Infant Behavior & Development 33 (2010) 159–167

Contents lists available at ScienceDirect

Infant Behavior and Development

Memory development throughout the second year: Overall developmental pattern, individual differences, and developmental trajectories

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ARTICLE INFO

Article history:
Received 7 January 2009
Received in revised form 29 June 2009
Accepted 29 December 2009

Keywords:
Memory development
Deferred imitation
Language
Self
Infancy

ABSTRACT

The present three-wave longitudinal study analyzed the development of declarative memory in $N = 92$ infants (12-, 18- and 24-month-olds) using a deferred imitation task. As expected, overall memory performance improved throughout the second year. Previous research is also replicated insofar as stability of inter-individual differences was low to moderate within this age range. In addition, cluster analyses identified two developmental groups showing different growth and different stability patterns. Multivariate analyses revealed specificities in language and self-development in these two developmental groups having different developmental trajectories.

1. Introduction

For learning and memory in infancy, imitation has been identified as a central mechanism. While in newborns immediate imitations are reported (Meltzoff & Moore, 1977), the imitative acts of infants become more and more decoupled from the presence of a model, i.e. deferred imitations are found. In a classical study Piaget (1962) described deferred imitation through behavioural observations of his daughter Jacqueline in a real-life situation. In more recent years, an experimental task for assessing this ability has been proposed (e.g., Meltzoff, 1985). In this deferred imitation task, young infants observe short series of simple, object-based actions demonstrated by a model (demonstration phase). After a delay of minutes, hours or even days the infants are given the props and their target behaviour is coded (imitation phase).

Experimental and clinical work provided evidence for the claim that deferred imitation can be classified as tapping declarative memory (Mandler, 2004; McDonough, Mandler, McKee, & Squire, 1995). First, the cross-modal character of the deferred imitation task renders it improbable that infants' imitations are due to priming processes, which are sensitive to modality changes. Second, the possibility that infants learn these actions through incremental learning processes can be excluded, since infants acquire instrumental actions via observation and not through motor learning. Next, deferred imitation tasks use new, unknown actions as memory material. These actions are not available in the infant's knowledge before. Finally, it has been demonstrated that deferred imitation is not found in amnesics, whose declarative memory system is impaired.

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0163-6383/$ – see front matter © 2010 Elsevier Inc. All rights reserved.
doi:10.1016/j.infbeh.2009.12.007

The cross-sectional developmental studies conducted so far using this type of memory task showed that 6-month-old infants are already capable of deferred imitation after short retention intervals. In the course of development, infants learn faster as they need less exposure to the target actions and they retain actions in memory for an increasing amount of time (e.g., Barr, Dowden, & Hayne, 1996).

Generally consistent with cross-sectional deferred imitation studies, the rare longitudinal studies indicate that declarative memory improves with age (Goertz, Kolling, Frahsek, Stanisch, & Knopf, 2008; Heimann & Meltzoff, 1996; Kolling, Goertz, Frahsek, & Knopf, 2009; Nielsen & Dissanayake, 2004). In addition, it was demonstrated that correlations between four individual memory tests assessed in a longitudinal design are low to moderate in the second year (Nielsen & Dissanayake, 2004). In other words, inter-individual variability of intra-individual change is high. The reasons for this huge amount of inter-individual variability of intra-individual change are still unclear. To shed further light on this issue the present multivariate, longitudinal study tracks two main goals besides the replication of previous longitudinal research on memory development throughout the second year both with respect to overall developmental pattern as well as with respect to the development of inter-individual differences. The first goal of this longitudinal study is to identify developmental groups varying in their developmental trajectories. A second goal is to explain how these groups differ in terms of developmental determinants.

A proper analysis of inter-individual differences in intra-individual change and the identification of developmental groups necessitates the use of person-centred analysis approaches, as they focus on the individual subject and its development (von Eye & Bogat, 2006). Exploratory and confirmatory person-centred analysis approaches, i.e. longitudinal cluster analysis and longitudinal configural frequency analysis are applicable in this methodological context. These approaches allocate the subjects under study into different developmental groups under the assumption that different subgroups exist. In a next step of analysis, external validity of groupings is established by explaining intra-individual change with significantly related variables. Finally, externally validated groups are interpreted on the base of substantive theory (von Eye & Bogat, 2006). To our knowledge, only one deferred imitation study used this analysis approach so far. In a person-centred analysis of two waves of longitudinal data (12- and 18-month-old infants), Kolling et al. (2009) identified subgroups revealing differential growth (high, low and moderate) and stability (higher stabilities for subgroups than for the total group) of declarative memory performance.

To understand and explain different developmental courses of declarative memory throughout the second year, the assessment of language, self, social interaction abilities (joint attention, turn-taking skills) and cognitive development in general seem to be fruitful, since there is at least some recent theoretical work as well as empirical research linking the development of deferred imitation and the development of cognitive-, language- and self-aspects to one another. In several studies, joint development between declarative memory and language has been found. In one study enriching deferred imitation items with verbal cues, Herbert and Hayne (2000) showed that children at the age of 24 months, who outperformed younger children, used language cues efficiently, whereas 18-month-olds were not able to do so. This analysis has been realized for the overall age group and cross-sectionally, however, not for specific groups having different developmental trajectories. In a longitudinal study Heimann et al. (2006) found that visual recognition memory (at 6 months), deferred imitation (at 9 months) and turn-taking skills (at 14 months) predicted language skills at the age of 14 months, with deferred imitation accounting for the highest variance in the regression model. Furthermore, Strid, Tjus, Smith, Meltzoff, and Heimann (2006) reported that deferred imitation and joint attention were predictive for cognitive abilities at 4 years of age demonstrating the important role of social interaction variables.

While the aforementioned theoretical considerations and findings assume that the development of declarative memory are directly related to the improvement of abilities like language or social interaction, other theoretical considerations assume qualitative changes in deferred imitation during the second year. Declarative memory performance and the development of self are believed to be interrelated in a complex manner both from a theoretical (Knopf, Mack, & Kressley-Mba, 2005) and an empirical (Prudhomme, 2005) perspective in the second year. According to Tulving (2002) the emergence of a (conceptual) self, which develops around the middle of the second year, is a prerequisite for episodic (auto-noetic) remembering. With the development of the self, encoding of deferred imitation actions becomes more episodic-like in nature. In accordance with this line of thinking, Perner's (1991) theory of the representational mind postulates significant changes in the representational system at the age of 18 months. Perner claims that around the age of 18 months a new quality of representation, namely secondary representations, emerges, being the basis of a new type of representational activity. By linking deferred imitation memory performance and self development assessed via mirror self-recognition to each other, Prudhomme (2005) demonstrated empirically that 20-month-old children who passed the mirror test (rouge test) were less affected by a change of colours of the relevant target props given within the deferred imitation test than those who did not pass the mirror test. This finding is seen as an evidence for the fact that a more advanced development of the self allows a more flexible memory performance in a deferred imitation test. All in all, the research reviewed points out that the development of different cognitive and non-cognitive characteristics importantly determines declarative memory development in the second year of life. However, much more evidence is needed about the role these different concepts play for the occurrence and explanation of inter-individual differences of intra-individual change of declarative memory throughout the second year.

By putting together the evidence reviewed above we hypothesize that while there is an overall improvement of memory throughout the second year, inter-individual differences in intra-individual change of declarative memory performance are high. If the use of person-centred approaches (cluster analyses) leads to the extraction of developmental cluster groups differing in growth, group differences will need to be described by important developmental determinants (external validity