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Infants' Response to Potential Risk: Social Interaction and Perceptual Exploration

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How do infants decide how to respond when faced with a novel, potentially risky situation? Vigilant parents provide a wealth of social information by altering their facial expressions, gestures, voice, and content of speech. Experimental studies on social referencing show that infants use mothers' social cues for deciding whether to approach an ambiguous toy (e.g., Klinnert, 1984) and whether to avoid an ambiguous 12" drop-off on the visual cliff (e.g., Sorce, Emde, Campos, & Klinnert, 1985). In addition, infants may spontaneously emit a range of facial, vocal, and gestural behaviors to elicit social cues from their mothers (Adolph & Eppler, 1999).

A second source of information is generated by direct perceptual exploration of the environment. For example, at the edge of a cliff or steep slope, crawling and walking infants explore possibilities for locomotion by looking, swaying, stepping, touching the precipice, and testing various locomotor strategies (e.g., Adolph, 1997).

In the present experiment, we examined infants' social interactions with their caregivers and perceptual exploration of the environment when challenged with the novel task of crawling down safe and risky slopes. Of particular interest was whether infants' responses were related to relative degree of risk, whether they vocalized and gestured toward their mothers before or after obtaining information from perceptual exploration of the slopes, and whether their information-generating behaviors on the starting platform were related to the accuracy of their motor decisions.

Method

We tested 28 11-month-old crawling infants on an adjustable sloping walkway (0°-90°). Over the course of 17-50 30s trials, a modified psychophysical staircase procedure (Adolph, 1997) estimated a "crawling boundary" (steepest slope infants could crawl down) which demarcated safe and risky slopes for each infant. Mothers waited at the bottom of the walkway and were instructed to encourage their babies to descend. An experimenter followed alongside infants to provide rescue if they began to fall. We ensured that infants made brief visual contact with the slope at the beginning of each trial. From videotapes of the sessions, coders scored infants' information-generating activity on the starting platform: behaviors directed both toward their mothers (positive and negative vocalizations, gestures) and toward the slope (looking, touching, and shifts in position). In addition, coders scored mothers' positive and negative vocalizations, facial expressions, and gestures directed toward their babies.

Results & Discussion

Most measures of infants' information-generating behaviors were related to relative degree of risk (Figure 1A). Overall latency increased on risky slopes, indicating longer decision times before infants determined whether and how to descend. Infants' vocalizations toward their mothers increased on risky slopes. Surprisingly, infants emitted approximately equal proportions of positive (laughing, babbling) and negative vocalizations (whining, crying) on risky slopes, suggesting that many vocalizations did not reflect frustration or fear. Arm gestures (pointing, "gives", "shows", "pick-me-ups") were infrequent and distributed randomly across safe and risky slopes. Mothers' vocalizations (96.0%) and facial expressions (91.9%) were nearly always positive indicating that they followed the experimenters' instructions to encourage their infants to descend. The frequency of mothers' positive vocalizations increased on risky slopes. Most vocalizations of mothers (84.1 %) and infants (69.4 %) occurred within the first 5s. Mothers tended to vocalize before their infants vocalized on both safe (71.1%) and risky (65.6%) trials. These findings suggest that babies' responses reflected replies to their mothers' exhortations, generalized arousal, statements about their

assessment of the situation, proximity seeking and requests for physical assistance, as well as information-seeking requests.

Infants' perceptual exploration also increased with risk (Figure 1B). As found in previous work (e.g., Adolph, 1997), on risky slopes infants displayed more visual, haptic, and means/ends exploration. By

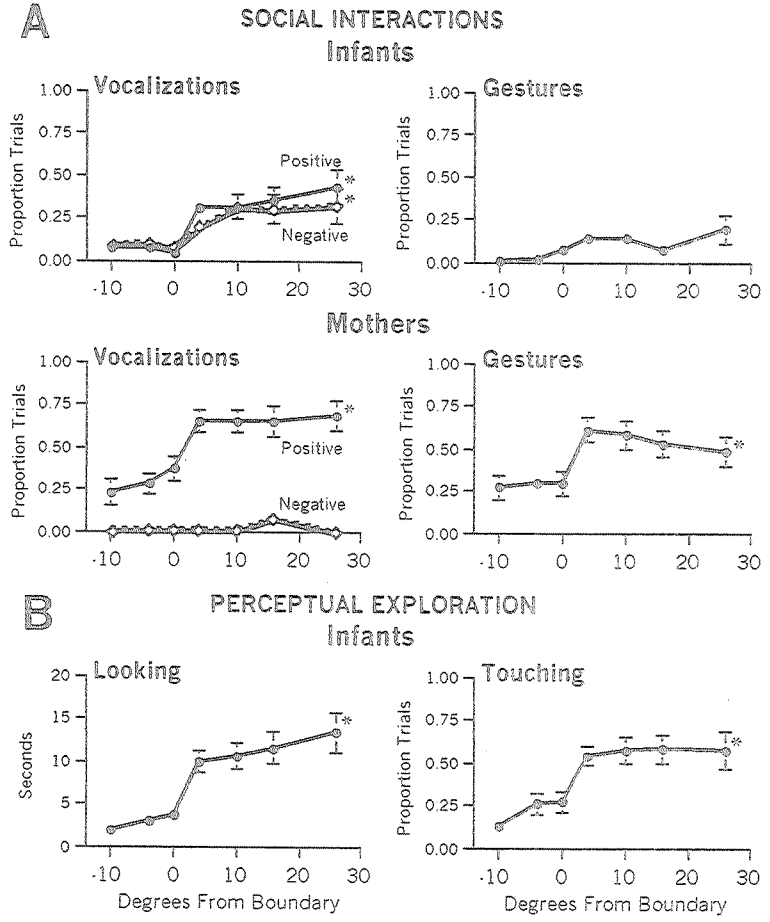

Figure 1. Social interactions and perceptual exploration preceding motor decisions normalized to each infant's crawling boundary (denoted by 0 on x-axis). Negative and positive numbers on the x-axis represent respectively safe and risky slopes. Asterisks denote a significant linear trend ($p < .001$). (A) Infants' and mothers' vocalizations and gestures. (B) Infants' looking and touching.

definition, all trials began with infants looking toward the slope. On 85.0% of risky trials, additional visual exploration preceded infants' vocalizations, suggesting that the look prompted the vocalization. However, touching (51.2% of risky trials) and testing positions (51.1% of trials) usually followed vocalizations on risky slopes, suggesting that spontaneous perceptual exploration begins with infants' first survey of the presented slope. Resulting from this elaborate sequence of exploratory behaviors, infants formulated a plan to descend.

Overall, infants' motor decisions were impressively accurate. They attempted to crawl down safe slopes shallower than crawling boundary on nearly every trial. The proportion of crawling attempts decreased from .91 at crawling boundary to .44, .30, .18, and .14 on increasingly risky slopes 4°, 10°, 16°, and 26° steeper than boundary, respectively. If infants generated information via social interaction or perceptual exploration, they were most likely to refuse to crawl: vocalizing (67.5%), gesturing (72.9%), prolonged looking (53.7%), touching (54.7%), and testing alternative methods of locomotion (75.2%). If they did not generate information, they were most likely to attempt to crawl: vocalizing (82.1%), gesturing (70.0%), prolonged looking (87.8%), touching (77.9%), and testing alternative methods of locomotion (73.0%). The results indicate that infants' social interactions, like their spontaneous exploration of the environment, may serve a central role in generating information to guide motor decisions.

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Perception-movement in a Stepping Across Task

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A number of studies have been conducted to examine the control mechanism of the regulation during the long jumping approach (e.g., Berg, Wade, & Greer, 1994). It is accepted that the long jumping approach is composed of a stereotyped phase and a visual control phase. But Montagne, Cornus, Glize, Quaine and Laurent (2000) suggested that the control of this approach is compatible with the use of continuous control based on a perception-movement coupling. This study revealed a relation between the amount of adjustment and the step number at which regulation was initiated. These results support the use of continuous visual control similar to the 'funnel-like' type of control described by Bootsma, Houbiers, Whiting and Van Wieringen (1991).

The question is whether the control type observed in long jumping is entirely due to the characteristics of the task or whether the same type of control mechanism can be described for goal-directed locomotor displacements, e.g., with different constraints. Two tasks of stepping across an obstacle were used to address this question.

Method

In the first experiment, nineteen subjects were asked to walk on the track while stepping across the flat obstacle placed on average 12.4 m from the starting point (15 trials). To determine the size of the obstacle, each subject performed the largest step across compatible with a regular pace (15 trials). For each subject obstacle length was adjusted to "shadowed" step across length minus 0.1 m (M = 1.03 m).

In the second experiment, ten subjects were asked to step across the flat obstacle placed on average 8.20 m from the starting point. The sizes of obstacle corresponded to 10% (obstacle A : M = 0.05 m), 40%