Infancy, *13*(4), 366–392, 2008

ISSN: 1525-0008 print / 1532-7078 online
DOI: 10.1080/15250000802188776

Psychology Press
Taylor & Francis Group

How Mothers Encourage and Discourage Infants' Motor Actions

Lana B. Karasik, Catherine S. Tamis-LeMonda,
Karen E. Adolph, and Katherine A. Dimitropoulou
New York University

The content of mothers' emotional, verbal, and gestural communication to their infants was examined under conditions of potential physical risk in a laboratory motor task. Mothers encouraged and discouraged their 12- and 18-month-old infants to crawl or walk down a sloping walkway. Mothers expressed positive affect on nearly every trial. They rarely expressed purely negative affect in their faces and voices, even when discouraging. Instead, they discouraged infants with a mixture of positive and negative expressions. In both encourage and discourage conditions, mothers coupled their emotional messages with rich verbal and gestural information to elicit infants' attention, regulate their location, guide their actions, and describe the situation and potential consequences of their actions. The content of mothers' communication was attuned to infants' age and locomotor experience.

One consequence of independent mobility is that caregivers must monitor and regulate infants' actions from a distance. Caregivers must recognize, from moment to moment, when to encourage infants' actions to promote learning and when to discourage infants' actions to ensure their safety. Caregivers often play the role of cheerleader, celebrating infants' locomotor achievements and coaxing them to try new skills: They encourage infants to take their first steps, descend the playground slide, and leap into the security of their arms at the edge of the pool. Caregivers also frequently adopt the role of lifeguard: They warn infants of impending dangers such as streets, staircases, and slippery surfaces.

Despite these continual shifts between the dual roles of cheerleader and lifeguard, researchers know little about the ways that caregivers encourage and dis-

Correspondence should be sent to Lana B. Karasik, 4 Washington Place, Room 415, Department of Psychology, New York University, New York, NY 10003. E-mail: lbk224@nyu.edu.

courage infants' motor actions in potentially dangerous situations. How do parents communicate safety and danger to their infants? Do caregivers modify their communications in response to infants' changing abilities and locomotor skills? To address these questions, we examined the emotional, verbal, and gestural content of mothers' messages as they encouraged and discouraged their infants to crawl or walk down a sloping walkway in a laboratory motor task. Additionally, we investigated the effects of infants' age and locomotor experience on mothers' communications.

SOCIAL INFORMATION

By the end of their first year of life, infants show increasing reliance on social information to learn about their world. Studies of dyadic play reveal that mothers use multiple channels, including face, voice, and gestures, to communicate with their infants (Gogate, Bahrick, & Watson, 2000; Papousek, Papousek, & Bornstein, 1985; Stern, 1974; Walker-Andrews, 1997). However, these studies reveal little about how mothers might communicate to their infants in potentially risky situations. Studies of social referencing show that infants often solicit advice from knowledgeable adults about ways to respond to unfamiliar objects, people, and tasks, and they approach or avoid referent objects or events based on caregivers' facial and vocal expressions of emotion (Campos & Stenberg, 1981; Hirschberg & Svejda, 1990; Hornik & Gunner, 1988; Hornik, Risenhoover, & Gunnar, 1987; Klinnert, Campos, Sorce, Emde, & Svedja, 1983; Klinnert, Emde, Butterfield, & Campos, 1986; Mumme, Fernald, & Herrera, 1996; Sorce, Emde, Campos, & Klinnert, 1985; Vaish & Striano, 2004). However, social messages were experimentally controlled to test the effects of caregivers' emotions on infants' behavior. Because the focus of previous work was on infants as recipients of social information, little is known about the content of mothers' social messages.

Here, our goal was to document the content of mothers' multimodal messages in a seminaturalistic research design. Mothers were instructed to encourage and discourage their infants in a potentially risky motor task in the laboratory; mothers could use their faces, voices, and gestures in any way they felt was natural. The examination of mothers' communications in a motor task is especially important in light of rapid changes in infants' locomotor skills across their first two years of life. With the advent of crawling and walking, unsupervised encounters with obstacles can be costly. Mothers' communications might serve to focus infants' attention, regulate their actions, and provide information that enables infants to better gauge the extent of their abilities and the demands of the situation (Tamis-LeMonda, Adolph, Dimitropoulou, & Zack, 2006).

EMOTIONAL CONTENT OF MOTHERS' MESSAGES

Emotional displays are a fundamental channel through which mothers engage their infants (Chong, Werker, Russell, & Carroll, 2003; Klinnert et al., 1983; Malatesta, Grigoryev, Lamb, Albin, & Culver, 1986; Stern, 1974; Trevarthen, 1977). Mothers display exaggerated and prolonged facial expressions such as "mock surprise" in which they place their heads near their infants' faces, raise their eyebrows, and open their eyes and mouths widely (Stern, 1974). Adult raters reliably distinguish among different facial emotions, and can judge whether mothers are interacting with their infants or other adults merely by viewing mothers' facial expressions (Chong et al., 2003).

Parents also convey emotional information in their voices. Mothers and fathers from different language and cultural backgrounds vary their intonation patterns when interacting with infants (Fernald et al., 1989). Infant-directed speech is characterized by changes in pitch and intonation that convey praise, approval, disapproval, and comfort (Fernald, 1989, 1993; Papousek et al., 1985). The prosodic characteristics of infant-directed speech are particularly salient to infants and lead to heightened infant responsiveness (Kitamura & Burnham, 1998). Adult raters can identify adult- versus infant-directed speech and glean information about the emotional content of the message simply by listening to the prosodic contours of speech (Fernald, 1989). However, researchers have not yet examined how mothers use emotional displays in face and voice when encouraging and discouraging their infants' motor actions in potentially dangerous situations. Mothers might display discrete positive emotions when encouraging infants and negative emotions when discouraging them (as is typically modeled in social referencing studies). Alternatively, mothers might present infants with a blend of positive and negative emotions.

VERBAL AND GESTURAL CONTENT OF MOTHERS' MESSAGES

Speech and gestures (e.g., wagging finger, beckoning arms) may be effective tools for regulating infants' actions and explaining the consequences of potential hazards. However, studies on mother–child interactions during innocuous tasks such as semistructured play rarely elicit negative messages or prohibitions (e.g., Schaffer, Hepburn, & Collis, 1983) and therefore cannot inform on how mothers use speech and gestures to ensure infants' safety and encourage new motor skills. Similarly, social referencing studies preclude analyses of verbal content because variations in verbal information involve scripted messages. When mothers of young crawling and walking infants are asked about their communications, they report an increase in verbal prohibitions, stern voices, and hands-on interventions

(Biringen, Emde, Campos, & Applebaum, 1995; Campos et al., 2000). Similarly, descriptive studies of mothers' communications with preschoolers and school-age children indicate that mothers use verbal information to explain rules of appropriate behavior and to inform children about the consequences of their actions. Mothers of 2- to 3-year-olds use verbal strategies as their children approached potentially hazardous objects that could result in burns, poisoning, falls, and cuts (Morrongiello & Dawber, 1998). They use commands and explanations to curb inappropriate behavior (Peterson, Ewigman, & Kivlahan, 1993). Mothers of 6- to 8-year-olds command their children to stop and caution them about the consequences of their actions in dangerous playground situations (Morrongiello & Dawber, 2000).

In addition to speech, mothers also frequently gesture to their young children. Mothers pair gestures, such as pointing, with talk about objects when addressing their 11- to 24-month-olds (Gogate et al., 2000; Messer, 1978; Murphy & Messer, 1977; Zukow-Goldring, 1997). Pointing may enhance rather than replicate maternal speech (O'Neill, Bard, Linnell, & Fluck, 2005) and may disambiguate verbal messages (Iverson, Capirci, Longobardi, & Caselli, 1999). Mothers' gestures may be particularly effective in guiding the attention of 12- and 18-month-olds toward objects outside of the visual field (Deak, Flom, & Pick, 2000). Infants look in the correct direction more often when their mothers simultaneously look, vocalize, and gesture than when mothers only look at the target. Gestures, such as pointing, may be especially effective in eliciting joint visual attention because of the visual salience of the outstretched arm. However, despite findings on the importance of gestures in maternal communication, it is unclear whether mothers use gestures to encourage or discourage their infants' motor actions. Given the effectiveness of emotional displays and vocal expressions, mothers may suppress their gestures in potentially dangerous settings.

ROLE OF INFANTS' AGE AND EXPERIENCE

Studies of mother–infant free play indicate that mothers modify the emotional, verbal, and gestural content of their communications in accordance with infants' age (Schaffer et al., 1983; Schmidt, 1996). For example, mothers use more emotions in their voice (i.e., positive and negative tone) with 6- to 12-month-olds but more words, phrases, and gestures with 18-month-olds (Adamson & Bakeman, 1984). Mothers use more specific action directives when communicating with 18-month-olds, and more general directives offering vague, simple commands with 10-month-olds (e.g., "Do it"), perhaps recognizing the language limitations of younger versus older infants (Schaffer et al., 1983). Additionally, mothers use more diverse verbal strategies to warn older infants of impending dangers (Tamis-LeMonda et al., 2006). In contrast, mothers display equivalent numbers of atten-

tion directives to older and younger infants, suggesting that mothers recognize the need to maintain infants' attention toward situations that involve potential physical risk.

Mothers also use gestures differently toward younger versus older infants. In play settings, mothers rely on deictic gestures such as pointing to draw young infants' attention to distal features of the environment (Murphy & Messer, 1977). When communicating with 2- to 3-year-olds, mothers produce a greater number of deictic gestures (i.e., pointing) than mothers of 4- to 5-year-olds (Gutmann & Turnure, 1979). Mothers of younger infants produce more gestures and rely less on verbal information than mothers of older infants when communicating about novel objects (Dimitropoulou, Tamis-LeMonda, Adolph, & Alibali, 2007; Schnur & Shatz, 1984).

Infants' locomotor experience, distinct from age, is also a potentially important factor in mothers' communications (Tamis-LeMonda & Adolph, 2005). Depending on infants' level of experience, the same situation could potentially place infants at different levels of risk. A flight of stairs can be treacherous for new walkers in an upright position, but perfectly manageable for experienced crawlers who go down backward feet first. Over weeks of everyday locomotor experience, infants become increasingly accurate when faced with challenges to locomotion (Adolph, 1997, 2000). For example, 12-month-old experienced crawlers faced with a steep slope chose an alternative strategy such as backing or sitting, whereas 12-month-old novice walkers plunged forward indiscriminately (Adolph, Tamis-LeMonda, Ishak, Karasik, & Lobo, in press). If mothers are attuned to infants' locomotor experience, mothers of crawlers might differ from mothers of walkers in their communications. One possibility is that mothers of novice walkers will work harder to keep their infants from descending slopes, and would therefore display a greater variety of verbal and gestural strategies to walkers versus crawlers. Alternatively, mothers might respond to the greater skill level of their crawlers by presenting them with more verbal and gestural information about ways to act.

Differences in mothers' communications to walkers and crawlers might also exist if mothers are sensitive to postural differences in types of infant locomotion. Mothers of walkers may view their infants as more mature and increase their encouragement. They may view falling as more risky from an upright posture and increase their prohibitions. Indeed, observational data show that mothers increase their positive and negative interactions with infants after the transition from crawling to walking (Biringen et al., 1995).

THIS STUDY

In summary, the literature is replete with studies on mothers' emotional expressions, language, and gestures when communicating with their infants. However,

the majority of this work has been based on free play, face-to-face interactions, and teaching tasks. Despite mothers' dual role as cheerleader and lifeguard, no study has examined maternal encouragement and discouragement of infants' motor actions where the consequences of inappropriate actions are costly. Accordingly, we investigated mothers' unconstrained messages to their 12- and 18-month-olds in a potentially risky motor situation—descending slopes. We examined mothers' distal communications as their infants confronted slopes for two reasons. First, change in the elevation of surface layout is a naturally occurring challenge for infants. Thus, the task of descending a sloping walkway provided an analog of situations that infants typically encounter either at home or at the playground (e.g., descending couches, stairs, and playground slides). Second, our laboratory task was designed so that mothers were visually but not physically available to their infants, which required them to use distal communicative strategies. This design mirrored everyday situations in which mothers cannot provide hands-on assistance to rescue their infants from impending danger.

We focused on maternal communication to 12- and 18-month-old infants because infants typically transition from crawling to walking over the course of these 6 months and also shift from understanding and producing a handful of words to acquiring new words at a rapid rate. Moreover, at 12 months, some infants are experienced crawlers and others are new walkers, enabling us to examine the role of infants' locomotor experience and posture on mothers' communications with infants' age held constant.

METHOD

Participants

Fifty-two mothers and infants were recruited from the New York City area through purchased mailing lists, brochures, and referrals. They received a framed infant–mother photograph and an infant diploma as souvenirs of their participation. Twenty-eight mothers of 12-month-old infants (M = 12.36 months, SD = 0.43; 14 boys and 14 girls) participated. Half of the 12-month olds (n = 14) were experienced crawlers (M = 3.56 months of crawling experience, SD = 1.12) and half (n = 14) were novice walkers (M = 1.10 months of walking experience, SD = 0.86). Twenty-four mothers of 18-month-old infants (M = 18.08 months, SD = 0.21; 10 boys and 14 girls) participated. All 18-month-old infants were experienced walkers (M = 5.84 months of walking experience, SD = 1.75 months).

Mothers were primarily White, from middle- to upper middle-class families and were all native English speakers. All mothers were children's primary caregivers. Mothers' age was similar in both groups: M = 35.51 years (SD = 3.90) for the 12-month-olds and M = 36.87 (SD = 4.10) for the 18-month-olds. Most moth-

ers were first-time parents (79% and 75% of mothers in the 12- and 18-month-old groups, respectively).

To be included in this study, mothers had to encourage and discourage their infants at least once in each condition. Data from an additional 19 infants were excluded: 14 infants became fussy or tired during the test trials and 5 completed the study but data from their test trials were accidentally not recorded. The attrition rate for the test trials was 20% (14/71).

Walkway

The data described here were drawn from a larger study examining infants' use of social and perceptual information when descending slopes (Adolph et al., 2007). Mothers encouraged and discouraged their infants from crawling or walking down a sloping walkway (Figure 1). A middle sloping section connected flat starting and landing platforms (each 86 cm wide × 91 cm long). The slant of the midsection could be adjusted from 0° to 90° in 2° increments, using a push-button remote. A protractor on one side of the walkway indicated the degree of slant to the experimenter. Plush carpeting covered the surface to cushion infants' falls. Netting extended along the length of the walkway to serve as a safety barrier, and wooden posts at the corners of the walkway provided infants with extra support. An experimenter walked alongside infants to ensure their safety.

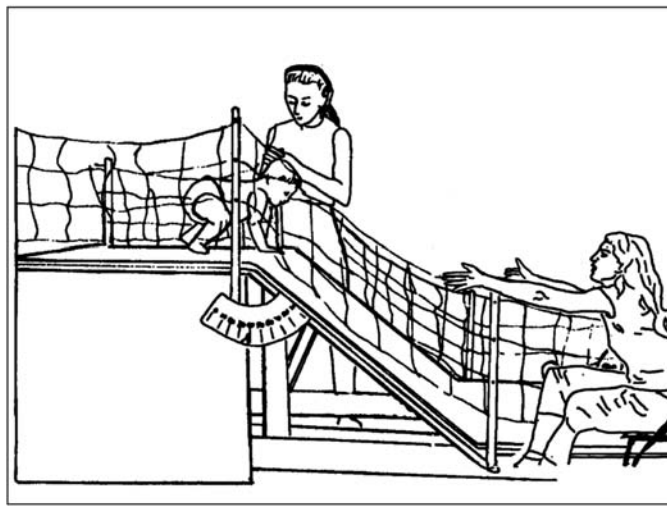

FIGURE 1 Walkway with adjustable slope. Mothers sat on a raised platform adjacent to the flat landing platform and began encouraging or discouraging while an experimenter held infants on the starting platform. The experimenter followed alongside infants to ensure their safety.

During test trials, mothers sat in a straight-backed chair on a raised platform that was positioned diagonally to the walkway at infants' eye level. At the start of each trial, mothers were in constant view at a distance of 320 cm from infants. Mothers' arms and hands were free so they could gesture as they chose, and they wore a wireless microphone that captured their verbal messages. A remotely operated video camera located 147 cm above the walkway recorded mothers' facial expressions and arm movements. One assistant panned a side-view camera to capture infants' movements on the walkway and a second assistant focused a third camera on infants' faces. All three camera views were mixed online into a single video stream for later coding and analyses.

Procedure

Laboratory visits lasted 1 to 1.5 hr. First, mothers reported infants' crawling or walking experience (the first date when infants crawled and walked at least 10 ft. independently) using baby books and calendars to facilitate their memories (Adolph, 2002). As an additional check of infants' locomotor status, at the start of the study, infants crawled or walked over the flat walkway four times. We classified infants as walkers if they could walk independently over the walkway without stopping or falling. None of the 12-month-old crawlers passed the criterion for walking, but all could crawl over the walkway without stopping.

Then, we observed mothers and infants on slopes. Mothers encouraged and discouraged infants' actions on slopes at, below, and above infants' motor skill level in two blocked and counterbalanced conditions with approximately half of the boys and half of the girls receiving each condition order first. Each infant received 24 test trials total: 11 trials in the discourage condition, 11 trials in the encourage condition, and 2 trials at 4° (always with mothers encouraging) at the end of each condition to maintain their motivation to continue with the experiment. Data from these additional 2 trials were also included in the analyses of the encourage condition. Thus, infants received 2 more encourage than discourage trials.

Mothers were told that the purpose of the study was to examine how mothers naturally communicate with their crawling and walking infants. They were allowed to use their words, hands, and voices to encourage and discourage their infants as they chose. Experimenters removed toys and distractions to prevent mothers from using objects to entice their infants. In the encourage condition, mothers were instructed to get their infants to crawl or walk down the slope in ways similar to those they used to encourage their infants in everyday situations. In the discourage condition, mothers were told to keep their infants from crawling or walking down the slope as though the walkway were a sheet of ice that would jeopardize their infants' safety.

At the start of each trial, an experimenter held the infant at the starting platform. An assistant signaled mothers when to begin communicating by ringing a bell.

Mothers had 3 to 4 sec to deliver their message ($M = 3.84$ sec, $SD = 0.75$) before the assistant verbally signaled to the experimenter to release the infant onto the walkway. Mothers continued to instruct their infants through the end of the trial, which lasted until infants made a motor decision (i.e., to crawl, walk, or slide down the slope) or after 30 sec if infants remained on the starting platform. If the infant made a motor decision immediately after being placed on the walkway, mother's message only during the time the experimenter held the infant was considered. The experimenters did not speak or gesture to the infants during the test trials.

Data Coding

All maternal social messages were scored from videotapes using a computerized video coding system, MacSHAPA (www.OpenSHAPA.org), which records the frequencies and durations of specific behaviors (Sanderson et al., 1994). Coders noted whether mothers displayed each of the target behaviors at least once during each trial. They noted mothers' displays of negative and positive facial expressions, negative and positive vocal affect, six types of verbal statements, and four types of manual gestures. The primary variables used in analyses were the percentage of trials in which mothers displayed each of the target behaviors.

Affect. Coders scored mothers' facial affect without sound. Negative affect included downward curls of the mouth, frowns, and scrunched eyebrows. Positive affect was coded whenever mothers displayed either smiles or neutral facial expressions. In a second coding pass, coders listened to mothers' statements during the trial without watching the videotape and categorized mothers' vocalizations as negative or positive. Negative vocalizations included stern, angry, or whiny tones. Vocalizations that ranged from cheerful and positive to emotionally neutral were scored as positive. Because mothers could display positive and negative facial and vocal expressions in a single trial, trials that contained both a positive and a negative emotional message were classified as face mixed or voice mixed. Therefore, for each condition separately, six variables represented the content of mothers' emotional message for face and voice: proportion of trials that contained purely positive facial expressions, purely positive voice, purely negative facial expressions, purely negative voice, and trials that contained both positive and negative face, and both positive and negative voice (termed mixed trials). This coding system did not distinguish between positive and neutral affect in mothers' facial and vocal expressions. Thus, the coder's decision for each trial was whether mothers displayed negative affect with other expressions being coded as neutral or positive.

Speech. Building on prior research in our laboratory, six mutually exclusive verbal categories were developed based on a content analysis of mothers' verbal messages (Tamis-LeMonda et al., 2006). These verbal statements could be used in

either condition. *Location regulators* (e.g., "Come here," "Don't come down") and *action shapers* (e.g., "Keep walking," "Sit down") delivered specific information about how to respond. Location regulators informed infants about the direction of their movements in relation to the walkway and action shapers provided specific information about how to complete or modify ongoing actions. *Attention grabbers* (e.g., "Child's name," "Look at mommy") were statements with information to orient the child to the mother or the task. *What/why* statements provided information about the nature of the task and the potential consequences of an action (e.g., "It's safe," "You'll fall"). Expressions of *praise* (e.g., "Good girl") affirmed infants' behavioral responses. *General directives* (e.g., "Let's go," "No! Stop") were simple statements that encouraged or prohibited action without providing specific instruction about whether to continue an action or how to complete it.

Given that mothers were free to offer a variety of verbal statements, we calculated diversity scores for each mother on each trial, which specified the number of different strategies they used to encourage or discourage infants' actions (ranging from 0–6 if mothers used none or all six categories). For example, a verbal diversity score of 3 indicated that a mother suggested three different strategies to her infant (e.g., general directive, "No"; location regulator, "Don't come down"; and action shaper, "Sit") whereas a diversity score of 1 implied that a mother relied on one strategy to direct her infant even if she used different words to do so (e.g., "Come," "Let's go," "Come on," as general directives). Diversity highlights the number of different communicative statement types used by mothers. This measure parallels the distinction made in the language literature between word forms versus sheer number of words, referred to as word "types" versus "tokens" (MacWhinney, 1995). Therefore, although two mothers might theoretically use the same amount of language overall, repetitions would result in lower diversity scores. Mothers use more repetitions with younger infants who are at early stages of language development (e.g., Snow, 1972), a finding that might generalize to mothers' verbal statements surrounding motor action.

Gestures. Four types of manual gestures were coded. *Location* gestures included signaling infants to descend slopes by mothers' outstretched arms and beckoning (Figure 2a), and signaling infants to stay on the starting platform using a "crossing-guard" gesture (Figure 2b), in which mothers extended an arm with the palm facing outward or a stationary index finger raised upward (Figure 2c). *Action* gestures (Figure 2d) presented iconic depictions of strategies that infants might use to descend or remain on the platform (e.g., swinging arms to indicate walking). *Points* (Figure 2e) were gestures that contained an index finger extended forward at the slope. Coders also scored whether mothers used *claps* (Figure 2f). Similar to speech, diversity scores were calculated for gestures on each trial.

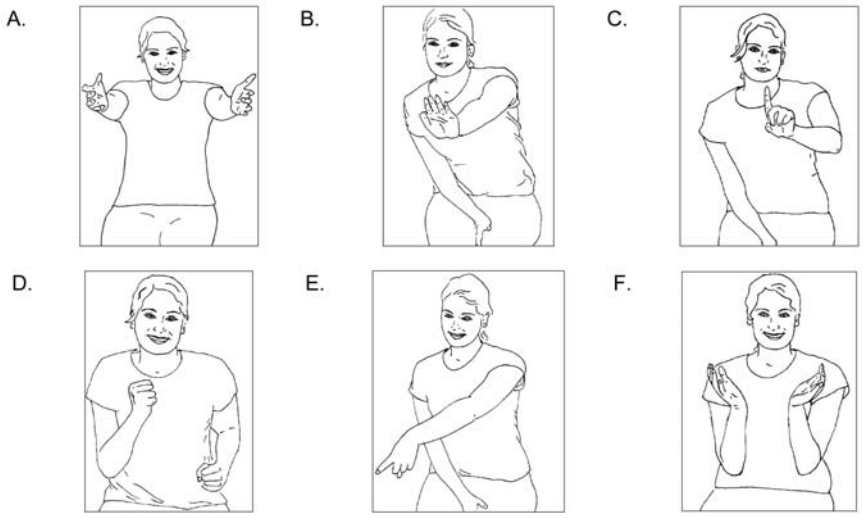

FIGURE 2 Mothers' gestures of (a–c) location—beckoning motions, used to summon infants to descend the slope; "crossing-guard" and stationary index finger used to keep infants in place on the starting platform; (d) action—arm motions depict walking, (e) pointing, and (f) clapping.

Within each modality, codes were mutually exclusive. However, multiple codes could occur within a trial for verbal and gestural statements and facial and vocal affect. Mutually exclusive categories were preferred for analytic reasons (i.e., "double credit" for the same response into different categories would violate assumptions of independent observations). In developing the current coding system, we decided to code mothers' messages at the level of the utterance rather than word. Therefore, in the preceding example, "don't" is part of the phrase "Don't come down;" the utterance itself refers to the infant's location. In contrast, "Don't!" as a single exclamation would be coded as a general prohibition.[1]

A primary coder scored all maternal behaviors from video. A secondary coder scored 100% of the trials for purposes of reliability. Interrater reliability ranged from 94.8% to 99.7% for the six types of affective expressions ($\kappa = .63–.84$, $p < .001$). Interrater reliability ranged from 93.4% to 96.6% for the six categories of verbal statements ($\kappa = .80–.92$, $p < .001$), and from 94.4% to 99.7% for the various forms of verbal statements within each category ($\kappa = .76–.98$, $p < .001$). Interrater reliability ranged from 95.4% to 96.9% for the four categories of gestural behaviors ($\kappa = .84–.94$, $p < .001$), and from 95.4% to 98.0% for various forms of gestures within each category ($\kappa = .84–.94$, $p < .001$).

[1]The coding manual is available from the authors on request.

RESULTS

The data set consisted of 1,016 trials. On average, infants completed an average of 19.54 ($SD = 3.99$) of the total 24 test trials, $M = 10.77$ ($SD = 2.13$) of the 13 encourage trials, and $M = 8.77$ ($SD = 2.03$) of 11 discourage trials. The average number of trials was greater in the encourage condition than the discourage condition, $t(51) = 12.31$, $p < .001$. However, within each condition, trial number did not vary by infants' age or locomotor experience.

Mixed measures analyses of variance (ANOVAs) were used to analyze the effects of condition (encourage and discourage) and infant's age (12 and 18 months) on the proportion of trials in which mothers displayed the six different types of emotions, six types of verbal content, and four types of gestures. Separate ANOVAs were conducted to consider the effect of infant's locomotor experience on mothers of 12-month-old crawlers and 12-month-old walkers on each variable. Significant overall effects were further analyzed with post hoc comparisons using Bonferroni-adjusted alpha levels ($p = .05$/number of tests). Initial analyses showed no effects of infants' sex, condition order, or trial number (first half vs. second half of trials within each condition) on mothers' behaviors ($ps > .05$), and data were collapsed across these factors in further analyses.

Manipulation Checks

Prior to analyses, several manipulation checks were conducted to ensure that mothers differentially communicated encouragement and discouragement as instructed, and to test whether their messages varied by slope increments. Our first step was to verify that mothers' encouraging and discouraging messages influenced infants' motor actions. Coders scored whether infants descended slopes in their typical locomotor posture (i.e., crawling or walking) or chose an alternative strategy (e.g., slid down, avoided descent); interrater agreement was high, 96.8% of trials; $\kappa = .95$, $p < .001$. Both 12- and 18-month-olds showed a main effect for condition: Infants were more likely to crawl or walk when mothers encouraged ($M = 0.71$, $SD = 0.19$) than when they discouraged ($M = 0.46$, $SD = 0.26$), $F(1, 51) = 99.39$, $p < .001$.

Although infants acted in accordance with mothers' messages, we were concerned that mothers had more opportunity to offer messages in the discourage condition than in the encourage condition. Trial length ranged from 3.38 to 28.72 sec ($M = 11.23$ sec, $SD = 6.48$). However, trial length was longer in the discourage ($M = 14.99$ sec, $SD = 5.40$) than the encourage condition ($M = 8.28$ sec, $SD = 5.40$), $t(51) = -8.12$, $p < .001$. Moreover, the average total message time (taking the number of trials in each condition into account by accumulating trial time across trials) was longer in the discourage condition ($M = 129.60$ sec, $SD = 79.65$) than in the encourage condition ($M = 86.97$ sec, $SD = 55.07$), $t(51) = 5.97$, $p < .001$.

Trial length and total message time did not differ between 12- and 18-month-olds ($p > .05$). However, for the two experience groups (12-month-old crawlers and 12-month-old walkers), trial length and total message time were greater for crawlers than walkers ($ps < .05$). This was due to crawlers being more cautious and therefore more likely to avoid the steeper slopes by remaining on the starting platform (e.g., Adolph, 1997).

We used two methods to verify that mothers' messages did not vary across slope increments, while equating time to deliver the message. First, we compared mothers' messages (for types of verbal expressions and gestures) in the encourage and discourage conditions on slopes at infants' skill level, shallower than skill level, and steeper than skill level during the 3-sec period while the experimenter held infants on the starting platform (thereby holding trial length constant across risk levels). The ANOVAs showed no effects for risk ($ps > .05$), suggesting that mothers delivered uniform messages across risk level.

Second, we asked expert coders, blind to risk level and social message condition, to rate the risk level and social message condition. Specifically, 18 laboratory members (all experts at coding mother and infant behaviors) viewed 72 edited video clips of mothers encouraging and discouraging their infants. The clip length was constant across trials (5 sec). Information about the slope and infants' behaviors was removed from video excerpts. Raters accurately detected the social message; on 89% (chance = 50%) of trials they correctly distinguished the encourage and discourage conditions. However, coders were at chance levels when deciding on the degree of slant (35%, chance = 33%). Again, the manipulation check indicated that mothers varied their messages by social condition, but there was no evidence that mothers varied their social messages by risk level.

Emotional Content

Mothers used primarily positive emotional signals in both face and voice, regardless of infants' age and locomotor status, and even when they were discouraging infants from descent. Purely negative affect was extremely rare. The predominance of positive emotions was not explained by a handful of mothers displaying positive emotions on most trials. Nearly every mother displayed positive face and voice in both conditions. Although facial and vocal affect tended to occur in concert, affect was not uniform across the two modalities. When encouraging their infants, 98.1% of mothers displayed positive facial affect and 100% displayed positive vocal affect. In the discourage condition, 94.2% of mothers displayed positive facial expressions and 96.2% of mothers emitted positive vocal expressions. Only two mothers (3.8%) displayed purely negative facial affect and eight mothers displayed purely negative vocal affect (15.4%) when discouraging at least once. A greater proportion of mothers displayed mixed affect (i.e., displaying both positive and negative emotional messages within the same trial) in face and voice when dis-

couraging (65.4% and 82.7% for face and voice, respectively) than when encouraging (30.8% and 17.3% for face and voice, respectively).

The ANOVA (2 Condition × 2 Age × 6 Types of affect) confirmed main effects for condition, $F(1, 50) = 84.37$, $p < .001$, and affect, $F(5, 250) = 417.18$, $p < .001$, and a significant Condition × Affect interaction, $F(5, 250) = 52.96$, $p < .001$. A separate ANOVA comparing mothers of 12-month-old walkers and 12-month-old crawlers revealed no significant effects for locomotor experience (ps > .05). Post hoc analyses showed that the main effect for types of affect was due to mothers' reliance on positive facial and vocal affect rather than mixed or negative affect. The average proportion of trials in which mothers displayed positive (M = .82, SD = .21), mixed (M = .17, SD = .18), and negative facial affect (M = .01, SD = .04) differed from each other (ps < .001). Similarly, the proportion of trials in which mothers displayed positive (M = .80, SD = .15), mixed (M = .18, SD = .14), and negative vocal affect (M = .02, SD = .03) differed (ps < .001).

The condition by affect interaction reflected differences in the proportion of trials containing purely positive and mixed emotional messages (Figure 3). Mothers exhibited more purely positive facial affect in the encourage condition (M = .93, SD = .17) than in the discourage condition (M = .68, SD = .32; $p < .001$). A similar pattern was noted for positive vocal affect (Ms = .96 and .60; SDs = .09 and .30 in encourage and discourage, respectively; $p < .001$). Mothers displayed more mixed facial (M = .32, SD = .31) and vocal (M = .37, SD = .28) expressions in the same trial when discouraging than when encouraging (Ms = .07 and .04; SDs = .13 and .09; ps < .001, for face and voice, respectively). Trials with purely negative facial (M = .01, SD = .04) and vocal affect were infrequent (M = .02, SD = .03). Purely negative vocal affect increased slightly from the encourage (M = .00, SD = .00) to the discourage condition (M = .03, SD = .07), although remaining extremely rare ($p < .05$).

Verbal Content

Mothers used a variety of verbal messages, rather than simply telling their infants to stay or to go, and they tailored the content of their messages to the condition, and to infants' age and locomotor experience. Nearly all mothers used location regulators (100% of mothers), action shapers (96.2%), at tention grabbers (100%), and general directives (98.1%); most praised infants (76.9%); and nearly half used what/why statements describing the situation and consequences of infants' actions (48.1%). The ANOVA (2 Condition × 2 Age × 6 Types of verbal statements) revealed a main effect for verbal category, $F(5, 250) = 135.81$, $p < .001$, an Age × Verbal Category interaction, $F(5, 250) = 5.67$, $p < .001$, and a Condition × Verbal Category interaction, $F(5, 230) = 2.69$, $p < .05$. Post hoc analyses showed that the main effect for verbal category resulted from a greater proportion of location regulators (M = .72, SD = .21), attention grabbers (M = .81, SD = .17), general direc-

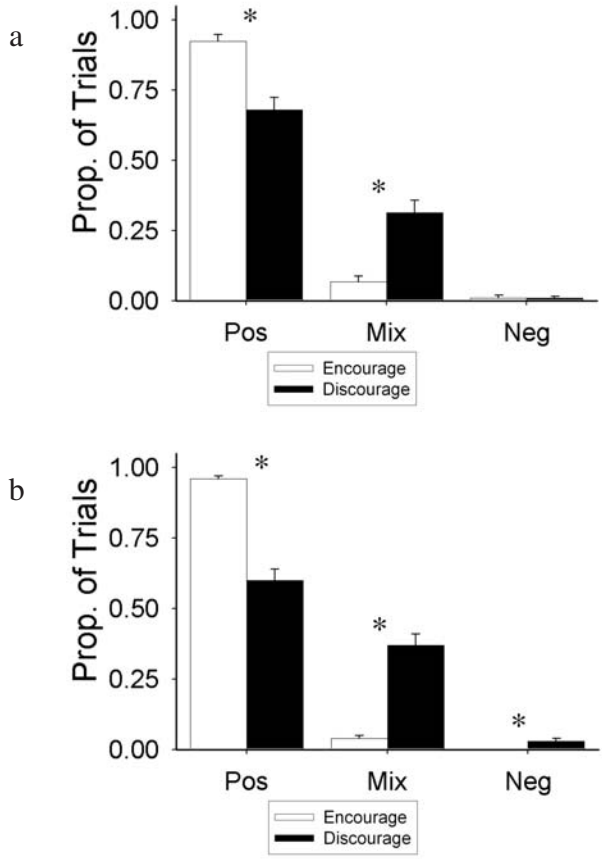

FIGURE 3 Facial and vocal affect. (a) Proportion of trials in which mothers displayed positive, mixed positive/negative, and negative facial affect, in encouraging and discouraging conditions. (b) Proportion of trials in which mothers displayed positive, mixed positive and negative, and negative vocal affect, in encouraging and discouraging conditions.

tives ($M = .65$, $SD = .23$), and action shapers ($M = .43$, $SD = .28$) compared to what/why statements ($M = .08$, $SD = .14$) and praise ($M = .16$, $SD = .15$), $ps < .05$. The Condition × Verbal Category interaction was explained by a higher rate of attention grabbers, what/why statements, and praise in the discourage condition, all $ps < .001$. The latter result was unexpected. When we checked the video records, we determined that mothers praised infants more while discouraging them from descent because they told infants, "Good girl," and "Great job" when they stopped moving toward the brink of the slope.

More differences in the verbal content of mothers' messages emerged when the broad categories of location regulators, action shapers, and general directives were

broken down further. In the discourage condition, mothers prohibited specific actions ($M = .23$, $SD = .27$), suggested a change in action ($M = .21$, $SD = .29$), banned a location ($M = .15$, $SD = .21$), instructed infants to maintain their place on the walkway ($M = .65$, $SD = .32$), and said, "No," "Don't," and "Stop" ($M = .61$, $SD = .25$). When encouraging, mothers promoted specific actions ($M = .35$, $SD = .35$), advised infants to relocate ($M = .71$, $SD = .24$), and said, "Come on," or "Let's go!" ($M = .63$, $SD = .27$), $ps < .001$.

Finally, the Age × Verbal Statement interaction resulted from mothers of 18-month-old infants relying more on specific action shapers ($M = .57$, $SD = .28$) than mothers of 12-month-olds ($M = .30$, $SD = .22$). Mothers of 18-month-olds were almost twice as likely to offer specific information about what infants should or should not do ("Sit down" or "Walk slowly"), $p < .001$.

Mothers of the 12-month-olds also tailored the verbal content of their messages to infants' locomotor experience—that is, whether infants were experienced crawlers or novice walkers. A (2 Condition × 2 Locomotor experience × 6 Verbal statement) mixed measures ANOVA revealed a main effect for condition, $F(1, 26) = 26.91$, $p < .001$, and verbal statement, $F(5, 130) = 105.85$, $p < .001$, replicating the results for condition and verbal statement from the preceding analyses on the effects of age. The ANOVA also revealed a main effect for locomotor experience, $F(1, 26) = 5.61$, $p < .05$, and an interaction between verbal statement and locomotor experience, $F(5, 130) = 2.53$, $p < .05$. Mothers of experienced crawlers displayed more general directives ($M = .77$) and marginally more action shapers ($M = .38$) and praise ($M = .21$) than mothers of novice walkers ($Ms = .54, .23$, and $.11$ for the three types of verbal statements, respectively), $ps = .013, .08, .06$. Despite the marginal effect for action shapers at the trial level, when examining the proportion of mothers offering action shapers in the discourage condition, all mothers of crawlers used action directives compared to 10 (71.4%) mothers of 12-month-old walkers, $\chi^2(1, N = 28) = 4.67$, $p < .05$.

Mothers used a larger variety of verbal statements in the discourage condition. An ANOVA (2 Condition × 2 Age) on verbal diversity scores confirmed a greater number of different types of verbal statements in the discourage condition ($M = 3.08$, $SD = .72$) than in the encourage condition ($M = 2.67$, $SD = .65$), $F(1, 50) = 23.20$, $p < .001$. Similarly, an ANOVA (Condition × Locomotor Experience) on diversity scores in the 12-month-olds showed greater diversity in the discourage ($M = 3.07$, $SD = .72$) than encourage condition ($M = 2.54$, $SD = .62$), $F(1, 26) = 26.91$, $p < .001$. The ANOVA also showed greater diversity by mothers of experienced crawlers ($M = 3.02$, $SD = 0.59$) than novice walkers ($M = 2.53$, $SD = 0.55$), $F(1, 26) = 5.61$, $p < .05$.

Gestures

Gestures, especially the beckons and crossing-guard motions denoting location, were common, and were geared to condition and infants' locomotor experience.

Mothers gestured on 63% of the trials, and all but one mother gestured at least once. Most mothers used gestures to signal location (90.4%), point at the slope (80.8%), and clap to applaud infants' progress (82.7%). Half (51.9%) used iconic gestures to represent various means of descent, such as swinging their hands and arms back and forth to demonstrate crawling or walking, and twirling their fingers in a circle to suggest sitting down, scooting, or backing. The ANOVA (2 Condition × 2 Age × 4 Types of gestures) revealed main effects for condition, $F(1, 50) = 5.67$, $p < .05$, and gesture type, $F(3, 150) = 38.34$, $p < .001$, and a Condition × Gesture Type interaction, $F(3, 150) = 13.82$, $p < .001$. Overall, mothers gestured more in the encourage ($M = .26$, $SD = .17$) than discourage condition ($M = .21$, $SD = .16$), primarily due to a preponderance of clapping. Across conditions, mothers used more location gestures ($M = .47$, $SD = .33$) than points ($M = .17$, $SD = .16$), claps ($M = .20$, $SD = .20$), and action gestures ($M = .09$, $SD = .13$), ps $< .001$.

The condition by gesture category interaction resulted from differences in claps and points between the social conditions. Mothers clapped more in the encourage ($M = .33$, $SD = .30$) than discourage condition ($M = .05$, $SD = .13$), $p < .001$. But, they pointed twice as often in the discourage condition ($M = .24$, $SD = .27$) than in the encourage condition ($M = .13$, $SD = .19$), $p < .05$. When location gestures were further broken down, mothers were more likely to beckon in the encourage condition ($M = .48$, $SD = .39$) versus discourage condition ($M = .01$, $SD = .03$), and to gesture "stop" when discouraging ($M = .45$, $SD = .38$) than when encouraging ($M = .01$, $SD = .04$), ps $< .001$.

Mothers used a larger variety of gestures in the encourage condition. An ANOVA (Condition × Age) on gestural diversity scores yielded a greater number of different types of gestures in the encourage condition ($M = 1.02$, $SD = .64$) than in the discourage condition ($M = .82$, $SD = .63$), $F(1, 50) = 5.02$, $p < .05$. Mothers' gestures were also tailored to infants' locomotor experience. As in verbal content, mothers of experienced crawlers displayed more gestures and a greater diversity of gestures than mothers of novice walkers. The (2 condition × 2 locomotor experience × 4 gesture category) ANOVA showed main effects for condition and gesture type, and a Gesture Type × Condition interaction as earlier (all ps $< .05$). The main effect for locomotor status was also significant, $F(1, 26) = 4.67$, $p < .05$. Mothers gestured on more trials to crawlers ($M = .30$, $SD = .13$) than to walkers ($M = .20$, $SD = .13$). The main effect of locomotor experience was also evident for diversity of gestures, $F(1, 26) = 4.43$, $p < .05$. Mothers of 12-month-old crawlers used a greater variety of gestures ($M = 1.18$, $SD = .14$) than mothers of walkers ($M = .79$, $SD = .14$).

Illustration of a Message

Of course, mothers' multimodal and emotionally mixed messages must unfold over time, presumably choreographed in synchrony with infants' ongoing behaviors. Figure 4 depicts one encourage and one discourage trial from a typical mother

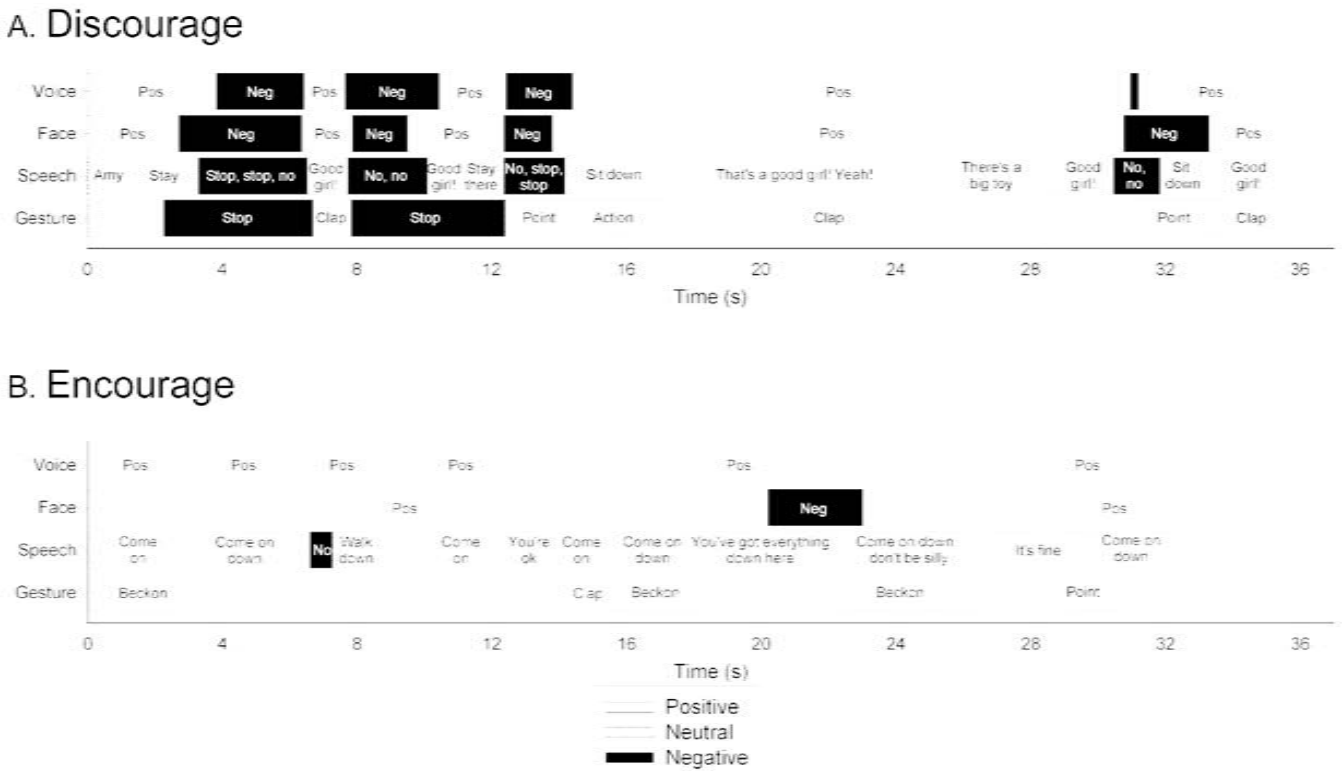

FIGURE 4 Timeline graphs of one discouraging (a) and one encouraging (b) trial of a mother of an 18-month-old infant. Each row of the graphs represents a different modality (facial affect, vocal affect, speech, and gestures). Shading represents the positive, negative, or neutral valence of each behavior.

of an 18-month-old to illustrate how the various channels of information are coordinated from moment to moment in the mother's message.

Usually, the affective components of facial and vocal expressions were in concert, but as illustrated in Figure 4, occasionally a mother's face was stern while her voice was positive (sec 32–36 in discourage and sec 21–23 in encourage). The content of mothers' words and gestures can also be conceptualized as communicating positive and negative valences (as depicted by the shading for the corresponding rows in the figure). Accordingly, the affective content of words or gestures was sometimes in concert and sometimes discordant with the expression on the mother's face or the sound of her voice.

Over the course of the trial, mothers rapidly switched back and forth between positive and negative affect, resulting in the high rate of mixed affect trials. For example, in the discourage trial, the mother shifted between positive and negative facial and vocal expressions, tempering a harsh face and voice in one moment with positive affect in the next moment. Speech and gestures also oscillated between positive and negative messages; after a stern command, reinforcing statements, "good girl," and hand clapping praised the baby for compliance. In the encourage trial, the mother expressed a no-nonsense grimace and instructed her infant to relocate and not to dawdle ("Come on down, don't be silly"), followed by positive reassurances when the infant balked.

As the trial unfolded, mothers produced a variety of verbal statements and gestures, rather than repeating the same words and phrases and limiting themselves to general prohibitions to discourage descent and to praise to encourage descent. As shown here, over the course of the discourage trial, the mother oriented her infant ("Amy"), provided information about location ("Stay") and action ("Sit down"), and offered general prohibitions to halt inappropriate behavior ("No, stop, stop"). While encouraging, she provided specific instruction about location and action ("Walk here") in addition to basic, encouraging commands such as, "Come on." The mother displayed four different types of gestures over the course of the discourage trial (crossing-guard stop, pointing at the slope, clapping, and an iconic "sit down" gesture) and three different types in the encourage trial (beckoning, clapping, and pointing).

At some time during the trials, all of the channels of information were redundant: a crossing-guard gesture coupled with a stern "no" and a negative facial expression; a beckoning gesture concurrent with an upbeat "come on down" and a smiling face. Sometimes the channels provided different types information, as when gestures augmented speech by providing new information: "sit down" paired with a point at the slope to show where to sit.

DISCUSSION

In the course of everyday interactions with their newly mobile infants, mothers encourage and discourage their infants' motor actions. Physical barriers and hands-

on interventions allow infants the freedom to explore while maintaining their safety. However, when physical interventions are not possible, mothers must rely on distal messages carried by emotional displays, language, and gestures. This study addressed how mothers freely use these channels of communication to encourage and discourage their 12- and 18-month-old infants in a potentially risky motor task. Because mothers encouraged and discouraged their infants over the course of multiple trials, we were able to observe the range of strategies that mothers might use to warn their infants of repeated dangers and to coax their infants to attempt new challenges.

The current focus on the content of mothers' social messages to their locomoting infants complements the body of research on mother–infant communication and extends the research on early motor development. Mothers and infants were tested across repeated trials in a laboratory analog of common challenges that mobile infants encounter. The task here was potentially dangerous, as infants who attempted to descend steep slopes experienced the consequence of falling (before being rescued by an experimenter). Moreover, the slope was in clear view of mothers who were well beyond the reach of their infants. In daily life, infants have repeated encounters with potentially risky situations (e.g., the apartment steps), in which mothers may be beyond arms' reach.

Building on previous findings that infants seek and use social information in making decisions about action, the key question here concerned how mothers encourage and discourage their infants' motor actions. Findings revealed that mothers augment emotional messages with frequent and varied verbalizations and gestures that inform their infants about the task at hand and appropriate ways to act.

Emotional Expressions

A commonsense supposition is that mothers' emotional expressions would closely align with the goals of the condition: Mothers would use stern or panicked voices and negative (angry or fearful) facial expressions to discourage infants' actions, and use positive voices and faces (soothing or happy tones with smiles) to encourage their actions. However, mothers effectively guided infants' actions in both social conditions using predominantly positive affect. When discouraging their infants, mothers rarely displayed purely negative affect ($< 5\%$ of trials); instead, they oscillated between positive and negative facial and vocal expressions within the same trial. A second surprising finding was that mothers frequently used praise in the discourage condition (twice as many trials compared with the encourage condition).

What might account for the high frequency of positive affect and praise in the discourage condition when infants faced a potentially risky situation? One possibility is that mothers did not regard the task as truly dangerous because they knew that the experimenter would rescue infants who began to fall. Indeed, mothers saw

the experimenter spot their infants on previous trials, and therefore, over the course of multiple trials, the element of potential danger might have waned. However, mothers who received the discourage condition first were equally likely to display positive affect and praise on their first trial, regardless of the degree of slant (M = 96% of trials). A second possibility is that the nature of mothers' warnings will depend on characteristics of the potential dangers—including whether dangers are unexpected versus anticipated, and beyond or within the control of infants. When danger is unexpected and immediate, such as an oblivious infant toddling to the top of the stairs or an older child darting into the path of an oncoming car, mothers are likely to respond with purely negative affect: a screeching "No!" or the child's name accompanied with a negative (likely fearful) facial expression (Tamis-LeMonda et al., 2006). However, in the slope task, as in many everyday situations, the potential danger can be anticipated and the interaction between mother and child is prolonged. Therefore mothers' discouragement might serve the dual functions of preventing mishaps and teaching infants appropriate ways to act (Garling & Garling, 1995). For example, mothers may discourage their toddlers from descending stairs in an upright position with a combination of negative prohibitions against walking and more positive information about alternative methods of descent. Similarly, mothers may discourage their older children from crossing the street by teaching them to look both ways for oncoming cars and to obey the crossing signals. Steep slopes, like busy streets, cleaning supplies, electrical outlets, and knives, are not inherently dangerous; the situation becomes dangerous only when children's actions are inappropriate.

Thus, interleaving positive facial expressions and praise with negative prohibitions may have served several functions. Positive messages may reflect mothers' proactive use of positive communicative strategies to elicit compliance from their infants. Positive messages may reward infants for avoiding the slope or may have been in response to infants' smiles or bids for help. Phrases such as, "Good girl, that's right," delivered in a soothing tone may also regulate infants' arousal so that mothers can maintain infants' attention and offer alternative solutions for how to cope with the situation.

An additional reason for oscillating between positive and negative expressions is that mothers might feel compelled to temper negative tones and facial expressions with reassuring emotional messages. By doing so, mothers can emphasize the urgency of their directions while maintaining infants' motivation and rewarding them for compliance. Similarly, in everyday situations, mothers of 12-month-old walkers increased both positive and negative emotions, perhaps reflecting the need to prohibit dangerous behaviors while praising infants' accomplishments (Biringen et al., 1995).

In everyday situations, mothers rarely present isolated facial expressions to their infants. One study corroborates the findings reported here by demonstrating clear differences in mothers' messages to their 12-month-old infants in con-

strained, as compared to unconstrained, conditions (Rosen, Adamson, & Bakeman, 1992). In the constrained condition, mothers were instructed to display happy or fearful facial expressions as their infants approached a toy. In the unconstrained condition, mothers were asked to encourage and discourage, but they were not informed about how to deliver their messages. The authors found that when unconstrained, mothers' messages varied considerably from the posed expressions in terms of clarity and modality. For example, when constrained, mothers' facial expressions were clearly happy in the happy condition and clearly fearful in the fear condition. In the unconstrained condition, happy messages were clearer than fear messages. That is, in the fear condition, the valence of mothers' messages was not always evident to the independent coder. Moreover, mothers used a variety of strategies to deliver their unconstrained messages when compared to the constrained condition; they almost always enhanced facial expressions with verbal messages and gestures. In turn, infants have been shown to benefit from multimodal, complex stimuli when compared with isolated features, perhaps due to redundancy in the available information (Meltzoff & Kuhl, 1989; Walker-Andrews, 1997).

Verbal and Gestural Information

Mothers' mixed facial and vocal expressions might create confusion for infants if not for the accompanying verbal and gestural information. In terms of mothers' verbal statements, findings extend previous studies that have relied on mothers' repeated use of a single phrase such as "Nice toy!" (e.g., Walden & Ogan, 1988). Mothers displayed a variety of verbal statements that provided infants with specific information about locations and actions when encouraging (e.g., "Come down," "Walk slowly"), and, when discouraging, drew their attention to the situation ("Look") and described features of the slope and the consequences of attempting descent ("It's steep," "You'll hurt yourself"). Mothers also provided a rich array of gestures that offered visually salient information to infants. Nearly all mothers used conventional gestures such as claps and indexical gestures (e.g., beckons, "stop" gestures, and points) to refer to locations and the slope. Approximately half of mothers used iconic gestures, which visually depicted the actions they wished their infants to carry out.

Mothers produced a greater variety of vocalizations during the discourage trials, perhaps because they had more of an opportunity to offer their verbal messages. The average accumulated time was greater in the discourage condition, in part because mothers were successful in getting infants to hesitate, especially on steeper slopes. In contrast, mothers produced more gestures when encouraging infants' motor actions due to the high prevalence of claps (33% of encourage trials vs. 5% of discourage trials). Possibly, mothers used claps to arouse their infants and get them moving. Specifically, mothers were more likely to pair claps with general directives ("Let's go!") to encourage their infants' actions. However, moth-

ers' pointing gestures doubled in the discourage condition. In addition to using points to orient infants' attention to the slope, mothers often coupled points with location regulators to communicate where infants should place their bodies.

Age and Locomotor Experience

Verbal and gestural communications were attuned to changes in infants' age and locomotor experience. Mothers referred to actions (e.g., "Scoot down on your bottom") more frequently when communicating with their 18-month-olds as compared to 12-month-olds. Despite less frequent use of action statements with younger infants overall, mothers of 12-month-old crawlers used action statements more than mothers of 12-month-old walkers, particularly when discouraging. Similar to the teaching-type warnings used by mothers of 2- and 3-year-olds (Garling & Garling, 1995), action shapers require children to understand and execute commands about actions. The relatively higher use of action shapers with older infants may be due to the fact that 18-month-olds are in the process of rapidly acquiring verbs in their lexicons and might be viewed by mothers as better able to understand action words than their younger counterparts (Dale & Fenson, 1996; Golinkoff, Jacquet, Hirsh-Pasek, & Nandakumar, 1996). Mothers might also use action shapers more with experienced crawlers than novice walkers out of a belief that experienced infants are better able to heed advice about ways to modify their actions.

Mothers of experienced crawlers also displayed a greater diversity of language and gestures than mothers of novice walkers, which again might reflect the expectation that more experienced infants would benefit from a range of verbal and gestural information. Rather than repeating the same message multiple times, mothers suggested various strategies to enable their crawling infants to effectively navigate the slope. Like mothers of experienced crawlers, mothers of 18-month-old walkers displayed a greater diversity in their verbal messages when compared to mothers of 12-month-old walkers. In fact, their scores exceeded the scores for mothers of 12-month-old walkers by 3 *SD*. These findings suggest that infants' locomotor experience, rather than posture or age, influenced mothers' verbal diversity.

It is also possible that the greater diversity evidenced in mothers of crawlers versus walkers was due to the greater caution displayed by their crawling infants. That is, because crawlers are more likely to avoid slopes by remaining on the starting platform, mothers have more time to encourage or discourage. These findings have implications for the safety of new walkers, as they may make quick, inaccurate decisions about walking that leave mothers with little time to advise them about what to do or not to do. Indeed, previous work showed that new walkers plunge over the brink of steep slopes without hesitation (Adolph, 1997; Adolph et al., 2007). The findings reported here suggest that mothers did not have time to express an appropriate message.

Limitations and Future Directions

This study points to several important directions for future research. First, although we coded many aspects of maternal communication (i.e., a total of 14 main categories of maternal behavior in two conditions, across two age groups, and across two locomotor experience groups), the coding scheme did not examine aspects of mothers' messages that are meaningful to infants, including emotional intensity or urgency, loudness, duration, and repetition (e.g., Fogel, Hsu, Shapiro, Nelson-Goens, & Secrist, 2006; Kamman, Muir, Koester, & Dimiter, 2005).

Second, analyses involved variables that were coded at the trial level (e.g., whether mothers produced positive or negative affect, or a specific type of verbal statement during a given trial). However, Figure 4 demonstrates the richness of mothers' social messages over the course of a trial, and points to the value of examining the conditional probabilities of particular events in the sequence of maternal behaviors.

Third, mothers' greater diversity in the discourage condition versus encourage condition might be explained by the overall amount of maternal language. Mothers might have talked more when discouraging than when encouraging out of concern for their infants' safety. More talk, in turn, would lead to a greater number of different strategies in the discourage condition. Whether the use of more talk explained mothers' greater language diversity in discourage trials remains unexplored. However, we can say with confidence that mothers used more diverse language with experienced infants and when discouraging, even if unable to address reasons for these differences.

Fourth, although we attempted to create a laboratory analog of common locomotor challenges, this does not guarantee that the findings reported here generalize to what mothers do in real-world situations that elicit encouragement and discouragement (e.g., infants descending stairs, using playground equipment, or jumping into a swimming pool). Moreover, although mothers' messages were unconstrained, they were also not spontaneous in the sense that an experimenter told mothers when to encourage or discourage. However, despite the structure of the task, mothers used their own discretion and amended their messages when they felt it necessary to do so. For example, Figure 4 demonstrates that despite the discourage condition, this mother is not exclusively discouraging (e.g., "Stop, stop, no" is followed by "Good girl"). In the encourage condition, a cheering, "Come on down," is followed by a "No."

Finally, questions of generalizability also arise in terms of the relatively homogeneous sample of participants. We examined communications of mothers who were primarily White, from middle- to upper middle-class, and all English speakers. Whether findings would generalize to mothers from other ethnic, cultural, and socioeconomic groups is open to question.

Taken together, we extend previous work by using a potentially risky task in an experimental setting and by allowing mothers to freely vary their messages. Findings reveal that infants are exposed to rich, multimodal information that might be used to guide their decisions about motor actions. An infant with limited language may benefit from a mother's crossing-guard gesture that accompanies a verbal command "Stay there." Beyond words and gestures, infants may interpret mothers' smiling faces and enthusiastic voices as signals that it is safe to proceed. These findings bring us a step closer to describing the ways that mothers effectively fulfill their dual roles as cheerleader and lifeguard. Through various channels of distal communication, mothers effectively halt inappropriate behavior, suggest alternative means of action, and enthusiastically support infants within the limits of safety.

REFERENCES

Adamson, L. B., & Bakeman, R. (1984). Mothers' communicative acts: Changes during infancy. *Infant Behavior & Development, 7,* 467–478.

Adolph, K. E. (1997). Learning in the development of infant locomotion. *Monographs of the Society for Research in Child Development, 62*(3, Serial No. 251).

Adolph, K. E. (2000). Specificity of learning: Why infants fall over a veritable cliff. *Psychological Science, 11,* 290–295.

Adolph, K. E. (2002). Learning to keep balance. In R. Kail (Ed.), *Advances in child development and behavior* (Vol. 30, pp. 1–30). Amsterdam: Elsevier Science.

Adolph, K. E., Tamis-LeMonda, C. S., Ishak, S., Karasik, L. B., & Lobo, S. A. (in press). Locomotor experience and use of social information are posture specific. *Developmental Psychology.*

Biringen, Z., Emde, R. N., Campos, J. J., & Applebaum, M. I. (1995). Affective reorganization in the infant, the mother, and the dyad: The role of upright locomotion and its timing. *Child Development, 66,* 499–514.

Campos, J. J., Anderson, D. I., Barbu-Roth, M. A., Hubbard, E. M., Hertenstein, M. J., & Witherington, D. C. (2000). Travel broadens the mind. *Infancy, 1,* 149–219.

Campos, J. J., & Stenberg, C. R. (1981). Perception, appraisal, and emotion: The onset of social referencing. In M. Lamb & L. Sherrod (Eds.), *Infant social cognition* (pp. 273–314). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Chong, S. C. F., Werker, J. F., Russell, J. A., & Carroll, J. M. (2003). Three facial expressions mothers direct to their infants. *Infant and Child Development, 12,* 211–232.

Dale, P. S., & Fenson, L. (1996). Lexical development norms for young children. *Behavioral Research Methods, Instruments & Computers, 28,* 125–127.

Deak, G. O., Flom, R. A., & Pick, A. D. (2000). Effects of gesture and target on 12- and 18-month-old's joint attention to objects in front of or behind them. *Developmental Psychology, 36,* 511–523.

Dimitropoulou, K., Tamis-LeMonda, C. S., Adolph, K. E., & Alibali, M. (2007, June). *How do childrens' age and knowledge shape mothers' messages?* Paper presented at the meeting of the International Society on Gesture Studies, Evanston, IL.

Fernald, A. (1989). Intonation and communicative intent in mothers' speech to infants: Is the melody the message? *Child Development, 60,* 1497–1510.

Fernald, A. (1993). Approval and disapproval: Infant responsiveness to vocal affect in familiar and unfamiliar languages. *Child Development, 64,* 657–674.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language, 16,* 477–501.

Fogel, A., Hsu, H., Shapiro, A. F., Nelson-Goens, G. C., & Secrist, C. (2006). Effects of normal and perturbed social play on duration and amplitude of different types of infant smiles. *Developmental Psychology, 42,* 459–473.

Garling, A., & Garling, T. (1995). Mothers' anticipation and prevention of unintentional injury to young children in the home. *Journal of Pediatric Psychology, 20,* 23–36.

Gogate, L. J., Bahrick, L. E., & Watson, J. D. (2000). A study of multimodal motherese: The role of temporal synchrony between verbal labels and gestures. *Child Development, 71,* 878–894.

Golinkoff, R. M., Jacquet, R. C., Hirsh-Pasek, K., & Nandakumar, R. (1996). Lexical principles may underlie the learning of verbs. *Child Development, 67,* 3101–3119.

Gutmann, A. J., & Turnure, J. E. (1979). Mothers' production of hand gestures while communicating with their preschool children under various task conditions. *Developmental Psychology, 15,* 197–203.

Hirschberg, L. M., & Svejda, M. (1990). When infants look to their parents: I. Infants' social referencing of mothers compared to fathers. *Child Development, 61,* 1175–1186.

Hornik, R., & Gunner, M. R. (1988). A descriptive analysis of infants' social referencing. *Child Development, 59,* 626–634.

Hornik, R., Risenhoover, N., & Gunnar, M. (1987). The effects of maternal positive, neutral, and negative affective communications on infant responses to new toys. *Child Development, 58,* 937–944.

Iverson, J. M., Capirci, O., Longobardi, E., & Caselli, M. C. (1999). Gesturing in mother–child interactions. *Cognitive Development, 14,* 57–75.

Kamman, T., Muir, L., Koester, L. S., & Dimiter, M. (2005). Linking maternal perceptions to behavior: Nurturing attitudes and facial expressions of affect. *Parenting: Science and Practice, 5,* 237–258.

Kitamura, C., & Burnham, D. (1998). The infant's response to vocal affect in maternal speech. In C. K. Rovee-Collier & L. R. Lipsitt (Eds.), *Advances in infancy research* (Vol. 12, pp. 221–236). Norwood, NJ: Ablex.

Klinnert, M. D., Campos, J. J., Sorce, J. F., Emde, R. N., & Svedja, M. (1983). Emotions as behavior regulators: Social referencing in infancy. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research, and experience* (Vol. 2, pp. 57–86). New York: Academic.

Klinnert, M. D., Emde, R. N., Butterfield, P., & Campos, J. J. (1986). Social referencing: The infant's use of emotional signals from a friendly adult with mother present. *Developmental Psychology, 22,* 427–432.

MacWhinney, B. (1995). *The CHILDES project: Tools for analyzing talk* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Malatesta, C. Z., Grigoryev, P., Lamb, C., Albin, M., & Culver, C. (1986). Emotion socialization and expressive development in preterm and full-term infants. *Child Development, 57,* 316–330.

Meltzoff, A. N., & Kuhl, P. K. (1989). Infants' perception of faces and speech sounds: Challenges to developmental theory. In P. R. Zelazo & R. G. Barr (Eds.), *Challenges to developmental paradigms: Implications for theory, assessment and treatment* (Vol. XII, pp. 67–91). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Messer, D. J. (1978). The integration of mothers' referential speech with joint play. *Child Development, 49,* 781–787.

Morrongiello, B. A., & Dawber, T. (1998). Toddlers' and mothers' behaviors in an injury-risk situation: Implications for sex differences in childhood injuries. *Journal of Applied Developmental Psychology, 19,* 625–639.

Morrongiello, B. A., & Dawber, T. (2000). Mothers' responses to sons and daughters engaging in injury-risk behaviors on a playground: Implications for sex differences in injury rates. *Journal of Experimental Child Psychology, 76,* 89–103.

Mumme, D. L., Fernald, A., & Herrera, C. (1996). Infants' responses to facial and vocal emotional signals in a social referencing paradigm. *Child Development, 67,* 3219–3237.

Murphy, C. M., & Messer, D. J. (1977). Mothers, infants, and pointing: A study of a gesture. In H. R. Schaffer (Ed.), *Studies in mother–infant interaction* (pp. 325–354). Glasgow, Scotland: Academic.

O'Neill, M., Bard, K. A., Linnell, M., & Fluck, M. (2005). Maternal gestures with 20-month-old infants in two contexts. *Developmental Science, 8,* 352–359.

Papousek, M., Papousek, H., & Bornstein, M. (1985). The naturalistic vocal environment of young infants: On the significance of homogeneity and variability in parental speech. In T. M. Field & N. A. Fox (Eds.), *Social perception in infants* (pp. 261–298). Norwood, NJ: Ablex.

Peterson, L., Ewigman, B., & Kivlahan, C. (1993). Judgements regarding appropriate child supervision to prevent injury: The role of environmental risk and child age. *Child Development, 64,* 934–950.

Rosen, W. D., Adamson, L. B., & Bakeman, R. (1992). An experimental investigation of infants' social referencing: Mothers' messages and gender differences. *Developmental Psychology, 28,* 1172–1178.

Sanderson, P. M., Scott, J. J. P., Johnston, T., Mainzer, J., Wantanbe, L. M., & James, J. M. (1994). MacSHAPA and the enterprise of Exploratory Sequential Data Analysis (ESDA). *International Journal of Human–Computer Studies, 41,* 633–681.

Schaffer, H. R., Hepburn, A., & Collis, G. M. (1983). Verbal and nonverbal aspects of mothers' directives. *Journal of Child Language, 10,* 337–355.

Schmidt, C. L. (1996). Scrutinizing reference: How gesture and speech are coordinated in mother–child interaction. *Journal of Child Language, 23,* 279–305.

Schnur, E., & Shatz, M. (1984). The role of maternal gesturing in conversations with one-year-olds. *Journal of Child Language, 11*(1), 29–41.

Snow, C. E. (1972). Mothers' speech to children learning language. *Child Development, 43,* 549–565.

Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: Its effects on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21,* 195–200.

Stern, D. N. (1974). Mother and infant at play: The dyadic interaction involving facial, vocal, and gaze behaviors. In M. Lewis & L. A. Rosenblum (Eds.), *The effects of the infant on its caregiver* (pp. 187–213). Oxford, UK: Wiley-Interscience.

Tamis-LeMonda, C. S., & Adolph, K. E. (2005). Social cognition in infant motor action. In B. Homer & C. S. Tamis-LeMonda (Eds.), *The development of social cognition and communication* (pp. 145–164). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Tamis-LeMonda, C. S., Adolph, K. E., Dimitropoulou, K. A., & Zack, E. A. (2006). "No! Don't! Stop!" Mothers words for impending danger. *Parenting: Science and Practice, 7,* 1–25.

Trevarthen, C. (1977). Descriptive analyses of infant communication behavior. In H. R. Schaffer (Ed.), *Studies in mother–infant interaction* (pp. 227–270). San Diego, CA: Academic.

Vaish, A., & Striano, T. (2004). Is visual reference necessary? Contributions of facial versus vocal cues in 12-month-olds' social referencing behavior. *Developmental Science, 7,* 261–269.

Walden, T. A., & Ogan, T. A. (1988). The development of social referencing. *Child Development, 59,* 1230–1240.

Walker-Andrews, A. S. (1997). Infants' perception of expressive behaviors: Differentiation of multimodal information. *Psychological Bulletin, 121,* 437–456.

Zukow-Goldring, P. (1997). A social ecological realist approach to the emergence of the lexicon: Educating attention to amodal invariants in gesture and speech. In C. Dent-Read & P. Zukow-Golding (Eds.), *Evolving explanations of development: Ecological approaches to organism-environment systems* (pp. 199–250). Washington, DC: American Psychological Association.