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Put your hands up! Gesturing improves preschoolers' executive function

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ABSTRACT

This study addressed the causal direction of a previously reported relation between preschoolers' gesturing and their executive functioning on the Dimensional Change Card Sort (DCCS) sorting–switch task. Gesturing the relevant dimension for sorting was induced in a Gesture group through instructions, imitation, and prompts. In contrast, the Control group was instructed to "think hard" when sorting. Preschoolers (N = 50) performed two DCCS tasks: (a) sort by size and then spatial orientation of two objects and (b) sort by shape and then proximity of the two objects. An examination of performance over trials permitted a fine-grained depiction of patterns of younger and older children in the Gesture and Control conditions. After the relevant dimension was switched, the Gesture group had more accurate sorts than the Control group, particularly among younger children on the second task. Moreover, the amount of gesturing predicted the number of correct sorts among younger children on the second task. The overall association between gesturing and sorting was not reflected at the level of individual trials, perhaps indicating covert gestural representation on some trials or the triggering of a relevant verbal representation by the gesturing. The delayed benefit of gesturing, until the second task, in the younger children may indicate a utilization deficiency. Results are discussed in terms of theories of gesturing and thought. The findings open up a new avenue of research and theorizing about the possible role of gesturing in emerging executive function.

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Introduction

During early childhood, action and cognition are closely linked (e.g., Kontra, Goldin-Meadow, & Beilock, 2012). One type of bodily movement—gesturing—appears to be particularly important for children's cognition. Gesturing both reflects knowledge that cannot yet be verbalized and changes thinking (Goldin-Meadow & Alibali, 2013). Gesturing helps children's learning and problem solving on a variety of tasks such as recall (Cameron & Xu, 2011), math (Broaders, Cook, Mitchell, & Goldin-Meadow, 2007), and spatial reasoning (Ehrlich, Levine, & Goldin-Meadow, 2006). Evidence that gesturing can be for one's own thinking, rather than merely for communicating with others, is that congenitally blind individuals spontaneously gesture during reasoning tasks (Iverson & Goldin-Meadow, 2001).

Gestures may contribute to both cognitive ability and performance (effective use of ability). Regarding cognitive ability, gestures may contribute to thinking by representing information not found in verbal representations such as holistic visual imagery (Goldin-Meadow & Alibali, 2013). Sometimes this additional information represents knowledge that a child cannot yet express in words. For example, research examining children's spontaneous gestures while explaining how they solved a balance beam task revealed that one third of the children's gestures conveyed information that did not match their speech such as gesturing about weight while discussing distance from the fulcrum (Pine, Lufkin, Kirk, & Messer, 2007). Further analysis of these mismatches indicated that on 80% of instances, children's gestures contained more advanced knowledge than their accompanying verbalizations, and that on more than half of these instances, information was conveyed in gesture before—if ever—showing up in speech. In general, information was also clearer and more precise in gestures than in speech. Thus, children often know more than they can articulate, and gestured information can run ahead of verbalized information. This implicit gestural knowledge may become explicit knowledge (Broaders et al., 2007).

Gesturing is also an effective form of instruction. For example, previous research found that instructing third and fourth graders to gesture a correct math problem-solving strategy led to greater learning than when instruction involved no gesturing or partially correct gestures (Goldin-Meadow, Cook, & Mitchell, 2009). Thus, it would appear that gesturing can activate implicit ideas that then facilitate learning.

Gestures may not only improve cognitive abilities but also facilitate children's application of their cognitive abilities during problem solving. In particular, gesture is thought to lighten the cognitive load during problem solving (e.g., Goldin-Meadow, Nusbaum, Kelly, & Wagner, 2001; Wagner, Nusbaum, & Goldin-Meadow, 2004). For example, while testing children on math equivalence problems, Goldin-Meadow and colleagues (Goldin-Meadow et al., 2001) increased children's cognitive load by giving them a list of letters to remember. Children who spontaneously gestured while providing explanations for the math problems recalled more items than those who did not, which was taken as evidence that gesturing on the explanation trials reduced cognitive load, allowing children to allocate more cognitive resources toward word recall.

Given the considerable evidence that gestures can facilitate cognitive ability and performance, it is surprising that researchers have only recently begun to consider the possible role of gesturing in one of the most active areas of research on cognitive development—children's executive function (EF). Executive function refers to cognitive processes used to control thinking and behavior when trying to achieve a goal, particularly when solving a novel problem. EF is related to various important outcomes in children, including academic achievement, behavior in the classroom, and social competencies (Best, Miller, & Jones, 2009). Studies have identified several processes underlying the development of EF such as brain maturation (Johnson, Munro, & Bunge, 2014), the ability to construct a hierarchical set of rules (Marcovitch & Zelazo, 2009), physical activity (Davis et al., 2011), and parenting behaviors (e.g., Deater-Deckard, 2014). The purpose of the current study was to examine whether gesturing can facilitate children's performance on an EF task.

So far, only one study has examined gesturing in an EF task in young children. O'Neill and Miller (2013) demonstrated that preschoolers who spontaneously gestured the relevant dimension on an