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Not just playing around: Infants' behaviors with objects reflect ability, constraints, and object properties

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ABSTRACT

This study describes infants' behaviors with objects in relation to age, body position, and object properties. Object behaviors were assessed longitudinally in 22 healthy infants supine, prone, and sitting from birth through 2 years. Results reveal: (1) infants learn to become intense and sophisticated explorers within the first 6 months of life; (2) young infants dynamically and rapidly shift among a variety of behavioral combinations to gather information; (3) behaviors on objects develop along different trajectories so that behavioral profiles vary across time; (4) object behaviors are generally similar in supine and sitting but diminished in prone; and (5) infants begin matching certain behaviors to object properties as newborns. These data demonstrate how infants learn to match their emerging behaviors with changing positional constraints and object affordances.

This study aimed to describe the ontogeny of the behaviors infants perform with objects throughout the first 2 years of life using a systematic yet naturalistic assessment. Infants were seen in their homes and were handed objects to grasp in a manner reminiscent of typical play. The first objective was to quantify the behaviors infants performed on objects in relation to infants' changing abilities, or with increasing age. The second objective was to determine whether infants' behaviors on objects were influenced when task demands were altered. To this end, we tracked infants' behaviors in three positions typically experienced during infancy: (1) supine, or lying on the back, (2) prone, or lying on the stomach, and (3) sitting supported in a seat. The third objective was to determine when infants begin to behave selectively on objects with different properties, matching their behaviors with the affordances of objects. These objectives are based on dynamic systems theory's tenet that behavioral performance emerges from the complex interplay of an individual's experience and ability and characteristics of the task and environment (Smith, 2005; Thelen, 2005). This study describes how infants adapt their emerging abilities to changing constraints and object affordances (Gibson, 1979; Newell, Scully, McDonald, & Baillargeon, 1989).

The existing object exploration literature suggests that cyclical grasp is an early exploratory tool for neonates (Molina & Jouen, 2004). Mouthing, looking, fingering, and multimodal behaviors then increase through 5 months (Rochat, 1989). Then through 12 months, infants increase performance of a greater variety of finer behaviors, such as rotating, transferring,

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and manipulating, with objects (Palmer, 1989; Ruff, 1984). This study builds upon the existing literature in important ways. First, object exploration studies have typically focused on either cross-sectional data or data collected over periods of weeks to a few months (Rochat, 1989; Ruff, 1984). Thus, despite great interest in the development of object exploration, there are few longitudinal studies on how infants' changing abilities affect the ways they interact with objects. Second, studies have typically focused on infants older than 6–9 months of age although data suggest the origins of object exploration behaviors are much earlier. For example, many of the behaviors measured in studies with older infants, including looking, fingering, mouthing, rotating, and transferring, were already present by 6 months when the studies began (Palmer, 1989; Ruff, 1984). In addition, recent studies suggest that infants begin to adapt and utilize their existing abilities, such as cyclical grasping, touching the face with objects, and mouthing, to explore objects even in the first days and months of life (Molina & Jouen, 2004; Rochat, 1987). Research like the present study assessing behaviors early and longitudinally can best inform us about the *emergence* of object exploration behaviors. Third, studies have typically focused on a limited set of behaviors providing a relatively narrow view of infants' behaviors with objects. For instance, in object exploration studies with infants younger than 6 months, researchers have generally quantified performance of a limited number of variables, such as holding, mouthing, looking, and fingering (Molina & Jouen, 2004; Rochat, 1989). These studies with younger infants have shown increases in these behaviors and combinations of these behaviors across time and after the onset of reaching but they have not provided a comprehensive view of object exploration in infancy (Lobo & Galloway, 2013b; Rochat, 1989). We aimed to fill the gaps in the literature by studying object exploration *longitudinally* from *early* infancy through toddlerhood measuring a *broad* range of behaviors.

We wanted this study to provide an example of how infants learn to use their evolving perceptual-motor abilities to interact with objects in relation to time, body position, and object properties. This is important information developmentally because object exploration behaviors are facilitators for cognitive, social, language, and perceptual-motor development (Barsalou, 2008; Goldin-Meadow & Beilock, 2010; Lobo, Harbourne, Dusing, & McCoy, 2013). By understanding how these behaviors emerge and evolve, we gain understanding of how infants use their everyday play to form and shape cognition. It also has important implications for early intervention since we understand very little about the amount and variability of activities infants should be engaging in with objects. This lack of understanding of typical upper extremity behavioral performance in infancy limits our ability to identify and treat delays in infants when most measures of upper extremity function focus on behaviors like dressing, feeding, or other activities expected of older children and adults but not relevant for infants. In addition, infant motor assessments typically determine whether an infant can perform a behavior once in an isolated context rather than observing how often and how variably the infant uses the behavior across contexts to explore and learn (Bayley, 2006; Lobo & Galloway, 2013a). The data provided in this study inform us about the typical activity patterns infants should be capable of engaging in with objects.

We assessed object exploration behaviors in supine, prone, and sitting because these positions are ones naturally experienced by infants and because they provide unique challenges to infants' exploration behaviors (Dudek-Shriber & Zelazn, 2007; Fetters & Huang, 2007). Body position affects infants' ability to reach for and contact objects. For instance, infants may find it easier to initiate reaches but harder to sustain object contact when objects are offered in front of the chest in supported sitting compared to supine (Carvalho, Tudella, & Savelsbergh, 2007; Savelsbergh & Vanderkamp, 1994). In contrast, they may find it harder to initiate reaches but easier to sustain contact with objects in this same relative object location in supine. Some have proposed that supine is a more challenging position than sitting for infants to explore objects (Bly, 1994; Soska, Galea, & Adolph, 2011). However, there has been only one study manipulating body position and assessing its effects on object exploration. This study involved one assessment session with infants between 5 and 7 months of age and found infants performed more manual, oral, visual, and multimodal exploration in sitting relative to prone and supine (Soska & Adolph, 2013). Interestingly, although young infants spend much of their time playing on the floor, all of the other studies we reviewed, even studies with neonates, assessed object exploration in sitting or reclined sitting (Lobo & Galloway, 2013b; Molina & Jouen, 2004; Rochat, 1989). This study is the first to our knowledge to longitudinally assess object exploration behaviors outside of sitting in other positions infants commonly assume. The assessment of object exploration across positions provides a picture of how infants learn to adapt their behaviors when the demands of the task and effects of environmental forces are altered (Carvalho, Tudella, Caljouw, & Savelsbergh, 2008).

Although the prone position may be uniquely challenging because one or both of an infant's arms are typically used for support, assessing behavioral performance with objects in this position is also important. It provides insight into whether infants fundamentally change their behaviors on objects in this challenging position or if they perform the same behaviors as in supine and sitting but to a lesser degree. It also informs us of the state of prone play abilities in typically developing infants after the "Back to Sleep Campaign" evolved into the "Back to Sleep, Prone to Play Campaign". The latter campaign emerged in response to research suggesting that infants had less play time in prone and later crawling onset in response to the "Back to Sleep Campaign" aimed at reducing the frequency of sudden infant death syndrome (Davis, Moon, Sachs, & Ottolini, 1998).

Finally, we assessed when infants selectively adapted their behaviors on objects based on the properties of those objects. Adults perform specific exploratory procedures to gather information about object properties. For instance, they move objects to learn about their weight and they finger objects to learn about their texture (Lederman, 1993). Similarly, 9–12 month olds perform more banging when exploring objects that vary in weight and more rotating and transferring when exploring objects that vary in shape (Ruff, 1984). Two to five month olds alter their scratching, mouthing, and looking behaviors when exploring objects varying in size (Rochat, 1989). There is even evidence that newborns oscillate their grip