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## Cinderella indeed – a commentary on Iverson’s ‘Developing language in a developing body: the relationship between motor development and language development’\*

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As Iverson (this issue) points out, it is ironic that motor development has been relegated to peripheral ‘Cinderella’ status in developmental psychology. After all, for those researchers who view psychology as the study of behavior, motor development is the stuff of the science. All behaviors – walking, talking, looking, laughing, reaching, playing, sleeping, breathing – are motor behaviors. And for those researchers who view psychology as the study of mind, motor behaviors – looking times and reaction times, vocalizations and gestures, avoidance responses and proximity seeking – provide the basis for inferences about infants’ percepts, thoughts and feelings.

Now, at long last, motor development, the neglected and wretched Cinderella of developmental psychology, has been rescued from the dustbin and invited to the language ball. As researchers in both motor (Adolph and Karasik) and language (Tamis-LeMonda) development, how do we feel about this? On the one hand, we embrace Iverson’s proposal that developmental changes in infants’ motor skills can affect developmental changes in linguistic, cognitive and social aspects of language acquisition. As one of many examples cited by Iverson, the transition from crawling to walking is associated with qualitative changes in the ways that infants share objects with their mothers, which in turn creates new opportunities for social interactions (Karasik, Tamis-LeMonda & Adolph, under review). We also find that infant motor development and expertise shape both the language and gestures mothers use to encourage and discourage infant actions in situations of potential risk (Karasik, Tamis-LeMonda, Adolph & Dimitropoulou, 2008), and infant exploratory and play actions are key behaviors to which mothers verbally respond during everyday interactions (Bornstein, Tamis-LeMonda, Hahn & Haynes, 2008; Tamis-LeMonda & Bornstein, 2002). Clearly, infants’ motor actions and development are a driving force in their social development and interactions.

On the other hand, we feel that Iverson’s proposal only captures a small piece of the story – one in which motor development is viewed as a ‘key participant’, as Iverson puts it, in the service of the true princesses of psychology – language, cognition, perception and social

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interaction. An alternative approach is to recast motor development in the leading role, with perception, cognition and social development playing supporting roles. Perception is a necessary condition for adaptive motor control; motor actions must be selected, modified, discovered and constructed to suit the constraints and demands of the current situation (Adolph & Berger, 2006; Gibson & Pick, 2000). And, more germane to Iverson's arguments, language and social interaction can also be key participants.

Our own research illustrates the participatory role of social cognition in infant motor action. Inspired by Sorce, Emde, Campos & Klinnert's (1985) classic study of social referencing on the visual cliff, we asked whether infants use social information from their mothers when deciding whether to descend safe and risky slopes (0°–50°). On some trials, mothers encouraged their infants to crawl or walk down the slopes, and on other trials, mothers discouraged descent (Karasik *et al.*, 2008). If infants ignored the social information offered by their mothers, motor decisions would depend only on risk level. They did not. But neither did social information always win the day.

Use of social information depended on the infants' age (a stand-in for language knowledge and social cognition) and motor expertise. Experienced crawlers aged 1;0 refused to descend risky slopes regardless of mothers' messages, but became slightly more cautious on safe slopes when their mothers discouraged them. Novice walkers aged 1;0 marched blithely over the edge of both safe and risky slopes, but became slightly more cautious at the steepest 50° increment when their mothers discouraged them (Adolph, Tamis-LeMonda, Ishak, Karasik & Lobo, 2008). By age 1;6, when infants are sophisticated consumers of social information and have accumulated six months of walking experience, they only deferred to mothers' advice when risk level was uncertain: on slopes at the limits of their abilities, infants walked when mothers said go and avoided when mothers said no. Otherwise, infants ignored their mothers' advice by avoiding steep slopes and crossing safe ones regardless of the social message (Tamis-LeMonda, Adolph, Lobo, Karasik & Dimitropoulou, 2008). However, when infants aged 1;6 were outfitted with slippery Teflon-soled shoes that diminished their walking skill, they now relied on mothers' social messages to decide whether formerly safe slopes were safe or risky (Adolph, Tamis-LeMonda, Karasik & Lobo, in prep.). Clearly, when social information is available – as it is in the everyday lives of infants and caregivers – infants weigh and integrate social messages with the perceptual information generated by their own exploratory activities in making decisions about action.

Cross-cultural research makes an even stronger case for social influences on motor development. Childrearing practices – how infants are held, carried, bathed, dressed, exercised, toileted, and so on – can affect the onset of motor skills, their developmental trajectories and their ultimate form (Adolph, Karasik & Tamis-LeMonda, 2009). For example, rigorous Jamaican bathing routines accelerate the onset of sitting and walking (Hopkins & Westra, 1988; 1989), and restricted time in a prone position delays the onset of crawling (Davis, Moon, Sachs & Ottolini, 1998). Daily exercise of infants' upright stepping changes the developmental trajectory in alternating leg movements from the characteristic U-shape (in which stepping is seen in early infancy, disappears, and then 'reappears' when infants begin walking) to a monotonic increase (Zelazo, 1983). Trajectories can even stop short: parents' lack of encouragement to walk resulted in a family of adult hand-and-foot

crawlers (Humphrey, Skoyles & Keynes, 2005). Foot-binding of young Chinese girls (Fang & Yu, 1960; Ping, 2000), load carriage in East African girls (Heglung, Willems, Penta & Cavagna, 1995; Maloiy, Heglung, Prager, Cavagna & Taylor, 1986) and endurance running in the Tarahumaran Indians (McDougall, 2009) alters the form of walking movements. The Chinese girls relearned how to walk with tottering steps on three-inch feet. The African load carriers alter the form of their walking movements to maximize the energetics of gait dynamics. And the Tarahumarans regularly run ultra-marathon distances by changing the positions of their heads, torsos and feet. Even the very skills we acquire – chopsticks versus spoons, body surfing versus bicycling – are affected by social context.

Finally, beyond both its supporting and leading roles vis-à-vis perception, cognition and social development, motor development is a model system for understanding fundamental developmental issues such as flexibility, prospectivity, agency, emergence of new forms, continuity and discontinuity, variability and variety of means, individual differences, age and experience, sampling intervals, and so on (Adolph & Berger, 2006; Adolph & Joh, 2007; Gibson, 1997). For example, the specificity of learning between experienced crawlers who precisely perceive affordances for locomotion and novice walkers who haplessly do not, suggests that flexibility of behavior in the face of novel challenges (slopes, cliffs, etc.) requires something more than the acquisition of static rules (e.g. ‘steep slopes and big cliffs are dangerous’). Yesterday’s cliff can become today’s step as crawling skill improves; and yesterday’s step can become today’s cliff when infants transition from crawling to walking. Flexible and adaptive responding requires infants to gauge each potential obstacle relative to the current status of their bodies and skills.

Of course, coping with novel and variable circumstances is not limited to the motor domain. The ‘learning to learn’ evidenced by infants as they approach the brink of a slope or a cliff may prove to be a useful notion for understanding flexibility and generativity in language, cognition and social interaction. We suggest that a broader appreciation for general principles of developmental psychology may show poor Cinderella to be a true princess who needn’t wait for rescue by a handsome prince or a make-over by a fairy godmother to be worthy of attending the ball.

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