Chapter 6

Social Referencing in Infant Motor Action

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INTRODUCTION

In this chapter, we adopt a novel approach to understanding the origins of social cognition. In contrast to typical studies that examine the development of social cognition and communication in the context of language and play, we examine how infants come to seek and use social information from their caregivers in the context of making decisions about challenging motor actions. Potentially risky motor situations heighten the relevance of caregivers’ social information because infants’ motor decisions have practical consequences for their safety. Moreover, the threat of physical harm provides a unique opportunity for investigating central issues in the literature on social referencing. In particular, how and when infants reference their caregivers as they plan a course of motor action has the potential to reveal new insights about babies’ knowledge of self and others.

Our interest in the intersection of developmental changes in social cognition and motor action is dually motivated. First, on a developmen-
tial time scale, important strides in social cognition and motor abilities emerge in tandem (Campos et al., 2000). Most notably, between the ages of 8 and 18 months, infants become independently mobile. Infants who could formerly interact with the world from a fixed position become mischievous crawlers, wobbly toddlers, and confident walkers over a relatively short time span. During this same developmental period, infants are increasingly able to capitalize on adults’ knowledge. They follow adults’ gaze, imitate adults’ actions with novel objects, look toward adults in ambiguous circumstances, and vocalize and gesture to share experiences. These behaviors mark the start of a socio-cognitive revolution (Tomasello, Kruger, & Ratner, 1993).

A second motivation for studying social cognition in the context of motor action is that infants typically acquire new motor skills in a social context, supported by the encouragement and helping hands of their caregivers. Babies’ first attempts to reach are likely toward a toy offered by a caregiver, their first experience standing is bouncing up and down on a caregiver’s lap, their first crawling forays occur under their parents’ watchful eyes, and their first walking steps are into a proud parent’s open arms. Each motor action produces a rich, dynamic flow of perceptual and social information. The movements involved in reaching, sitting, bouncing, crawling, and walking generate visual, proprioceptive, vestibular, and auditory feedback about the position of the body relative to objects in the environment. At the same time, babies’ movements are accompanied by the sights and sounds of caregivers’ outstretched arms, smiling faces, and undulating voices expressing words of encouragement or warning.

In situations of potential motor risk, infants can gauge possibilities for action by looking at the obstacle, making physical contact through touching, testing the limits of their powers of strength and balance via swaying and rocking movements, and so on. Infants can also take an active role in ensuring their own safety by signaling their caregivers for information or help via puzzled or imploring looks, vocalizations, and gestures. Thus, infants’ decisions about everyday motor challenges involve weighing and integrating perceptual information generated by their own exploratory movements with social information offered by their caregivers.

The transition from relying primarily on self-generated knowledge to becoming a savvy seeker and consumer of social information signals infants’ entry into a world of social intentions (Baldwin, in this volume). Infants come to appreciate their caregivers as potential reservoirs of social information. Eventually, babies understand that people—their parents and others—can adopt varying psychological orientations toward objects and events (Moore & Corkum, 1994). This realization enormously expands infants’ opportunities for learning. By capitaliz-
how infants weigh and integrate the perceptual information gleaned from their own exploratory activities with social information offered by their caregivers. What might the process of weighing competing sources of information under conditions of potential motor risk tell us about infants’ emerging social understanding? In this chapter, we address this question by considering when and how infants seek and use social information as they make decisions about action.

**SOCIAL REFERENCING**

Seeking and using social information from caregivers is referred to as “social referencing”. Infants seek social information by intentionally attempting to gather information via looking to a caregiver’s face, vocalizing, and/or manually gesturing for help. Using social information entails that infants modify their emotions or behaviors in line with the social message. Thus, an infant who is wary of a stranger might seek social information by looking to mother in order to elicit her appraisal and use social information by reacting to mother’s comforting smile with a decline in fearful expressions or by approaching the stranger.

Social referencing is a central milestone in the development of social cognition because it requires layers of knowledge about self, others, and the referential nature of social information. A common anecdotal example of social referencing is infants’ stunned glance to their mothers after they fall down, as if to solicit mothers’ advice about the seriousness of the injury. Mothers’ assured smile signals to babies that “everything is okay” and a worried expression signals a more frightening interpretation of the event. The very core of social referencing is embedded in that slow-motion moment when babies decide whether to scream or to toddle off to their next adventure. Infants must recognize that they do not know how to behave or how to interpret an event and simultaneously recognize that their caregivers are valuable sources of advice about how to respond (Baldwin & Moses, 1996; Campos, 1983; Klinnert, Campos, Sorce, & Emde, 1983; Moore & Corkum, 1994).

**Knowledge of Self**

Because social referencing provides infants with useful information when their own knowledge is tenuous, ambiguity lies at the heart of social referencing. Infants should be more likely to seek social information or defer to unsolicited advice if they realize that they are unable to ap-

praise the situation independently. Infants must possess a modicum of self-awareness to assess the situation as uncertain. Babies cannot judge a situation to be ambiguous without knowing on some level what they do and do not know or what they can and cannot do. They must realize that they are uncertain about the degree of risk, that they are unsure of the appropriate response, and that their own abilities are inadequate for generating the necessary information to deal with the situation.

**Knowledge of Others**

In addition to recognizing the limitations of their own knowledge, true social referencing requires infants to recognize that others are repositories of information. Infants cannot truly seek advice or understand the intentionality of parents’ social messages until they appreciate the fact that more knowledgeable others can help resolve their own uncertainty about how to respond. Infants must understand the valence or content of others’ messages, as well as connect those messages to the correct referent, in order to respond appropriately (Mumme & Fernald, 2003).

**VISUAL CLIFF AND AMBIGUOUS TOY AND STRANGER PARADIGMS**

Perhaps the most famous study in the social referencing literature examines 12-month-olds’ reactions to mothers’ emotional signaling on a modified visual cliff (Sorce, Emde, Campos, & Klinnert, 1985). In the classic visual cliff paradigm (Gibson & Walk, 1960; Walk, 1966), infants are placed on a centerboard dividing a glass table. To one side of the centerboard, the floor is visible 90 cm below the safety glass. To the other side, the apparent drop-off is only 3 cm. Mothers call to their infants from first one side, then the other. On the deep side of the standard visual cliff, most 12-month olds avoid crawling over the apparent precipice and on the shallow side most cross without hesitation (Richards & Rader, 1983; Walk, 1966).

In the Sorce et al. (1985) study, the apparent drop-off was set to 30 cm, a height that was designed to be ambiguous. Mothers were trained to pose static facial expressions (happy, fearful, interested, angry, or sad) for the duration of the trial. Infants were 12 months of age. Many infants (21%) formed their motor decisions without glancing toward their mothers’ faces (an additional 19% could not be tested for other reasons). The 60% of infants who did look toward their mothers’ faces were
swayed by the emotional signals. Most babies crossed the 30 cm cliff when mothers posed positive expressions and avoided the drop-off when mothers posed negative expressions. On the 3 cm drop-off, 74% of infants immediately crossed without ever glancing at their mothers’ face (an additional 9% were eliminated from testing for other reasons). Of the 17% who referenced their mothers’ faces, mothers’ fearful pose did not deter infants from crossing.

Given the centrality of this study for arguments about infants’ social information seeking (Baldwin & Moses, 1996; Feinman, Roberts, Hsieh, Sawyer, & Swanson, 1992), it is surprising that more researchers have not used the visual cliff paradigm. The only additional study to test social referencing on the “ambiguous” 30 cm visual cliff failed to replicate Sorce’s findings (Bradshaw, Goldsmith, & Campos, 1987). Only 27% of infants traversed the cliff when mothers posed positive expressions, suggesting that many infants relied on their own intuitions about safety, rather than mothers’ advice, to make decisions.

The most common method for studying social referencing, however, entails exposing 9- to 14-month-old infants to a strange toy, animal, or person in the presence of their mothers (Feinman, 1982; Feinman et al., 1992), which avoids the requirement that researchers house a large unwieldy visual cliff apparatus in their labs. The key to the strange toy/person paradigm is that the novel objects or people are presumed to be ambiguous in nature, from babies’ point of view, potentially alluring or frightening. Researchers have selected, for example, a motorized robot (Klinnert et al., 1983), large hairy spider (Zarbatany & Lamb, 1985), and a bunny in a cage (Hornik & Gunner, 1988).

As on the modified visual cliff, infants can solicit information from their mothers by looking toward them or engaging them in social interactions. Mothers, in turn, are coached to provide their infants with social information about how to interpret the stimulus by varying their facial expressions and vocalizations in line with prescribed scripts. Researchers gauge the effectiveness of mothers’ social messages by observing infants’ affective responses, proximity to their mothers, and proximity to the toy or stranger. However, findings from these studies are based only on a subset of infants. Across studies approximately 20% never look towards their mothers and are eliminated from analyses (Feinman et al., 1992). Those infants who do look towards their mother tend to respond to the valence of their mothers’ messages. Twelve-month-olds, for example, demonstrate modest changes in their proximity to the toy and/or their affective displays in response to their mothers’ communications (e.g., Hirschberg & Svejda, 1990; Hornik & Gunner, 1988; Hornik, Risenhoover, & Gunnar, 1987; Mumme, Fernald, & Herrera, 1996; Stenberg & Hagekull, 1997).

THE PROBLEM WITH PREVIOUS PARADIGMS

Three interrelated problems plague extant studies of social referencing: (1) definitions of ambiguity are problematic; (2) the role of infants’ experience and age are not adequately examined; and (3) the meaning of infants’ responses on social referencing tasks is unclear.

Ambiguity

Despite the centrality of ambiguity in the social referencing literature, the construct has been ill defined. Weak results and conflicting findings across the strange toy/person and modified visual cliff paradigms may be the consequence of researchers’ failure to achieve ambiguity in the displays. Previous researchers have relied on their own intuitions about ambiguity to select toys, animals, people, or the height of the drop-off on the visual cliff to use as stimuli. As Baldwin and Moses (1996) point out, the definition of ambiguity in traditional studies ends up being circular. We can only know that a stimulus is ambiguous if infants seek social support from their mothers and defer to mothers’ social messages.

Thus, in some studies, infants may have considered the cliff/toy/animal/person to be perfectly safe. The visual cliff, for example, is indeed perfectly safe and infants can discover this fact after they touch the safety glass covering the drop-off. In such a case, infants may be oblivious to mothers’ negative or prohibiting social messages. Conversely, babies may have considered the hairy spider, bunny, or research assistant to be irrevocably scary. In this scenario, infants may ignore mothers’ positive and encouraging social messages.

Experience and Development

Related to the issue of ambiguity, researchers rarely consider individual differences in infants’ experience and development. Researchers typically take a “one size fits all” approach to ambiguity. Every infant in the sample is exposed to the same toy or the same 30 cm drop-off. This uniform approach is problematic in light of the vast individual differences in infants’ experiences and reactions to novel toys and strangers, and babies’ level of motor skill at the same chronological ages. A situation that is ambiguous to one infant might be perceived as unmistakably safe or dangerous to another. The role of infant experience is especially relevant to infants’ referencing on motor tasks, because a few weeks of locomotor experience can change novice crawlers or walkers into ex-
What Is the Meaning of Infants' Responses?

A true test of whether an infant is social referencing rests upon researchers' ability to gauge ambiguity for individual infants, independent of babies' response to the stimulus. However, without independent verification that a situation poses an ambiguous level of risk to individual infants, researchers cannot distinguish between true social referencing with all the cognitive underpinnings of self-other knowledge and communicative behaviors that lack the requisite layers of social knowledge. As Feinman (Feinman, 1982; Feinman et al., 1992) and others have pointed out, a host of nonreferential factors may cause infants to display social referencing-like behaviors. For example, babies may look to their mothers, vocalize, and gesture because they are aroused, seeking proximity or comfort, asking for hands-on assistance, or sharing affect. In such cases, these social behaviors can function as a bid for attention without infants possessing true referential knowledge. An infant who looks toward mother or vocalizes at the top of a stair may be checking on mother's whereabouts or may be merely aroused rather than seeking advice about whether to descend.

Just as nonreferential factors may explain apparent information seeking, nonreferential factors may also underlie apparent emotional and instrumental use of social information. Infants may be keenly receptive to parents' emotional displays in the absence of true social understanding. They may react to the emotional content of caregivers' messages through mood contagion or changes in mood states without understanding the referential nature of the social information. For example, a baby who freezes on the brink of a changing table as a parent expresses fear might be displaying emotional contagion, rather than using the information referentially to resolve uncertainty about the wisdom of leaping off the table. As yet, in the absence of objective criteria for quantifying ambiguity, we cannot distinguish among these various interpretations.

NEGOTIATING RISKY MOTOR TASKS

Recent work in our laboratory redresses problems in previous studies of social referencing. First, we tested infants in motor tasks where we objectively quantified ambiguity on an individual basis, rather than take a one-size fits all approach. Second, we considered the role of infants' locomotor experience. Finally, we considered various interpretations of infants' responses, including whether they were social referencing versus merely aroused or seeking proximity to their mothers.

Our general research strategy was to estimate psychophysical functions of actual risk levels for each infant, where risk varies from 0% (perfectly safe) to 100% (diabolically risky). Then, we determined the precision of infants' self-knowledge by examining whether their motor decisions were based on the degree of risk. Would babies limit themselves to situations that were completely safe? Would they be willing to incur small levels of risk? Or would they happily leap into the void?

More specifically, we challenged infants of different ages with varying levels of crawling and walking experience at the edge of shallow and steep slopes or small and large gaps in the floor (Adolph, 1995, 1997, 2000; Adolph & Avolio, 2000). As in the classic visual cliff paradigm, mothers beckoned their infants from the far side of the obstacle. Infants' task was to decide whether they could descend the slope or cross the gap so as to be reunited with their mothers. Unlike Sorce et al.'s (1985) famous visual cliff paradigm however, our slopes and gaps machines were adjustable rather than fixed at one setting. And, unlike the visual cliff paradigm, our test apparatuses had no safety glass covering the drop-off. Errors in judgment resulted in real life consequences: Babies could feel themselves lose balance and fall (an experimenter rescued them to prevent injury). Moreover, on the visual cliff, researchers were precluded from testing babies on multiple trials because babies learned after one exposure to the safety glass that the drop-off was actually safe. As a consequence of no safety glass, babies in our studies could be tested on dozens of trials without diminishing the strength of their avoidance response.

Figure 6.1 shows the adjustable sloping ramp and gaps apparatus. In the slope task, flat starting and landing platforms flanked a changeable slope. A motorized drive screw adjusted the height of the landing platform so that the slant could vary from 0°-90° in 2° increments. In the gap task, babies decided whether to cross a gap with a vertical drop-off of 60 cm. Pulling the landing platform along a calibrated track varied the gap size from 0-90 cm in 2 cm increments.

We used a psychophysical staircase procedure to estimate each infant's ability to traverse the obstacle at each session (Adolph, 1995, 1997, 2000). As in perceptual psychophysics, the staircase procedure estimated a response function and a point estimate of a threshold along the curve. In this case, we estimated a motor function, the curve describing the changing probability of success for crawling or walking, from 100% success to 0% success. And, we derived a point estimate of a motor
threshold midway along the curve—the steepest slope each baby could crawl or walk down safely or the largest gap each baby could span successfully. The experimenter coded each trial on-line as either a successful outcome (baby crawled or walked safely) or an unsuccessful outcome (baby tried to crawl/walk but fell, or baby refused to crawl/walk). The slope angle for each trial was adjusted depending on the outcome of the previous trial. After successful trials, the experimenter presented steeper slopes or larger gaps. After unsuccessful trials, the baby was presented with shallower slopes or smaller gaps. The process continued until the experimenter converged on a crawling or walking threshold where the probability of successful crawling or walking was uncertain (< 100% and > 0%). Thus, the motor threshold could serve as an individualized, objective measure of risk and ambiguity. Slopes shallower than the threshold increment were increasingly safe by definition and slopes steeper than the threshold were increasingly risky.

A “go ratio” (number of attempts to crawl/walk divided by the total number of trials) indexed the level of infants’ self-knowledge by the accuracy of their decisions at various increments of risk. If infants were aware of their abilities, they should attempt safe slopes where the probability of success was high (near 100%) and refuse to descend risky slopes where the probability of success was low (near 0%). Perfectly attuned self-knowledge would be evidenced by matching the go ratio (i.e., the probability of attempting) with the conditional probability of success.

Across studies, observations of hundreds of babies tested cross-sectionally or longitudinally revealed enormous variation across infants in their level of motor skill (e.g., Adolph, 1995, 1997; Adolph & Avolio, 2000; Adolph, Eppler, & Gibson, 1993). For example, at 9.5 months (± one week), infants’ ability to crawl over gaps varied from 2 cm to 18 cm. At 14.0 months (± one week), infants’ ability to walk down slopes varied from 0° to 28°. Gaps and slopes that were perfectly feasible for some infants were impossibly risky for others.

Individual variation in raw motor ability was matched by equally impressive variation in the precision of infants’ self-knowledge. At every age group tested, some infants perfectly matched their go ratios to their crawling or walking thresholds. Other more hapless infants overestimated their abilities by attempting to traverse impossibly large slopes or gaps, seemingly oblivious to the potential danger and requiring quick rescue by the experimenter. And, still other infants underestimated their abilities by refusing to attempt slopes or gaps that were demonstrably safe.

What factors affected infants’ motor thresholds and go ratios? At every age group, the strongest independent predictor of infants’ motor skill level and precision of self-knowledge was the duration of their motor experience (Adolph, 1997, 2000; Adolph & Eppler, 2002). Across age groups and longitudinal observations, experience was a stronger predictor than age. Infants with more experience in crawling or walking navigated steeper slopes and larger gaps than novice crawlers or walkers. More importantly, the more experienced crawling and walking infants closely matched their decisions to go with the conditional probability of success. They attempted safe slopes and gaps but avoided risky ones by refusing to budge from the starting platform or by engaging in alternative locomotor strategies (e.g., backing down). In contrast, inexperienced infants displayed serious over-estimation errors. In the first weeks after they began crawling and walking, infants plunged headlong over the brink of impossibly steep slopes and large gaps on trial after trial. Error rates were typically between 75% and 100% on risky increments.

The central role of experience on the precision of infants’ self-knowledge is illuminated in a longitudinal study of infants’ locomotion over slopes (Adolph, 1997). Fifteen babies were observed from their first week of crawling until several weeks after they began walking. Fourteen babies in a control group were observed at three matched session times: in their first week of crawling, tenth week of crawling, and first week of walking.

At the emergence of crawling, babies went headfirst over safe and risky slopes alike. No infant displayed error rates under 50%. Over weeks of everyday locomotor experience, infants’ motor decisions became increasingly accurate. After 22 weeks of experience, crawlers’ motor decisions were virtually error-free (< 10%) (See Fig. 6.2). However,
IMPLICATIONS FOR SEEKING AND USING SOCIAL INFORMATION

Our findings of babies at the edge of slopes and gaps have important implications for conceptualizing and quantifying ambiguity, thereby providing an ideal context for studying the emergence of infants' social referencing. Whether and when infants seek and use social information will depend on their knowledge of self, as indexed in their evaluation of the situation as safe, ambiguous, or dangerous. To know that a situation is ambiguous, infants must be able to gauge the limits of their own abilities. In the absence of self-knowledge, there can be no ambiguity. At least for motor abilities, self-knowledge depends on the duration of infants' motor experience.

SEEKING SOCIAL INFORMATION

How might experienced versus inexperienced infants differ in their seeking of social information across levels of risk? To explore this question, we are using the psychophysical staircase procedure to determine infants' crawling or walking thresholds on the slope apparatus. As in our previous research, mothers enthusiastically encourage their infants to crawl or walk down slopes until the experimenter converges on babies' motor thresholds. The point-estimate for the threshold is defined as the slope at which the probability for success is 50%.

Then, during test trials, we measure infants' appeals to their mothers at varying degrees of risk (100% success, 50% success, and 0% success). In contrast to the traditional toy, stranger, and visual cliff studies...
of social referencing, we aimed to test infants' social information seeking over multiple trials. We designed a set-up that would allow infants to tolerate mothers' inattention over repeated bids for assistance. Mothers sit caddy-corner at the bottom of the slope turned slightly to one side, occupied filling out forms. Our set-up is analogous to everyday situations in which mothers ignore bids from their infants such as when mother is occupied on the phone as her infant tugs at her skirt.

The critical question is whether and how infants might seek information from their mothers by directing looks, vocalizations, or gestures in her direction.

Figure 6.3 depicts three possible outcomes depending on infants' locomotor experience and the level of risk. The solid line represents true social referencing behaviors, the long-dashed line represents social behaviors driven by arousal, and the dotted line represents social behaviors driven by proximity seeking. True social referencing with all the layers of self and other knowledge should differ in experienced and novice infants. If experienced infants appreciate the referential value of mothers' social information, they should seek social information only at ambiguous increments—where risk level is 50%—because they are able to accurately appraise the limits of their own abilities relative to risk level. If novices are aware that they do not know the limits of their own abilities, they should seek social information at all levels of risk. Alternatively, infants' communications to their mothers might merely signal arousal. In this case, experienced and novice infants alike should increasingly bid to their mothers as risk level increases. Finally, if infants are simply proximity seeking or "checking in," experienced infants and novices should look to their mothers at a constant rate across all levels of risk.

**USING SOCIAL INFORMATION**

What about infants' differential use of social information? In a second study, we are examining infant's responses to mothers' unsolicited encouragement (i.e., mothers coax their infants to walk or crawl down slopes) and discouragement (i.e., mothers prohibit their infants from walking or crawling down slopes) across levels of risk.

Our previous research shows a clear pattern of results under conditions of mothers' unsolicited encouragement: Infants' decisions about whether to attempt slopes or gaps depend on their motor experience and the relative degree of risk (solid lines in Fig. 6.4). When mothers urged their infants to cross novel obstacles in their path, at all ages between 8 and 18 months, infants with more everyday locomotor experience attempted safe increments and avoided risky ones, but novices attempted all increments indiscriminately (e.g., Adolph, 1997, 2000).

Possibly, all infants understood the referential quality of mothers' social messages. Experienced infants overrode mothers' advice on extremely safe or risky increments based on their own assessment of the situation. Inexperienced infants, aware that they lacked the ability to determine an appropriate course of action, deferred to their mothers' encouraging social messages at all increments.

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**FIG. 6.3.** Projected results for infants' bids toward mother (looks, vocalizations, gestures) on safe and risky increments for (A) experienced and (B) novice crawlers and walkers. Vertical dashed line = infants' motor threshold (normalized to each infant's demonstrated ability to descend slopes successfully). Solid lines = infants' pattern of responses if they were truly seeking social information from their mothers. Dashed lines = infants' pattern of responses if they were aroused. Dotted lines = infants' pattern of responses if they were seeking proximity to their mothers.

**FIG. 6.4.** Hypothetical results for infants' motor decisions on safe and risky increments for (A) experienced and (B) novice crawlers and walkers. Vertical dashed line = infants' motor threshold (normalized to each infant's demonstrated ability to descend slopes successfully). Curves represent infants' go ratios. Solid lines = results obtained in earlier work where mothers supplied unsolicited encouragement. Dashed lines = projected results if infants recognize their own inability to determine an appropriate course of action and defer to their mothers' unsolicited prohibitions.
Equally plausible, however, is the possibility that infants did not understand the referential quality of mothers' messages. Expert crawlers and walkers could have based their decisions entirely on their own assessment of the obstacles rather than on mothers' advice. Their independent perceptual exploration might have afforded sufficient information about the slope's relative safety and mothers' stream of encouragement might have served no function at all. Inexperienced infants may have been blithely unaware of their own deficiencies in controlling actions adaptively. They might have resorted to a default behavior of going with little recognition of the value of mothers' encouraging advice. Alternatively, mothers' encouragement might have served a social function without providing real advice. Mothers may have provided a salient goal, drawn infants' attention to the far side of the obstacle, maintained infants' motivation to cross the obstacle over multiple trials, lifted infants' spirits via emotional contagion, comforted infants, regulated infants' arousal, or provided information about mothers' proximity. None of these alternative interpretations of mothers' seeming effectiveness require infants to appreciate the referential value of social messages.

In the absence of prohibitive social messages, however, we cannot distinguish among these alternatives. This limitation motivated an ongoing study of infants' responses to mothers' encouraging and discouraging messages. In the current study, we obtain individualized estimates of infants' crawling or walking thresholds using the staircase procedure. Then, in two blocks of counterbalanced test trials, mothers encourage and discourage their infants to descend slopes that are safe (100% probability of success), risky (0% probability of success), and set to infants' motor thresholds (50% probability of success).

If infants appreciate the referential value of social information, their motor decisions should be swayed in line with mothers' social message, but only on ambiguous slopes (see Fig. 6.4). Thus, for experienced infants should be most likely to go when mother says go and to stop when mother says no where ambiguous slopes surround their motor thresholds. In contrast, for novices where all slopes are ambiguous infants should defer to mothers at all increments. They should go when their mothers encourage them and remain on the platform when their mothers discourage them.

Alternatively, if infants' motor decisions are based only on experience and risk and not on mothers' social information there should be no effect for mothers' unsolicited advice in any of the contrasts. Experts and novices should attempt safe increments, but at risky increments, experienced infants should avoid and novices should go. In this scenario, responses for the encouraging and discouraging conditions would be identical and would follow the solid curves depicting encouragement in Fig. 6.4.

To date, predictions about the role of infant experience in babies' use of social information is supported by research in our laboratory. Eighteen-month-old walkers were most likely to defer to their mothers' advice at slopes at their thresholds, but to override mothers' advice to "not walk" at clearly safe increments and to "walk" at clearly risky increments. Novice walkers, in contrast, deferred to mothers' advice at all levels of risk (Karhik et al., 2004; Lobo et al., 2003).

THE DEVELOPMENT OF SOCIAL REFERENCING

There has been a longstanding debate in the literature about when in development infants appreciate the referential value of others' advice and come to seek adults' input in making decisions. Most scholars agree that social referencing emerges sometime during infants' first 18 months, although the precise timing of its onset continues to be debated. Some researchers assert that 9-month-olds understand that others are useful sources of information and intentionally solicit social information to resolve uncertainty (Brenner, 1992; Gopnik & Meltzoff, 1994). Infants' gaze following and pointing are offered as evidence for this 9-month sociocognitive revolution (Tomasello et al., 1993).

On a more skeptical account, infants' intentional seeking of social information does not emerge until closer to 18 months, when infants are demonstrably cognizant of their own gaps in knowledge and the potential of others to address those gaps (e.g., Baldwin & Moses, 1996; Moore & Corkum, 1994).

We are contrasting the roles of infants' experience and age in all of our studies. Findings from our motor tasks promise to illuminate the developmental timing of infants' social understanding. If infants' social understanding of self and others changes dramatically between 8 and 18 months, infants' seeking and using of social information in motor tasks should vary across age. Younger infants should base their decisions on experience only, whereas older infants should be more adept at taking mothers' social information into account. By testing infants of different ages and levels of motor experience, we hope to pinpoint how and when infants integrate social information with their own perceptual exploration in planning adaptive action.

CONCLUSIONS

Social referencing is more than an instrumental response to an unsolicited social message. Infants' intentional seeking and use of social information in ambiguous situations lies at the heart of social referencing. To
date however, investigators have adopted a one-size-fits-all approach to defining ambiguity. Consequently the developmental emergence of social referencing remains untested.

Potentially risky motor tasks render an ideal context for examining the phenomenon of social referencing. Our psychophysical staircase procedure, used with crawling and walking infants, enables us to quantify ambiguity on an individual basis and to examine how infants integrate perceptual and social information when making motor decisions. Whether infants attempt action under potential risk depends on their evaluation of the situation vis-à-vis their own motor abilities. Infants will seek and use social information differently under risky, safe, and ambiguous conditions. We are currently testing whether experienced and inexperienced infants of different ages display different patterns of social referencing at different levels of risk. This paradigm offers a new way to assess social referencing and bridges the long-standing divide between research on motor development and social cognition.

REFERENCES


Is Joint Attention Necessary for Early Language Learning?*

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Beginning with Bruner’s (1975, 1983) detailed descriptions of mother-infant interactions, many theorists have highlighted the importance of joint attention in early language learning.1 The empirical work inspired by Bruner’s ideas focuses on infants and children engaged in dyadic interactions with their caregivers. In these studies, joint attention has been defined as periods of time during which the caregiver and child are mutually focused on one another and on the same object or activity. The results show that dyads who engage in more episodes of joint attention generally have children with larger vocabularies (e.g., Tomasello & Farrar; 1986; Carpenter, Nagell, & Tomasello, 1998). Several ethnographic studies of families outside of the Western middle class context (e.g., Ochs, 1988; Schieffelin, 1990) indicate, however, that many of the world’s children grow up in situa-

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1There is extensive research on the development of joint attention (see Butterworth, 2001, and Trevarthen & Aitken, 2001, for reviews) but I focus only on the work that makes an explicit link between joint attention and language development.