Journal of Experimental Child Psychology 116 (2013) 487–498

Contents lists available at SciVerse ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Examining functional mechanisms of imitative learning in infancy: Does teleological reasoning affect infants' imitation beyond motor resonance?

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ARTICLE INFO

Article history:
Available online 25 December 2012

Keywords:
Infancy
Imitation
Social learning
Inferential processes
Motor resonance
Social cognition

ABSTRACT

Recently, researchers have been debating whether infants' selective imitative learning is primarily based on sensorimotor processes (e.g., motor resonance through action perception) or whether inferential processes such as teleological reasoning (i.e., reasoning about the efficiency of others' actions) predominantly explain selective imitation in infancy. The current study directly investigated two different theoretical notions employing the seminal and widely used head touch paradigm. In two conditions, we manipulated whether the action appeared to be efficient while motor resonance was optimized to enhance imitation performance in general. The results showed that infants imitated the target action to the same extent in both conditions irrespective of the action's efficiency. In addition, in both conditions, more infants imitated the head action than in an additional baseline condition or in a condition where the target action was performed by another effector. The results suggest that 14-month-olds do not imitate novel actions according to their apparent efficiency but that motor resonance is an important factor in infants' imitation.

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http://dx.doi.org/10.1016/j.jecp.2012.10.009

Introduction

Imitation in infancy has been a topic of research within the field of developmental psychology for more than a century (e.g., Baldwin, 1906; Barresi & Moore, 1996; Jones, 2007; Piaget, 1962). Yet, the mechanisms subserving infants' imitative learning of novel actions are still a topic of ongoing discussion (e.g., Barr, Wyss, & Somanader, 2009; Bauer, 2006; Elsner, 2007; Gergely & Csibra, 2003; Heyes, 2009; Huang & Charman, 2005; Jones, 2009; Meltzoff & Moore, 1989; Paulus, 2012).

One of the currently most influential approaches, the teleological stance theory, postulates that—from a very early age onward—humans normatively evaluate actions they observe by applying the *principle of rational action* (Gergely & Csibra, 2003). Employing this principle, they expect agents to act in a way that they infer to be most efficient for achieving their goals. In a seminal study, Gergely, Bekkering, and Király (2002) presented 14-month-old infants with a task originally employed by Meltzoff (1988) in a study on deferred imitation. Infants observed an adult who was sitting at a table with a black box in front of her on which a lamp was mounted. The adult leaned forward and touched the lamp with her forehead, causing an illumination effect. In one condition, the adult had a blanket wrapped around her shoulders that she held up with her hands (Hands Occupied condition) when she touched the lamp with her head. In a second condition, her hands were free and the blanket was hanging loosely around her shoulders (Hands Free condition). More infants imitated the head touch in the Hands Free condition than in the Hands Occupied condition. The authors suggested that in the Hands Occupied condition infants inferred that the model needed to use her head because her hands were occupied. In the Hands Free condition, however, the model appeared to use her head deliberately and so infants were, according to the authors, more likely to reproduce the head touch. In sum, this pattern of results has been interpreted to provide evidence for rational imitation in 14-month-olds. Following these theoretical considerations, it has been suggested that infants (and even animals such as apes and dogs) imitate actions "rationally," depending on the efficiency of the demonstrated action (e.g., Buttelmann, Carpenter, Call, & Tomasello, 2007; Range, Viranyi, & Huber, 2007; Schwier, van Maanen, Carpenter, & Tomasello, 2006; Zmyj, Daum, & Aschersleben, 2009).

Recently, however, evidence has been presented that the infants' apparent "rational" imitative behavior in the head touch paradigm might be caused by other, more low-level sensorimotor mechanisms. Paulus, Hunnius, Vissers, and Bekkering (2011c) pointed to an important difference between the two conditions; in the Hands Free condition the model supported herself with her hands on the table when performing the head touch, whereas in the Hands Occupied condition she bent over with her arms crossed in front of her chest. The authors had observed that when imitating the head touch, infants always put their hands on the table next to the lamp to maintain a stable position (Paulus, Hunnius, Vissers, & Bekkering, 2011b). Thus, the action modeled in the Hands Free condition resembled more closely the action infants performed themselves. This observation is crucial because recent findings have shown that a person's own action capabilities and action experiences influence the way that he or she perceives the actions of others (e.g., Daum, Prinz, & Aschersleben, 2011; Hauf, 2009; Hauf, Aschersleben, & Prinz, 2007; Longo & Berthental, 2006; Meltzoff, 2007; Sommerville & Woodward, 2005; Sommerville, Woodward, & Needham, 2005; van Elk, van Schie, Hunnius, Vesper, & Bekkering, 2008). In particular, it has been found that the observation of an action that is part of one's own motor repertoire leads to higher activation in the motor system (i.e., motor resonance) than the observation of an action that is not within one's motor repertoire (e.g., Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005; Heyes, 2011; Reid, Striano, & Iacoboni, 2011; van Elk et al., 2008; for a discussion, see also Uithol, van Rooij, Bekkering, & Haselager, 2011). Because the head action modeled in the Hands Free condition was more similar to the way that infants would subsequently perform the action themselves, it is likely that this action induced more motor resonance in the observing infant than the action that was demonstrated in the Hands Occupied condition.

This is important in light of the suggestion that imitative learning is based on the acquisition of action–effect associations through observation (Paulus et al., 2011b). That is, it has been suggested that by observing the other person's action, infants activate the corresponding motor code in their motor repertoire. At the same time, they perceive the consequence of the other's action, which activates an effect code (i.e., an effect representation) in the cognitive system. The motor code and the effect code