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Brief Report

Working memory constraints on imitation and emulation

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ABSTRACT

Does working memory (WM) constrain the amount and type of information children copy from a model? To answer this question, preschool-age children ($N = 165$) were trained and then tested on a touch-screen task that involved touching simultaneously presented pictures. Prior to responding, children saw a model generate two target responses: Order (touching all of the pictures on the screen in a target sequence three consecutive times) and Multi-Tap (consistently touching one of the pictures two times). Children's accuracy copying Order and Multi-Tap was assessed on two types of sequences: low WM load (2 pictures) and high WM load (3 pictures). Results showed that more children copied both Order and Multi-Tap on 2-picture sequences than on 3-picture sequences. Children who copied only one of the two target responses tended to copy only Order on 2-picture sequences but only Multi-Tap on 3-picture sequences. Instructions to either copy or ignore the Multi-Tap response did not affect this overall pattern of results. In sum, results are consistent with the hypothesis that WM constrains not just the amount but also the type of information children copy from models, potentially modulating whether children imitate or emulate in a given task.

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Introduction

Children are flexible social learners. In some instances, children imitate with exquisite fidelity, resulting in "overimitation." That is, they copy both causally relevant and causally irrelevant actions (Horner & Whiten, 2005; Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons, Young, & Keil, 2007). In other instances, children copy others' actions selectively, resulting in emulation. That is, they achieve a demonstrated goal by copying some actions while ignoring others (Nagell, Olguin, & Tomasello, 1993; Whiten, Custance, Gomez, Teixidor, & Bard, 1996) or achieve the demonstrated goal using idiosyncratic means (Gergely, Bekkering, & Kiraly, 2002; Meltzoff, 1988; Wood, 1989). But exactly why children imitate in some instances and emulate in others is a matter of great debate. Explanations fall into two broad camps that are domain specific: physical–causal (causal) and social–cultural (social). Causal theories emphasize that high-fidelity imitation, including overimitation, is a product of our species' long history with artifacts. Because the functions of many artifacts are opaque, it is proposed that we inhibit our own intuitions about the causal relevance of certain actions and imitate indiscriminately (Lyons, 2009; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). In contrast, social theories emphasize the fact that imitation is inherently social (Over & Carpenter, 2012; Uzgiris, 1981) and, importantly, occurs outside the artifact domain. Proponents of this view highlight the fact that imitation is influenced by a variety of factors, including the model's age (Zmyj, Aschersleben, Prinz, & Daum, 2012), social engagement (Nielsen & Blank, 2011), and whether the demonstrated actions are intentional or accidental (Zmyj, Buttelmann, Carpenter, & Daum, 2010), among many others (for a review, see Over & Carpenter, 2012).

These domain-specific theories have largely neglected domain-general cognitive processes that likely constrain both imitation and emulation. Working memory (WM), the ability to temporarily store and manipulate information (Baddeley, 1986, 2012), is a critical domain-general process that constrains the amount of information that children copy in a task (Bauer, 1992; Bauer & Hertsgaard, 1993; Bauer & Mandler, 1989; Bauer, Van Abbema, & de Haan, 1999; Harnick, 1978; Kemps, De Rammelaere, & Desmet, 2000; Simpson & Riggs, 2011). Yet, there is relatively little work on whether WM also constrains the *type* of information that children copy when they fail to imitate and, instead, emulate (e.g., Dickerson, Gerhardstein, Zack, & Barr, 2013; Simpson & Riggs, 2011). For instance, emulation might be a consequence of a task exceeding children's WM capacity. In this case, WM might predict what is most likely to be copied or ignored, potentially explaining some instances of imitation, overimitation, and emulation. We focused on WM, as opposed to other domain-general cognitive processes such as selective attention, for purely practical reasons. Although our current paradigm can be used to effectively manipulate WM load, it is less well-suited to assess attention.

Here, we tested WM constraints on imitation and emulation using a computerized imitation paradigm, the Cognitive Imitation Task (Fig. 1). This is a serial task that has been widely used to assess imitation learning in many different populations such as monkeys (Subiaul, Cantlon, Holloway, & Terrace, 2004), preschool-age children (Subiaul, Anderson, Brandt, & Elkins, 2012; Subiaul, Romansky, Cantlon, Klein, & Terrace, 2007; Subiaul, Vonk, & Rutherford, 2011), and individuals with autism (Subiaul, Lurie, et al., 2007).

The Cognitive Imitation Task is analogous to the Corsi and Knox tasks that have been widely employed to assess visual–spatial WM (Baddeley, 2012) in adults (Corsi, 1972; Kessels, van den Berg, Ruis, & Brands, 2008; Rossi-Arnaud, Pieroni, Spataro, & Baddeley, 2012) and in children (Kemps et al., 2000).[1] We used the Cognitive Imitation Task here because many studies on imitation (specifically overimitation) have employed object-based tasks such as puzzle/problem boxes where children must execute serial actions on objects to achieve a goal. Although these tasks may be more ecologically valid than the Cognitive Imitation Task, they cannot control for differences in affordances, familiarity, or top-down knowledge between tasks. And, importantly, the Cognitive Imitation Task allows the assessment of imitation learning within participants and across varying levels of difficulty.

[1] One important difference between the Cognitive Imitation Task and the Corsi and Knox tasks is that the Cognitive Imitation Task assesses visual skills independently of spatial skills, whereas most visual–spatial WM tasks confound the two.