Research in Developmental Disabilities 34 (2013) 538–545

Contents lists available at SciVerse ScienceDirect

Research in Developmental Disabilities

Review article

Understanding the mechanisms behind deficits in imitation: Do individuals with autism know 'what' to imitate and do they know 'how' to imitate?☆

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ARTICLE INFO

Article history:
Received 8 August 2012
Received in revised form 24 September 2012
Accepted 26 September 2012
Available online 1 November 2012

Keywords:
Imitation
Underlying mechanisms
Selection processes
Correspondence processes

ABSTRACT

Although imitation problems have been associated with autism for many years, the underlying mechanisms of these problems remain subject to debate. In this article, the question whether imitation problems are caused by selection or correspondence problems is explored and discussed. This review revealed that hypotheses on the nature of imitation problems in autism are complicated and inconclusive at the present time. There is some evidence for impaired selection, especially implicating poor preferential attention to biological motion and poor ascription of intention to action. There is also some evidence that both transformations of perspectives and mapping of visual to motor information are impaired, characterized as correspondence problems. However, it is not yet clear how poor selection processes contribute to correspondence problems and vice versa. Insight in this interaction may provide a valuable contribution to our understanding of imitation problems in autism. For further research we recommend that tasks should be constrained to target as few mechanisms as possible in given experiments.

Contents

☆ This study was supported by a Foundation Marguerite-Marie Delacroix grant (Tienen-Belgium) to M. Vanvuchelen.
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http://dx.doi.org/10.1016/j.ridd.2012.09.016

1. Introduction

Motor imitation is defined as the capacity of an individual to replicate an observed motor act. It requires the ability to transform visual-perceptual information into a motor copy of it (Prinz, 2002). It is a neurocognitive process that powers cognitive and social development in infancy and childhood; that promotes empathy, cooperation and well-being in our relationships with others; and provides a channel of evolutionary, cultural inheritance that makes us distinctively human (Heyes, 2009). The neurological circuit of motor imitation contrasts with that of vocal imitation at least at the stimulus input level (visual versus auditory input) and feedback level (kinesthetic and occasionally visual feedback versus auditory feedback) (Masur, 2006). This rejects the frequently made remark that the excessive vocal imitation or echolalia, described by McEvoy, Loveland, and Landry (1988) is not compatible with the impaired motor imitation in individuals with autism. In the present review the term motor imitation refers to the imitation of actions with and without objects. These actions can be goal-directed and non-goal-directed, respectively meaningful and non-meaningful. The paper reviews recent research relevant to problems of motor imitation in individuals with autism and considers these problems from two main perspectives, termed the "selection process" and the "correspondence process." In general, the former refers to stimulus input ("what" to imitate) and the latter to motor output ("how" to imitate).

Core theories of motor imitation (hereafter "imitation") can be divided into two main frameworks: the framework of separate and of common representational coding. The first framework assumes that perception and action have independent representational formats. The most prominent model according to this framework is the Active Intermodal Mapping (AIM) model of imitation (Meltzoff & Moore, 1997). The AIM-model proposes that visually perceived acts are actively mapped onto motor output via a supramodal representation system. The second framework assumes that codes related to perception and action share a common representational domain. This common-coding or direct mapping approach, states that the motor system is directly activated by the perception of an action. The motor system of the imitator receives direct input from observing the demonstrator's movement. This framework has generated several theories of imitation. In the Ideomotor Theory of Imitation, the observer acts what he sees, i.e., perceptual induction (Prinz, 1997, 2002) or what he would like to see, i.e., intentional induction (Prinz, 2002). The latter is related to the Goal Directed Theory of Imitation, which claims that imitation is guided by goals and that goals are hierarchically organized (Bekkering, Wohlschlager, & Gattis, 2000). Another issue with the ideomotor approach of imitation is whether and how well a person imitates depend on the past experiences of the imitator. This issue is central in the Associative Sequence Learning model of imitation. A person will be able to imitate an observed action, only if he has had the opportunity to form a link between visual and motor representations of this particular action by sensorimotor experiences (Heyes & Ray, 2004; Heyes, 2001). To resolve seemingly contradictory ideas of previous models, the Dual Route Theory of Imitation was forwarded. This theory assumes that the pattern of imitation depends on the type of the extrinsic properties of an action presented. For that reason, the Dual Route Theory distinguishes two distinctive routes for imitation: the direct and indirect route (Rumiati & Tessari, 2002). The direct non-linguistic mediated route is used for the imitation of novel non-meaningful and non-goal directed actions. The indirect linguistically mediated route is used for the imitation of well-trained familiar meaningful or goal directed actions (Rumiati & Tessari, 2002).

Although imitation problems have been associated with autism for many years, the issue of whether these problems are a core deficit in autism is yet to be determined (see recent reviews of Sevlever & Gillis, 2010; Vanvuchelen, Roeyers, & De Weerdt, 2011a; Williams, Whiten, & Singh, 2004). In their meta-analysis Williams et al. (2004) pooled the findings from twelve well-controlled case–control studies, involving 196 individuals with autism. They calculated the combined p-value of group differences with respect to imitation problems to an appropriate control group, resulting in a p-value of .00002 (Williams et al., 2004). Sevlever and Gillis (2010) discussed imitation problems in autism from a methodological perspective. The authors recommended a comparative taxonomy of imitation, a standardized methodology across researchers, and a standardized imitation battery for children with autism to improve imitation research in this population (Sevlever & Gillis, 2010). Vanvuchelen et al. addressed the question whether autism problems fulfil the criteria of uniqueness, specificity, universality, persistency, precedence and broadness. The findings of this review suggest that there is only partial evidence for the idea that imitation problems are unique, specific and broad to autism, and that these problems are long-lasting and persistent. In addition, imitation problems seem not to be universal in autism at an early age. Mental and motor impairment may affect imitation performance but they do not seem to explain imitation problems in a sufficient way (Vanvuchelen et al., 2011a). The findings of the same research group suggest that delay in imitation of actions with objects that go beyond the nonverbal mental delay may predict the diagnosis of autism at preschool age (Vanvuchelen, Roeyers, & De Weerdt, 2011b).

The present review lays out several current and some older theories related to the processes behind the imitation problems seen in many individuals with autism. It provides an overview of important advances in autism imitation research summarizing the state of play with respect to two key questions: Do individuals with autism know 'what' to imitate? And do they know 'how' to imitate? Imitation appears to result from the interaction of two distinct cognitive processes: the selection and the correspondence process (Breazeal & Scassellati, 2002; Lopes & Santos-Victor, 2005). Solving the selection problem is based on non-specific mechanisms which are involved in both imitative and non-imitative tasks, including social attention and motivation, visual attention, biological motion preference, action and intention recognition. On the contrary, the correspondence problem is solved by specific mechanisms which are exclusively involved in imitative tasks. Viewpoint transformation and visuomotor mapping are typical to converse observed actions into executed actions. There is relatively more research in the field of these specific mechanisms.