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Only domain-specific imitation practice makes imitation perfect

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Does imitation involve specialized mechanisms or general—unspecialized—learning processes? To address this question, preschoolers (3- and 4-year-olds) were assigned to one of four "practice" groups. Before and after the practice phases, each group was tested on a novel Spatial Imitation sequence. During the practice phase, children in the Spatial Imitation group practiced jointly attending, vicariously encoding, and copying the novel spatial sequences. In the Item Imitation group, children practiced jointly attending, vicariously encoding, and copying novel item sequences. In the Trial-and-Error group, children practiced encoding and recalling a series of novel spatial sequences entirely through individual (operant) learning. In the Free Play (no practice) control group, children played a touchscreen drawing game that controlled for practice time on the touchscreen and mirrored some of the same actions and responses used in the experimental conditions. Results of the difference between pre- and post-practice effects on novel spatial imitation sequences showed that only the Spatial Imitation practice group significantly improved relative to the Free Play group. Individual Spatial Trial-and-Error practice did not significantly improve spatial imitation. The effect of Item Imitation practice was intermediate. These results are inconsistent with the hypothesis that general processes alone--or primarily--support imitation learning and is more consistent with a mosaic model that posits

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an additive—interaction—effect on imitation performance where a more general social cognitive mechanism (i.e., natural pedagogy) gathers the relevant information from the demonstration and another more specialized mechanism (i.e., imitation specific) transforms that information into a matching response.

Introduction

All specialized cognitive skills (e.g., face processing) involve general, nonspecialized (e.g., visual attention) cognitive processes (Fodor, 2000; Kanwisher, 2010; Posner, Petersen, Fox, & Raichle, 1988). General learning mechanisms have long been associated with the development of complex, human-specific cognitive skills such as language and literacy development (Elman, 1996; Lee Swanson, Orosco, & Lussier, 2015; Lonigan, Lerner, Goodrich, Farrington, & Allan, 2016). An ongoing debate in the cognitive sciences is whether social cognition represents a special kind of cognition that is mediated by specialized mechanisms dedicated to processing information vicariously learned from conspecifics or whether nonsocial—general—cognitive processes mediate social and asocial cognition alike (Happe, Cook, & Bird, 2017; Heyes & Pearce, 2015; Heyes, 2012a).

Imitation, the ability to faithfully replicate demonstrated responses, is a foundational learning and social-cognitive construct whose underlying component cognitive features remain opaque. Researchers examining the development of imitation have addressed the problem in different ways. Some have focused on the role of more domain-general memory (Barr & Hayne, 2000) or learning processes (e.g., Heyes, 2016a). Others have focused on domain- and task-specific social learning processes (e.g., Subiaul, 2010; Subiaul, Patterson, & Barr, 2016; Zentall, 2012), the role of communicative/pedagogical cues (e.g., Csibra & Gergely, 2009), social learning strategies and information use (Morgan, Laland, & Harris, 2015; Rendell et al., 2011; Wood et al., 2016), and mental-state reasoning (e.g., Carpenter, Call, & Tomasello, 2002; Tomasello & Carpenter, 2007) or end-state reasoning (e.g., Bekkering, Wohlschlager, & Gattis, 2000). But rarely have imitation researchers considered the interaction of these different processes and how they shape imitation development (Barr, 2002; Heyes, 2016b; Subiaul, Patterson, Schilder, Renner, & Barr, 2015; Uzgiris, 1981).

Part of the problem may be historical. Imitation has been studied for more than a century; each successive generation has conceptualized and operationalized imitation differently (Galef, 1988; Subiaul, 2010; Zentall, 1996). Consequently, there is neither a "consensus" definition of imitation nor a consensus "method" or tool to measure it. In the developmental sciences, we have learned much about *what* children imitate and remember as well as *when* in development such skills emerge (Barr & Hayne, 2000; Barr, Dowden, & Hayne, 1996; Meltzoff, 1988; Over & Carpenter, 2012; Vanvuchelen, Roeyers, & De Weerdt, 2011a, 2011b; Young et al., 2011). But it is an under-appreciated fact among developmental scientists that we know relatively little about *how* children imitate. Specifically, the component cognitive processes underlying imitation performance across task domains and how such cognitive processes change during the course of development[1] are largely unknown. We know even less about the source(s) of individual differences in imitation performance and, consequently, why imitation performance varies—sometimes significantly—on what are otherwise superficially similar tasks.

Most of what we know about individual differences and the component cognitive processes supporting imitation performance comes from research on autism spectrum disorder (ASD). Individuals diagnosed with ASD are characterized by pervasive communication and social learning deficits (American Psychiatric Association, 2013). Researchers studying ASD have linked imitation deficits to a variety of skills and component cognitive processes, including forming multimodal representations,

[1] For an exception, see the work by Heyes and colleagues (Bird, Brindley, Leighton, & Heyes, 2007; Bird & Heyes, 2005; Bird, Osman, Saggerson, & Heyes, 2005; Catmur & Heyes, 2013; Cooper, Cook, Dickinson, & Heyes, 2013).