



Relations between 18-month-olds' gaze pattern and target action performance: A deferred imitation study with eye tracking



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ABSTRACT

Deferred imitation studies are used to assess infants' declarative memory performance. These studies have found that deferred imitation performance improves with age, which is usually attributed to advancing memory capabilities. Imitation studies, however, are also used to assess infants' action understanding. In this second research program it has been observed that infants around the age of one year imitate selectively, i.e., they imitate certain kinds of target actions and omit others. In contrast to this, two-year-olds usually imitate the model's exact actions. 18-month-olds imitate more exactly than one-year-olds, but more selectively than two-year-olds, a fact which makes this age group especially interesting, since the processes underlying selective vs. exact imitation are largely debated. The question, for example, if selective attention to certain kinds of target actions accounts for preferential imitation of these actions in young infants is still open. Additionally, relations between memory capabilities and selective imitation processes, as well as their role in shaping 18-month-olds' neither completely selective, nor completely exact imitation have not been thoroughly investigated yet. The present study, therefore, assessed 18-month-olds' gaze toward two types of actions (functional vs. arbitrary target actions) and the model's face during target action demonstration, as well as infants' deferred imitation performance. Although infants' fixation times to functional target actions were not longer than to arbitrary target actions, they imitated the functional target actions more frequently than the arbitrary ones. This suggests that selective imitation does not rely on selective gaze toward functional target actions during the demonstration phase. In addition, a post hoc analysis of interindividual differences suggested that infants' attention to the model's social-communicative cues might play an important role in exact imitation, meaning the imitation of both functional and arbitrary target actions.

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1. Introduction

Infants' imitation has been subject to a wide range of developmental studies. On the one hand, imitation of observed actions after a retention interval (deferred imitation) has been taken as a measure of infants' declarative memory performance (e.g., Meltzoff, 1985, 1988). Infants show deferred imitation of a small number of target actions from about six months of age on (Barr, Dowden, & Hayne, 1996; Collie & Hayne, 1999; Heimann & Nilheim, 2004; Kressley-Mba, Lurg, & Knopf, 2005).

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With increasing age, infants' deferred imitation performance improves rapidly, which is usually attributed to improving information processing and memory capabilities (Barr et al., 1996; Bauer, 2005; Hayne, 2004; Jones & Herbert, 2006; Knopf, Goertz, & Kolling, 2011). The age-related improvement of deferred imitation performance is shown by the increasing amount of target actions infants are able to imitate, suggesting an improvement in the capacity of infants' memory (Barr et al., 1996; Collie & Hayne, 1999; Elsner, Hauf, & Aschersleben, 2007; Kolling, Goertz, Frahsek, & Knopf, 2010). With increasing age, infants also become able to show deferred imitation after longer delay intervals, suggesting an improvement in retention (Barr & Hayne, 2000; Herbert & Hayne, 2000). Additionally, older infants need fewer repetitions of target action demonstration to successfully engage in deferred imitation, which suggests that encoding also becomes more efficient with age (e.g., Barr et al., 1996).

On the other hand, imitation methods have been applied to investigate infants' understanding of observed actions (see Elsner, 2007 for a review) as well as psychological states, such as goals and intentions, of the persons demonstrating these actions (e.g., Bellagamba & Tomasello, 1999; Carpenter, Akhtar, & Tomasello, 1998; Meltzoff, 1995). Within this line of research it has been found that in a pedagogical context (i.e., when the model uses ostensive cues to communicate the target actions to the child, see Csibra & Gergely, 2006; Gergely & Csibra, 2005; Király, Csibra, & Gergely, 2013) infants around the age of one year usually imitate selectively. This means that infants imitate certain kinds of target action more frequently than others, according to the actions' perceived intentionality (Carpenter et al., 1998), goal-relevance (Brugger, Larivière, Mumme, & Bushnell, 2007), or efficiency (Gergely, Bekkering, & Király, 2002; Schwier, van Maanen, Carpenter, & Tomasello, 2006). In contrast, children from about the age of two years have been repeatedly found to imitate the model's actions exactly (Nagell, Olguin, & Tomasello, 1993; Nielsen, 2006). 18-month-olds imitate neither as selectively as 12-month-olds, nor as exactly as 24-month-olds. For example, Nielsen (2006) found that while 12-month-olds only reproduced the model's specific actions when they were given a rational reason to do so and 24-month-olds imitated the model's specific actions in all conditions, 18-month-olds imitated selectively when the model acted aloof, but they were as likely to reproduce the specific actions as the actions' outcomes when the model acted socially, irrespective of the apparent logic of the actions. Similarly, Tennie, Call, and Tomasello (2006) found that 12-month-olds typically reproduced the goal of the target action, ignoring the exact movement, 18-month-olds reproduced the goal by copying the exact movement if the target action was demonstrated by a model and 24-month-olds reproduced the goal by copying the exact movement both when the target action was presented by a model and when the target object was seemingly moving on its own (ghost condition). Carpenter, Call, and Tomasello (2005) also reported that in a condition where infants were more likely to copy the exact movement than the action's goal state, 18-month-olds did so more frequently than 12-month-olds. Additionally, in a deferred imitation task varying the functionality of target actions, 12-month-olds were found to imitate only those target actions that required specific object properties (*functional actions*) and to completely omit target actions that could be performed on any kind of object (*arbitrary actions*). In contrast, 18-month-olds imitated both kinds of actions, but still reproduced more functional than arbitrary ones (Óturai, Kolling, Rubio Hall, & Knopf, 2012).

Although the finding that 18-month-olds imitate more exactly than 12-month-olds within the same task constraints seems to be consistent across imitation studies applying a pedagogical setting in infancy (see also Gergely & Király, 2003, as cited by Gergely, 2003), other studies report selective imitation in older children (McGuigan & Graham, 2010; McGuigan & Whiten, 2009; McGuigan, Makinson, & Whiten, 2011). This apparent contradiction might rely on task characteristics such as task complexity or the lack of pedagogical cues in studies with older children (e.g., McGuigan & Graham, 2010; McGuigan & Whiten, 2009; McGuigan et al., 2011; Wood, Kendal, & Flynn, 2012), as well as on different motivations and social pressure in infancy and toddlerhood vs. preschool age (Over & Carpenter, 2012a, 2012b). However, the present paper does not aim to provide a general account on imitation across all different task contexts and across the total preschool age. Instead, we focus on selective vs. more exact imitation in infancy, as it has been reported in (deferred) imitation studies applying a child-directed communication of target actions.

Several theoretical accounts have been proposed to explain selective imitation. Some of these claim that selective imitation can be explained by lower level, automatic processes, such as direct mapping of the observed actions onto one's own motor repertoire, i.e., motor resonance, combined with action-effect binding (Hauf & Prinz, 2005; Meltzoff, 2007; Paulus, Hunnius, Vissers, & Bekkering, 2011a, 2011b). Although these theories can explain some important issues related to selective imitation – e.g., why actions with salient effects are imitated more frequently than actions without salient effects (Elsner, 2007), they do not provide an explanation for age differences in selective vs. exact imitation.

These age differences can be better explained by theories proposing both that imitation involves some interpretation of the presented actions, and that the nature of these interpretations changes with development. Gergely (2003) describes a shift from teleological to mentalizing action interpretation: 14-month-olds interpret the observed actions in terms of their visible outcomes and situational constraints, whereas 18-month-olds attribute a communicative, teaching intention to the model. As a result, 14-month-olds only imitate the model's actions if those seem to be efficient (Gergely et al., 2002), while 18-month-olds exactly imitate the model's actions irrespective of their apparent efficiency (Gergely & Király, 2003, as cited by Gergely, 2003; cf. Nielsen, 2006). This argumentation is in line with the idea of a developmental change from object-centered to social imitation, as claimed by Uzgiris (1981), already. Uzgiris proposed that while 10-month-olds' imitation is guided by a cognitive motivation to learn about objects and actions, infants aged 16 months and older also use imitation to maintain the social interaction with the model.

Empirical evidence underlines the importance of the social-communicative context in guiding infants' imitation in that the more social engagement is possible, the more exact infants' imitation will be (Király, 2009; Nielsen, 2006; Nielsen, Simcock,

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