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Socioeconomic status (SES) affects means–end behavior across the first year☆

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ABSTRACT

This study assessed the impact of SES on early means–end behavior. Sixty-one 6- to 8- and 10- to 12-month-old infants from high and low SES families were presented with two tasks requiring a two-step process to retrieve a toy. On the cloth task, overall performance improved with age, but low SES infants showed delays. Performance by the 10- to 12-month-old low SES infants was identical to that of the 6- to 8-month-old high SES infants. On the hook task, again overall performance improved with age, but significant SES differences emerged at 10 to 12 months, with only 20% of low SES infants succeeding at the task, compared to 73% of high SES infants. The results suggest a divergence in means–end behavior between high and low SES infants by 6 months of age, adding to the well-known documentation of gaps in cognitive skills evident between high and low SES infants.

It has long been established that growing up in poverty has a significant impact on developing cognition. Children in poverty live in homes with significantly less cognitive stimulation, such as fewer age-appropriate toys and books and fewer stimulating routines, and are less likely to have safe, designated play spaces (e.g., Bradley, Corwyn, McAdoo, & Coll, 2001; Evans, 2004). In addition, children in poverty are spoken to and read to significantly less than children not in poverty (Bradley et al., 2001; Evans, 2004). These environmental stimulation factors are critical for early cognitive development. The negative effects of family poverty on the intelligence test scores of 2- and 3-year-olds have been found to be mediated by the amount of stimulation in the home environment (Klebanov, Brooks-Gunn, McCarton, & McCormick, 1998).

Several studies on school-aged children have demonstrated SES-related delays or deficits in cognitive control and goal setting. For example, Farah et al. (2006) tested working and spatial memory, prefrontal lobe functioning, cognitive control, and learning in 10- to 13-year-olds from low and middle SES families. Although reward processing and visual cognition did not vary significantly, working memory, cognitive control, language and memory were affected by SES. Similarly, Noble, McCandliss, and Farah (2007) examined the same neurocognitive systems in first graders and found that SES explained over 30% of the variance in language ability, which was thought to mediate the association between SES and cognitive control, visuospatial skills, memory, and working memory. In another example with yet younger children, Burns, Haywood, and Delclos (1987) gave intelligence test items that emphasized problem-solving and perceptual performance in high and low SES 4- and 5-year-olds. They found that low SES children did worse on the tests overall and engaged more frequently in trial and error behavior, were more impulsive, and more often asked for nonspecific help or looked to the experimenter while doing the task. Moreover, these differences in problem solving strategy accounted for 59% of the variance in performance on the cognitive tasks. Taken together, these deficits in working memory, cognitive control, and language suggest delays in the efficiency, fluency and speed of processing, conceptual transfer, and feedback utilization — key components of problem-solving.

The vast majority of research on the achievement gap between low and high SES children focuses on children at least 18 months of age and older, and more typically, school-aged children (e.g., Bumgarner & Brooks-Gunn, 2013; Farah et al., 2006). There is little knowledge in the literature in terms of understanding whether these differences start out small and grow or whether the gap is evident in the youngest children tested. This study begins to address this question by investigating the earliest form of problem-solving in infants, means–end behavior.

Means–end behavior involves recognizing a goal, recognizing that the way to achieve this goal is to remove an obstacle, and choosing the correct actions required to remove the obstacle and thus achieve the goal (e.g., Piaget, 1953; Willatts, 1984, 1999). Each of these components is critical in characterizing intentional means–end behavior. The behavior must be goal-oriented; exploratory movements that bring about a happy consequence are not considered means–end. There must be a multiple-step process (at least 2) needed to complete the

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goal: infants must first complete an initial step that successfully removes the obstacle, which then permits the goal to be achieved. And finally, the infant must actually achieve that goal, which then confirms the intentional nature of the initial step.

Infants first begin to demonstrate means–end behavior in the first few months of life. At this stage, means–end tasks involve the infants' own arms, legs, and mouths because the infants are in the early stages of learning to reach and grab objects. So tasks involve tying one end of a string to an infant's wrist or ankle and the other end to a toy or mobile, so that the object can be activated by moving or kicking (e.g., Rovee-Collier & Gekoski, 1979), or giving infants a pacifier that controls the clarity of a video, where sucking on the pacifier increases the clarity of the video (e.g., Bruner & Kalnins, 1973). Infants as young as 2 or 3 months of age can control the mobile and the clarity of the video, thus demonstrating means–end behavior.

Once infants are better able to control their reaching movements, means–end behaviors can be studied with the use of external tools, where the goal cannot be accomplished without the use of said tool. For example, tool use in 9- to 19-month-olds has been measured by presenting infants with spoons filled with food and toys with handles, alternating the orientation of the handles on subsequent trials (McCarty, Clifton, & Collard, 1999, 2001). In these tasks, to successfully place the head of the spoon in their mouth, infants must change which hand they reach with when the orientation of the handle changes, or, if they grab the spoon with the incorrect hand, they must subsequently correct their grip. At 14 months, infants reach with their preferred hand but correct their grip before placing the spoon in their mouths, and by 19 months, infants change which hand they reach with depending on the orientation of the handle (McCarty et al., 1999).

Tool use in infants between the ages of 6 and 12 months has also been studied by presenting infants with an out of reach toy that they can obtain by pulling on a cloth or hook (Schlesinger & Langer, 1999; Sommerville, Woodward, & Needham, 2005; Willatts, 1984, 1999). Trials in which the toy can be brought into reach by pulling the cloth or hook (i.e., toy sits on the cloth or in the crook of the hook, called "contact trials") are alternated with trials in which the toy cannot be brought into reach by pulling the cloth or hook (i.e., toy sitting next to the cloth or next to the arm of the hook, called "noncontact trials"). Alternating between contact and noncontact trials allows for differentiation between infants who pull the tool towards them to obtain the toy (means–end behavior) and infants who pull the tool towards them just to play with the tool (not means–end behavior; Schlesinger & Langer, 1999; Willatts, 1999). The present study focused on Willatts' (1999) and Schlesinger and Langer's (1999) cloth and hook tool use tasks because they have a well-known developmental trajectory, they are straightforward, and they allow for discrimination between means–end and non-means–end behaviors.

Infants show marked improvement in means–end behavior on the cloth task between 6 and 8 months of age (Willatts, 1999). Six-month-old infants retrieved the toy on about half of the contact trials but without evidence of means–end behavior (i.e., infants pulled the cloth but without looking at the toy) and they did not differentiate between the contact and noncontact trials; they exhibited the same, mainly exploratory behaviors on both. The 7-month-old infants retrieved the toy on about three quarters of the contact trials and engaged in more means–end behavior on contact trials than on noncontact trials. This is an improvement from the 6-month-old infants' behavior because the infants engaged in means–end behaviors by fixating on the toy while pulling the cloth to obtain the toy when it was appropriate, and either ignored the cloth or played with the cloth when there was no means–end task to accomplish. By 8 months, infants retrieved the toy on most of the contact trials and engaged in more means–end behavior on the contact trials. Schlesinger and Langer (1999) performed the same task with 8- and 12-month old infants and their findings supported Willatts' (1999) developmental trajectory of general success by 8 months of age.

The hook task requires the same type of means–end behavior, but is more challenging because the hook surrounds the toy, while the cloth supports the toy. The use of supporting tools generally emerges before the use of surrounding tools, so the hook task is more appropriate for older infants, around 12 months of age (Schlesinger & Langer, 1999). On a contact/noncontact hook task, most 8-month-old infants pulled the hook on both trial types, regardless of whether it brought the toy within reach. By 12 months, most infants discriminated between contact and noncontact trials, only using the hook when it helped bring the toy within reach (Schlesinger & Langer, 1999).

Thus, significant developments in infants' tool use ability are well documented between 6 and 12 months. At 6 months of age, most infants show primarily exploratory rather than means–end behavior in a cloth task. By 7 months, infants begin discriminating between noncontact and contact trials in a cloth task but do not do this in a hook task until they are 11 to 12 months old. The research supporting this developmental trajectory of tool use has sampled predominantly middle class families. The purpose of the present study was to examine the development of tool use in infants in an at-risk population: infants from low socio-economic status (SES) families.

Some recent studies provide a basis for positing that SES differences in means–end behavior might begin as early as infancy. First, several studies have documented SES differences in some of the components of developing cognition that are important precursors to problem solving and cognitive control. For example, cognitive flexibility involves the ability to shift attention between different operations in response to a change in a demand. In two separate studies, low SES infants showed difficulties with cognitive flexibility compared to high SES infants, as measured on a perseverative reaching task (Clearfield & Niman, 2012; Lipina, Martelli, & Colombo, 2005). Another key component of cognitive control is attention. Low SES infants demonstrated significant attention deficits on a free play task compared to their high SES counterparts beginning at 6 months (Clearfield & Jedd, 2012). Thus, SES differences in some of the basic components of cognition are reported by six months of age.

Moreover, there is a direct link between means–end behavior and early object exploration, which is yet another skill where low SES infants lag behind. Lobo and Galloway (2008) found that 9- to 21-week-old infants' means–end behavior significantly increased in sophistication after a three-week intervention in which the infants were encouraged to reach for and explore objects that vary in texture, shape, size, and hardness. So early object exploration helps support means–end behavior. Critically, a study of object exploration that directly compared low and high SES infants reported that low SES infants showed an atypical developmental trajectory of object exploration from 6 to 12 months of age. Specifically, low SES infants had less mature object exploration (mouthing) but never replaced mouthing with the more mature haptic exploration (fingering, rotating the object or transferring the object from hand to hand). This resulted in less overall exploration by the low SES infants, compared to a middle/high SES control (Clearfield, Bailey, Jenne, Stanger, & Tacke, 2014; Clearfield, Carter-Rodriguez, Merali, & Shober, 2014). These findings together suggest that low SES infants' limited experience with objects may lead to differences between low and high SES infants' means–end behavior.

The purpose of the present study was to examine the role of SES on means–ends behavior in infancy. Six-to-eight and 10- to 12-month-old infants from low and high SES households were tested with the cloth and hook tasks and the infants' ability to use the cloth and hook as tools and to distinguish between contact and noncontact trials was measured (Schlesinger & Langer, 1999; Willatts, 1999). For the easier cloth task, we predicted that most, if not all, of the older infants would use the cloth successfully, but the younger high SES infants would be better at using the cloth as a tool and at distinguishing between contact and noncontact trials compared to the younger low SES infants. On the more difficult hook task, we expected that the majority of 6- to 8-month-olds would not use the hook as a tool and would be unable to