the experimenter, (b) distracting the experimenter from the emotional stimulus by directing the experimenter's attention elsewhere, (c) eliciting the caregiver's help (e.g., "Mommy, fix."), or (d) attempting to resolve the situation (e.g., reattach the leg). We hypothesized that infants would be most likely to respond with prosocial behavior in the sadness condition compared to other emotion conditions (e.g., Zahn-Waxler et al., 1992).

Exploration of the stimulus (κ = .84). Infant behavior in the service of exploring the stimulus. Exploration often appeared as (a) manipulating the stimulus to bring it closer to the eyes, (b) peering in closer at the stimulus without handling it, or (c) manipulating (e.g., poking) the stimulus to discover more about its properties. We hypothesized that infants would be less likely to respond with exploratory behavior in the disgust condition (Repacholi, 1998) than in the other emotion conditions.

Relaxed play (κ = .80). Infant engagement in a playful manner with the experimenter, caregiver, or available toys. Relaxed infants often (a) appeared unaffected by the emotional display (even though they observed it) or (b) engaged with the caregiver or experimenter in play-like behavior. We hypothesized that infants would be more likely to exhibit relaxed play in the joy condition (e.g., Hertenstein & Campos, 2001; Klinnert, 1984) than the other emotion conditions.

Infant vocalizations to experimenter. Infant vocalizations were defined as any purposeful vocal production by the infant to communicate to the experimenter (e.g., grunts, babbling, and words) spaced approximately 1 s from other vocalizations. This operationalization helped to account for differences in verbal ability across infant age groups. Laughter, crying, and vegetative sounds (e.g., humming) were not coded as vocalizations. One rater naïve to the study's hypotheses reviewed all videos and counted the number of infant vocalizations. An additional naïve independent coder rated 25% of videos, which resulted in excellent interrater agreement (r = .97, M_{diff} = 0.04). We hypothesized that infants would vocalize to the experimenter less in the anger, fear, and disgust conditions, as these emotions have been shown to be associated with social withdrawal (e.g., Camras, 1977; Strayer, 1980), and more in response to joy and sadness emotions, which have been found to elicit social engagement (e.g., Strayer, 1980; Zahn-Waxler et al., 1992).

Results

Analytic Strategy

The analytic strategy closely followed recommendations outlined for conducting multiple comparisons (see Howell, 2010; Hsu, 1996; Keppel & Zedeck, 1989; Ruxton & Beauchamp, 2008; Wilcox, 1987). Specifically, for each of the a priori hypotheses, planned comparisons of infant behaviors were first conducted between specific emotion conditions. Additionally, post hoc comparisons examined differences in the prevalence of specific functional behaviors across the emotion conditions for which no hypotheses were specified. Benjamini-Hochberg corrections for multiple comparisons were used in these post hoc comparisons to control the false-discovery rate (Benjamini & Hochberg, 1995).

Planned and post hoc comparisons of infant behaviors were conducted independently for each age group using linear mixed effect models specified with either a binomial distribution and a logit link (functional behaviors) or a normal distribution and an identity link (infant vocalizations). Restricted maximum likelihood (REML) and Satterthwaite approximation for degrees of freedom were used for all models (see Wilcox, 1987). Additionally, paradigm (Mystery Box, Bunny) was included as a within-subjects factor in all models to account for any unanticipated differences across contexts. Infant vocalizations to the experimenter were log-transformed to account for positive skew before analysis. Significant differences in infant behavioral responding between emotion conditions for each age group are presented using horizontal subscripts in Table 3.

Security Seeking

Our a priori hypothesis was that infant security seeking would be most likely to occur in the fear condition in comparison to the other emotion conditions.

Twenty-four-month-old infants. Planned comparisons revealed that 24-month-old infants in the Fear condition were significantly more likely to exhibit security seeking than infants in the Joy condition, $t(34) = 3.18$, $p = .003$, $d = 0.78$, 95% confidence interval (CI) [0.08, 0.37]. Post hoc comparisons indicated that infants in the Joy condition were significantly less likely to seek security than infants in the Sadness, $t(33) = 2.94$, $p = .01$, $d = 0.73$, 97.5% CI[4] [−0.37, −0.04], Anger, $t(37) = 5.02$, $p < .001$, $d = 1.21$, 99.17% CI [−0.62, −0.18], and Disgust conditions, $t(36) = 4.83$, $p < .001$, $d = 1.17$, 98.33% CI [−0.58 −0.18].

Nineteen-month-old infants. Our planned comparisons indicated that infants in the Fear condition were significantly more likely to exhibit security seeking than infants in the Joy condition, $t(39) = 4.00$, $p < .001$, $d = 0.97$, 95% CI [0.17, 0.53]. Post hoc comparisons indicated that infants in the Joy condition were significantly less likely to seek security than infants in the Sadness, $t(34) = 3.20$, $p = .003$, $d = 0.82$, 98.33% CI [−0.55, −0.07], Anger, $t(39) = 2.35$, $p = .02$, $d = 0.59$, 97.5.% CI [−0.38, −0.001], and Disgust conditions, $t(46) = 3.38$, $p = .002$, $d = 0.81$, 99.17% CI [−0.48, −0.05].

Sixteen-month-old infants. Planned comparisons revealed that infants in the Fear condition were significantly more likely to exhibit security seeking than infants in the Joy condition, $t(29) = 2.98$, $p = .01$, $d = 0.78$, 95% CI [0.07, 0.39]. Post hoc comparisons among the other emotion conditions were not significant after the Benjamini-Hochberg correction.

Social Avoidance

It was hypothesized that infants would be most likely to demonstrate social avoidance in response to anger than to the other emotion conditions.

Twenty-four-month-old infants. As hypothesized, infants in the Anger condition were significantly more likely to demonstrate social avoidance than infants in the Joy, $t(47) = 3.22$, $p = .002$, $d = 0.78$, 95% CI [0.10, 0.41], Sadness, $t(48) = 3.26$, $p = .002$, $d = 0.78$, 95% CI [0.10, 0.41], Fear, $t(46) = 3.25$, $p = .002$, $d = 0.77$, 95% CI [0.10, 0.41], and Disgust conditions, $t(64) = 2.19$, $p = .03$, $d = 0.51$, 95% CI [0.02, 0.34]. Post hoc comparisons did not reveal any significant differences between other emotion conditions.

Nineteen-month-old infants. Neither planned nor post hoc comparisons revealed any significant differences between emotions.

Sixteen-month-old infants. Similar to the 19-month-old infants, neither planned nor post hoc comparisons revealed significant differences between emotions.

Information Seeking

No a priori hypotheses were made regarding infant use of information seeking across emotion conditions.

Twenty-four-month-old infants. Corrected post hoc comparisons revealed no significant differences between emotions for the 24-month-old infants.

Nineteen-month-old infants. Post hoc comparisons revealed that infants in the Disgust condition were significantly more likely to engage in information seeking than infants in the Joy, $t(61) = 4.36$, $p < .001$, $d = 1.04$, 99.5% CI [0.15, 0.73], Sadness, $t(50) = 2.75$, $p = .01$, $d = 0.69$, 98% CI [0.04, 058.], and Anger conditions, $t(53) = 3.42$, $p = .001$, $d = 0.84$, 99% CI [0.08, 0.63]. Infants in the Fear condition were also significantly more likely than infants in the Joy condition to engage in information seeking, $t(65) = 2.86$, $p = .01$, $d = 0.71$, 98.5% CI [0.04, 0.59].

Sixteen-month-old infants. In the youngest age group, post hoc comparisons revealed that infants in the Joy condition were significantly less likely to engage in information seeking than infants in the Sadness, $t(57) = 2.85$, $p = .006$, $d = 0.74$, 99% CI [−0.65, −0.02], Anger, $t(49) = 2.57$, $p = .01$, $d = 0.71$, 98.5% CI [−0.66, −0.01], and Disgust conditions, $t(48) = 2.96$, $p = .0048$, $d = 0.83$, 99.5% CI [−0.72, −0.003].

Prosocial Responding

We hypothesized that infants would be most likely to demonstrate prosocial responding when the experimenter expressed sadness than when she communicated other emotions.

[4] Confidence intervals greater than 95% reflect Benjamini-Hochberg corrected α levels for post hoc comparisons (see Benjamini & Hochberg, 1995).

Table 3
Percentage of Infants Demonstrating Each Behavioral Response

Behavior	Age	Joy	Sadness	Fear	Anger	Disgust
Security seeking	24	0%$_{SFAD}$	21%$_{J}$	23%$_{J}$	39%$_{J}$	38%$_{J}$
	19	6%$_{SFAD}$	31%$_{J}$	36%$_{J}$	26%$_{J}$	32%$_{J}$
	16	0%$_{F}$	7%	23%$_{J}$	12%	17%
Social avoidance	24	3%$_{A}$	3%$_{A}$	3%$_{A}$	29%$_{JSFD}$	11%$_{A}$
	19	0%	7%	6%	3%	3%
	16	0%	0%	3%	4%	0%
Information seeking	24	55%	59%	71%	63%	65%
	19	38%$_{FD}$	52%$_{D}$	70%$_{J}$	48%$_{D}$	82%$_{JSA}$
	16	27%$_{SAD}$	62%$_{J}$	47%	60%$_{J}$	63%$_{J}$
Prosocial response	24	39%	47%$_{A}$	31%	21%$_{S}$	32%
	19	18%$_{S}$	38%$_{J}$	30%	39%	32%
	16	13%$_{S}$	41%$_{JD}$	33%	24%	13%$_{S}$
Explore stimulus	24	88%$_{SFAD}$	53%$_{JD}$	49%$_{J}$	42%$_{J}$	30%$_{JS}$
	19	71%$_{FD}$	41%	36%$_{J}$	45%	26%$_{J}$
	16	73%$_{AD}$	55%	53%	36%$_{J}$	46%$_{J}$
Relaxed play	24	24%$_{FA}$	9%	6%$_{J}$	3%$_{J}$	16%
	19	32%$_{FD}$	21%	12%$_{J}$	19%	5%$_{J}$
	16	60%$_{SFAD}$	14%$_{J}$	23%$_{J}$	28%$_{J}$	13%$_{J}$
Vocalizations to experimenter	24	3.12$_{A}$	2.97$_{A}$	1.71	1.68$_{JS}$	2.00
	19	2.76	1.48	1.52	1.97	1.53
	16	3.10$_{FD}$	2.27	1.80$_{J}$	2.08	1.63$_{J}$

Note. Letters next to each percentage (J = joy, S = sadness, F = fear, A = anger, D = disgust) designate which pairwise comparisons were significantly different. For example, 24-month-old infants were significantly less likely to seek security in the joy condition (0%) than in the fear (23%), anger (29%), and disgust (38%) conditions. Post hoc comparisons were adjusted using Benjamini-Hochberg correction for multiple contrasts (starting $\alpha = .05$).

Twenty-four-month-old infants. Planned comparisons revealed that infants in the Sadness condition were significantly more likely to demonstrate prosocial behavior than infants in the Anger condition, $t(63) = 2.42$, $p = .02$, $d = 0.53$, 95% CI [0.05, 0.48]. Post hoc comparisons revealed no significant differences between other emotion conditions.

Nineteen-month-old infants. Our planned comparisons for the 19-month-old infants revealed that infants in the Sadness condition were significantly more likely to demonstrate prosocial behavior than infants in the Joy condition, $t(48) = 2.06$, $p = .04$, $d = 0.53$, 95% CI [0.00, 0.42]. However, post hoc comparisons among the other emotion conditions did not remain significant after the Benjamini-Hochberg correction.

Sixteen-month-old infants. Planned comparisons revealed that infants in the Sadness condition were significantly more likely to demonstrate prosocial behavior than infants in the Joy, $t(49) = 2.55$, $p = .01$, $d = 0.67$, 95% CI [0.06, 0.50], and Disgust conditions, $t(47) = 2.77$, $p = .01$, $d = 0.77$, 95% CI [0.08, 0.51]. Post hoc comparisons among the other emotion conditions did not remain significant after the Benjamini-Hochberg correction.

Exploration of the Stimulus

Infant exploration of the stimulus was hypothesized to be least prevalent in response to disgust than to other emotions.

Twenty-four-month-old infants. The planned comparisons in the oldest age group revealed that infants were significantly less likely to demonstrate stimulus exploration in the Disgust condition than in the Joy, $t(59) = 6.59$, $p < .001$, $d = 1.60$, 95% CI [−0.79, −0.42], and Sadness conditions, $t(67) = 2.11$, $p = .04$, $d = 0.51$, 95% CI [−0.47, −0.01]. Post hoc comparisons indicated that infants in the Joy condition were significantly more likely to explore the stimulus than infants in the Sadness, $t(52) = 3.58$, $p < .001$, $d = 0.89$, 97.5% CI [0.13, 0.60], Fear, $t(53) = 4.29$, $p < .001$, $d = 1.06$, 98.33% CI [0.18, 0.66], and Anger conditions, $t(59) = 5.31$, $p < .001$, $d = 1.28$, 99.17% CI [0.24, 0.74].

Nineteen-month-old infants. Our planned comparisons indicated that infants in the Disgust condition were significantly less likely to demonstrate stimulus exploration than infants in the Joy condition, $t(69) = 4.75$, $p < .001$, $d = 1.14$, 95% CI [−0.65, −0.27]. Post hoc comparisons indicated that infants in the Fear condition were also significantly less likely to explore the stimulus than infants in the Joy condition, $t(64) = 3.39$, $p = .001$, $d = 0.84$, 99.17% CI [−0.64, −0.07]. Other post hoc comparisons were not significant after the Benjamini-Hochberg correction.

Sixteen-month-old infants. For the youngest age group, planned comparisons revealed that infants in the Disgust condition were significantly less likely to demonstrate stimulus exploration than infants in the Joy condition, $t(40) = 2.27$, $p = .03$, $d = 0.63$, 95% CI [−0.61, −0.04]. Post hoc comparisons indicated that infants in the Anger condition were also significantly less likely to explore the stimulus than infants in the Joy condition, $t(45) = 3.31$, $p = .002$, $d = 0.91$, 99.17% CI [−0.78, −0.07].

Relaxed Play

Infants responding to joy were hypothesized to be most likely to exhibit relaxed play behaviors in comparison with the other emotion conditions.

Twenty-four-month-old infants. Tests of our a priori hypothesis revealed that infants in the Joy condition were significantly more likely to demonstrate relaxed play than infants in the Fear, $t(37) = 2.66$, $p = .01$, $d = 0.66$, 95% CI [0.06, 0.41], and Anger conditions, $t(34) = 2.94$, $p = .01$, $d = 0.71$, 95% CI [0.08, 0.42]. Post hoc comparisons among the other emotion conditions did not remain significant after the Benjamini-Hochberg correction.

Nineteen-month-old infants. Planned comparisons revealed that 19-month-old infants in the Joy condition were significantly more likely to demonstrate relaxed play than infants in the Fear, $t(60) = 2.13$, $p = .04$, $d = 0.53$, 95% CI [0.01, 0.41], and Disgust conditions, $t(46) = 3.18$, $p = .003$, $d = 0.76$, 95% CI [0.10, 0.46]. Post hoc comparisons revealed no significant differences between other emotion conditions.

Sixteen-month-old infants. Analysis of the planned comparisons confirmed that infants in the Joy condition were significantly more likely to demonstrate relaxed play than infants in the Sadness, $t(44) = 4.69$, $p < .001$, $d = 1.23$, 95% CI [0.29, 0.72], Fear, $t(58) = 3.11$, $p = .003$, $d = 0.82$, 95% CI [0.14, 0.62], Anger, $t(52) = 2.37$, $p = .02$, $d = 0.65$, 95% CI [0.05, 0.60], and Disgust conditions, $t(45) = 4.84$, $p < .001$, $d = 1.35$, 95% CI [0.30, 0.72]. Post hoc comparisons revealed no significant differences between other emotion conditions.

Infant Vocalizations to Experimenter

We hypothesized that infants would vocalize to the experimenter more frequently in response to the experimenter's joy and sadness displays than in response to other emotional expressions.

Twenty-four-month-old infants. Testing of planned comparisons revealed that infants in the Anger condition vocalized to the experimenter significantly less than infants in Joy, $t(65) = 2.39$, $p = .02$, $d = 0.58$, 95% CI [−0.37, −0.03], and Sadness conditions, $t(67) = 2.19$, $p = .03$, $d = 0.52$, 95% CI [−0.35, −0.02]. Post hoc comparisons revealed no significant differences between other emotion conditions.

Nineteen-month-old infants. Planned comparisons revealed no significant differences between emotions for 19-month-old infants' vocalizing to the experimenter. Post hoc comparisons among the other emotion conditions did not remain significant after the Benjamini-Hochberg correction.

Sixteen-month-old infants. Planned comparisons revealed that infants in the Joy condition vocalized to the experimenter significantly more than infants in the Fear, $t(44) = 2.43$, $p = .02$, $d = 0.64$, 95% CI [0.03, 0.33], and Disgusts conditions, $t(31) = 2.61$, $p = .01$, $d = 0.73$, 95% CI [0.05, 0.38]. Post hoc comparisons revealed no significant differences between other emotion conditions.

Discussion

The present investigation found that infants demonstrated selective use of specific goal-directed behaviors in response to discrete emotions, though not all patterns of responding were as clear as predicted. This is the first study to our knowledge to clearly demonstrate infants' developing appreciation for the *quality* of emotional signals through differential use of functional affective responses to discrete emotions. This more stringent criterion for infant emotional understanding is not to say that younger infants may not necessarily understand the value of discrete emotions (see Walker-Andrews, 1997). However, our view is that observing infants' flexible deployment of functional affective responses is necessary for such conclusions to be made with confidence (for a similar argument, see Walle & Campos, 2012).

Below we discuss the observed differences in infant behaviors across emotions. Additionally, we consider some possible differences in the deployment of behaviors to specific emotions across age groups. However, all age comparisons are descriptive in nature, as age differences were not explicitly tested.

Differential Functional Behaviors Across Emotions

Security seeking. At all ages, infants were less likely to seek security in the Joy condition than in the negative emotion conditions. However, contrary to our hypothesis, security seeking was not manifested more in the fear condition than in the other emotion conditions. Overall, there was less differentiation between the discrete negative emotions, with no comparisons reaching statistical significance for the 24- and 19-month-old infants. Even so, it is worth noting that 24-month-old infants demonstrated security seeking almost twice as often in response to Anger and Disgust than in response to Sadness. This suggests that infants may not simply engage in this behavior whenever a negative context is encountered, but rather do so in contexts in which a threat is perceived. This supposition is supported by work demonstrating that infants do not necessarily seek security in response to negative emotions (e.g., Hornik, Risenhoover, & Gunnar, 1987). Additionally, security seeking was demonstrated most frequently by 16-month-old infants in response to Fear, and significantly more so than in response to Joy. However, this younger age group did not demonstrate any significant differences in security seeking between discrete negative emotions.

Social avoidance. As hypothesized, infant social avoidance of the experimenter was primarily manifested in response to Anger, though only by the 24-month-old group. Such avoidance would appear to be a particularly adaptive response when confronted with anger as it allowed the infant to carefully monitor the angry adult, but not necessarily seek security. Although previous studies have noted younger infants' avoidant behaviors when the caregiver expressed negative affect toward a strange adult (e.g., Boccia & Campos, 1983; de Rosnay, Cooper, Tsigaras, & Murray, 2006) or a novel toy (e.g., Hornik et al., 1987), such behavior is described more generally as actions directed away from the person/stimulus, often representing the opposite of "approach." The only evidence to the authors' knowledge of a similar form of behavior in which the child appeared to actively avoid social interaction with the emoter was reported with somewhat older children responding to anger, described as "ignoring" in 3-year-old children (Denham, 1986) or a decrease in empathic engagement by 5-year-old children (Strayer, 1980). Additionally, research with infants found that 18-month-olds decreased imitative behavior when an angry onlooker was watching, suggesting an avoidant-like behavior (Repacholi, Meltzoff, & Olsen, 2008). As such, we believe that it is unlikely that previous research has captured the avoidant behavior observed in the present investigation with children of this age. Additionally, this behavioral response was nearly absent in 16- and 19-month-old infants, suggesting that social avoidance in response to anger may be a particular functional affective response developing later in the second year of life. It is possible that these younger infants less frequently observe expressions of anger in their daily lives, and thus have yet to appreciate the communicative value of the signal. However, one might hypothesize that children from abusive homes (see Pollak, Messner, Kistler, & Cohn, 2009) would demonstrate this functional behavior to anger at earlier ages.

Information seeking. Infant information seeking was prevalent in all groups. Although we had no a priori hypotheses regarding differences across emotion conditions, we found that the younger two age groups demonstrated relatively greater frequency of this behavior in three of the four negative emotion conditions, suggesting a more valence-based response. In contrast, the 24-month-old infants produced this behavior similarly across all emotion conditions, which may indicate a "default" to seek information in response to any emotional context (see Walle, Reschke, & Knothe, in press). It is possible that this behavior is similar to social referencing-type behaviors that infants exhibit when confronted with an ambiguous context (e.g., Campos & Stenberg, 1981). As such, the older infants may have viewed all contexts, including joy, as necessitating additional information so as to coordinate an appropriate response and monitored the adult more extensively to increase their understanding of the context (see Walden & Ogan, 1988). Conversely, the two younger age groups may have viewed the joy expression as sufficiently disambiguating the context and did not seek further information. Thus, negative affective communication may have alerted these infants that additional information was needed, which for 16-month-old infants included all negative contexts, and for 19-month-old infants was limited to contexts where the stimulus could be threatening to the self (i.e., fear and disgust).

Prosocial responding. Contrary to our hypothesis, infant prosocial behavior was not significantly more likely in response to sadness in comparison to the other emotions. Still, nonsignificant differences in the predicted direction were found for both the 16- and 24-month-old infants. That is, prosocial responses were produced more often in response to sadness than in response to any other emotion. However, although these infants were generally more prosocial in response to sad individuals, they also demonstrated this response in many other emotion conditions.

While the present study attempted to select functional behaviors theorized to be distinguishable in terms of goal-directedness, it is possible that prosocial responding is more nuanced than the present operationalization allowed. For example, prosocial behavior intended to make the adult feel better may be distinct from behavior designed to initiate positive engagement. Additionally, our use of contexts permitted flexible responding but also resulted in infants' faces not always being clearly in frame and preventing coding of infant facial expressions. Coding of facial affect or specific targets of visual fixation in conjunction with the functional coding of the present study may allow future investigations to better distinguish between specific goal-directed forms of prosocial behavior. Furthermore, 24-month-old infants' prevalence of helping in the Joy condition may suggest that the older infants relied on contextual cues over and above the experimenter's explicitly expressed affective cues (see Walle & Campos, 2014). Thus, although the experimenter expressed joy, infants may have perceived a potential issue based on the context (e.g., the bunny being broken) and responded to resolve it (e.g., reattaching the bunny's leg), particularly in the older age group.

Exploration of the stimulus. In support of our hypothesis, infants in the 24- and 19-month-old groups explored the stimulus the least in the Disgust condition. In particular, the 24-month-old infants explored the stimulus significantly less in response to disgust than in response to joy and sadness, indicating differential responding by valence and some discrete categories of emotion. It is possible that the older infants in the Sadness condition engaged in stimulus exploration so as to determine an effective means to help the adult cope with the context (see Martin et al., 2014). This suggests an emerging appreciation of the value of the disgust display as signaling physical avoidance (i.e., failure to explore) of the stimulus during the second year of life. Although research by Repacholi (1998) found that infants as young as 14 months of age avoided disgust-labeled stimuli, it is unclear whether those findings were specific to disgust or whether infants would have responded similarly to any negative emotion. Conversely, while recent work indicating that the development of a disgust response emerges gradually through childhood (Stevenson, Oaten, Case, Repacholi, & Wagland, 2010), those findings may have been limited by the verbal demands of the task. It should also be noted that all age groups in our study were generally more likely to explore the stimulus in the Joy condition than in the negative emotion conditions.

Relaxed play. As hypothesized, infants were most likely to demonstrate relaxed play behaviors in the Joy condition at all ages. This pattern of findings is consistent with previous research indicating that infants respond to positive emotion signals with little anxiety or concern (e.g., de Rosnay et al., 2006; Hornik et al., 1987; Walden & Ogan, 1988). It is also noteworthy that infants in the oldest age group demonstrated relatively little relaxed play in comparison with the other age groups. The relaxed play exhibited by the younger infants may indicate a more general pattern of decreased sensitivity to emotional communication. Although we ensured that all infants included in the analyses clearly viewed the adult's emotional communication, the older infants may have been more sensitive to the ambiguity of the context in the Joy condition (e.g., "I see that you're happy, but why?"), and thus were more likely to engage in other behaviors, as evident by their infrequent engagement in relaxed play. Conversely, the younger infants may have simply taken the joy expression at face-value and deemed the context as unimportant.

Infant vocalizations to the experimenter. Coding of infant vocalizations provided a more discrete, yet similarly functional, measure of infant behavioral responding. Consistent with our hypotheses, infants vocalized the most in the Joy condition compared with the other emotions. However, they did not consistently vocalize more in the Sadness condition than the other negative emotion conditions. In fact, only 24-month-old infants vocalized significantly more in the Sadness condition than the Anger condition. This difference may indicate that responses to sadness are characterized by increased social engagement, an interpretation supported by the 24-month-old infants also being less likely to seek security or avoid the experimenter in the Sadness condition.

An interesting finding was that the 16-month-old infants demonstrated a valence-based response with regard to vocalizing toward the experimenter, vocalizing more in the Joy condition than in the Fear and Disgust conditions and showing no differentiation between these two negative emotions. A similarly valenced pattern was observed in the 19-month-old age group, though no pairwise comparisons were significant. Additionally, the inclusion of all communicative vocalizations to the experimenter, regardless of verbal quality, and the similar number of vocalizations by 16- and 24-month-old infants provides evidence against any observed differences being an artifact of linguistic ability.

Future Considerations

Design strengths. The present findings were likely facilitated by three methodological strengths of our investigation. First, incorporating multiple negative emotions allowed for direct comparison of infant responses as a function of the discrete emotion, rather than only the valence of the emotion. Such comparisons across multiple discrete emotions are necessary to clearly understand infants' developing appreciation of the quality of emotional communication. Second, this investigation permitted the infant flexibility in responding to the adult's emotional communication. This allowed for comparison between emotion conditions because each experimental context had similar affordances of infant responding. Third, we utilized a coding scheme that emphasized the function of the infant's behavior. This approach is similar to that encouraged by previous researchers of infant social responding (e.g., Ainsworth et al., 1978; Sroufe & Waters, 1977; Walle & Campos, 2012). Although such an approach could be viewed as messier with regard to delineating clear behaviors of interest, we argue that emphasizing function over form improved the validity of our coding and analysis of infant behavior. We encourage future emotion research to utilize coding schemes that emphasize the function of human behavior (for a similar argument, see Coan & Gottman, 2007).

Design limitations. Our investigation also raises a number of considerations for future research, particularly with regard to context. Infants may utilize distinct sources of information from the emotional context differently at different ages. For example, older infants may have demonstrated greater prosocial behavior across emotion conditions because they relied on contextual cues (e.g., a broken bunny) over and above the emotion communicated. The importance of context is gaining empirical attention in the emotion literature (see Aviezer et al., 2008; Barrett, Mesquita, & Gendron, 2011; Hassin, Aviezer, & Bentin, 2013), and recent research indicates that infants are sensitive to contextual elements when judging the authenticity/credibility of adult emotion displays (e.g., Chiarella & Poulin-Dubois, 2013; Walle & Campos, 2014). Additionally, it is possible that familiar contexts may allow younger infants to demonstrate functionally specific behaviors through the use of emotion scripts (see Parkinson, Fischer, & Manstead, 2005; Russell, 2003).

Infants' behavioral responding may also have been influenced by their perception of the adult's relation with the context. For example, infants' may have perceived the adult's relation with the environment in both fear and sadness contexts as one indicating general distress. As such, an adaptive response based on such an attribution would be to alleviate the source of distress (i.e., prosocial behavior) in both emotion conditions. Comparison of discrete emotions across a broader range of contexts is important to tease apart this possibility. For example, fear directed toward a stimulus that is potentially dangerous to the adult, and likely the infant, may decrease the prevalence of prosocial and exploratory behaviors and increase behaviors of security seeking (e.g., Boccia & Campos, 1983; Klinnert, 1984).

Additionally, it should be noted that coders had access to the emotional information communicated by the experimenter. The use of a functional coding scheme makes essential that an observer view the relational context to infer the goal-directedness of the infant's actions. This approach is common in studies utilizing similar functional coding schemes, such as coding an infant closing a book as prosocial if the book had made the caregiver sad (Zahn-Waxler et al., 1992) or classifying the quality of an infant's attachment based on observed proximity-seeking and exploratory behaviors before and after separation with a caregiver (Ainsworth & Bell, 1970). Even so, it is possible that coders were influenced by implicit assumptions regarding the appropriateness of specific behaviors.

Additional considerations. Although the present study adds to our understanding of infant emotional development, it also raises a number of additional questions for further analysis. It can be expected that greater complexity of behavioral responding exists than was captured in the present study. As noted above, although the flexibility of our paradigms offered infants numerous ways with which to respond, it also limited our ability to capture some variables such as infant facial displays, physiology, and eye gaze patterning. For example, measuring infant heart rate could further differentiate responses in younger infants, as responding to fear may result in elevated heart rate in comparison to other emotions, such as disgust. Infants' temperament may also have played a role in their responses to the emotional contexts (e.g., Blackford & Walden, 1998; Bradshaw, Goldsmith, & Campos, 1987; Mangelsdorf, Shapiro, & Marzolf, 1995). Although the current study did not include measurements of temperament, inclusion of this factor may help to account for individual differences in responding.

It is also possible, in fact likely, that infants responded to the experimenters' emotions with *coordinated patterns* of functional responses. Consider findings from the Joy condition. In viewing our results, one could misconstrue 24-month-old infants as having a "Joy" pattern of responding characterized by exploratory, prosocial, and relaxed behavior, with occasional information seeking. However, multiple distinct configurations of these behaviors may have occurred. For example, it may be the case that 24-month-old infants responded to sadness with *either* prosocial behavior and information seeking *or* prosocial behavior and exploration, but never prosocial behavior, information seeking, and exploration together. In this example the distinct functional behavior patterns within an emotion condition would be mixed because the dependent variables were analyzed separately. Identifying such heterogeneity of behavioral response patterns within emotion conditions is essential for future research on this topic. Use of latent class analysis or cluster analysis may be a candidate analytic technique to more objectively achieve this goal (see Lanza & Cooper, 2016).

Additionally, examining the temporal unfolding of infant functional responding could help to further delineate patterns of infant responding or identify "primary" and "secondary" functional responses as infants engage in multiple separate goal-directed responses over the course of the observation. For example, although no differences were found in 24-month-old infants seeking information across emotion conditions, it is possible that this behavior occurred at different points during the response process. Infants may have responded to sadness by first seeking information, then exploring the stimulus, then demonstrating prosocial behavior, and then again seeking information to determine whether the response was effective in alleviating the other's distress. Furthermore, infants may have engaged in multiple response patterns during a single observation. For example, in response to fear the infant might first respond by seeking information and responding prosocially. However, when the experimenter continued to express fear (as per our procedures), the infant may have engaged in a secondary response, such as seeking security.

Understanding emotional development. More broadly, these findings highlight important considerations for the study of emotional development. First, emotional development is not akin to throwing a switch. Rather, just as emotion categories emerge gradually in early childhood (see Widen & Russell, 2008), so too do infants' behavioral responses to discrete emotions. The present study provides evidence that infant differential responding to discrete emotions is a work in progress during the second year. Moreover, it is important to consider the changing nature of emotional interactions between infants and those with whom they interact. For example, consider an infant reaching toward a plant. Early in infancy a caregiver may respond with *any* negative affect to regulate the infant's behavior. However, as the child develops, the caregiver may want the child to know more than "avoid the plant," but to understand that touching the plant may knock it over, hence anger, the plant could hurt the child's skin, hence fear, or the plant can be harmful to ingest, hence disgust. Thus, not only is the infant's understanding of emotional communication developing, so too is the caregiver's communicative intent toward the child. Examining the bidirectional nature of the infant's changing social ecology would help elucidate the development of different functional affective responses.

Second, the development of functional affective responding is likely nonmonotonic with ebbs and flows throughout development. Thus, rather than identifying the age at which particular functional behaviors are present or absent, examining developmental precursors and sequelae of specific behaviors may provide greater insight into the development and divergence of such responses (see also Barrett & Campos, 1987). Furthermore, although development may entail the narrowing of a particular behavior to a specific context (e.g., social avoidance in response to anger), behaviors may also be utilized more broadly if their functional utility is deemed adaptive across other contexts (e.g., information seeking in all social contexts, regardless of the discrete emotion). Thus, functional affective responding demonstrates equifinality in that the same behavior may be used in response to multiple discrete emotional contexts (see Campos, Frankel, & Camras, 2004).

Taken as a whole, this study highlights the complexity of examining infant social development in active and dynamic social contexts. We strongly believe that paradigms embracing the complexity of real-life social interactions are vital to furthering our understanding of infant emotional development. Marrying such investigations with analytic techniques capable of teasing apart the nuances of social behavior represents the next step in such research.

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