Available online at www.sciencedirect.com
SCIENCE DIRECT®
COGNITION
ELSEVIER
Cognition 97 (2005) 153–177
www.elsevier.com/locate/COGNIT

A memory span of one? Object identification in 6.5-month-old infants

Zsuzsa Káldy[a,*], Alan M. Leslie[b]

[a]*Psychology Department, University of Massachusetts Boston, 100 Morrissey Blvd., Boston, MA 02125, USA*
[b]*Department of Psychology and Center for Cognitive Science, Rutgers University, 152 Frelinghuysen Rd., Piscataway, NJ 08854, USA*

Received 10 December 2003; revised 4 June 2004; accepted 13 September 2004

Abstract

Infants' abilities to identify objects based on their perceptual features develop gradually during the first year and possibly beyond. Earlier we reported [Káldy, Z., & Leslie, A. M. (2003). Identification of objects in 9-month-old infants: Integrating 'what' and 'where' information. *Developmental Science*, *6*, 360–373] that infants at 9 months of age are able to use shape information to identify two objects and follow their spatiotemporal trajectories behind occlusion. On the other hand, another recent study suggests that infants at 4–5 months of age cannot identify objects by features and bind them to locations [Mareschal, D., & Johnson, M. H. (2003). The "what" and "where" of object representations in infancy. *Cognition*, *88*, 259–276]. In the current study, we investigated the developmental steps between these two benchmark ages by testing 6.5-month-old infants.

Experiment 1 and 2 adapted the paradigm used in our previous studies with 9-month-olds that involves two objects hidden sequentially behind separate occluders. This technique allows us to address object identification and to examine whether only one or both object identities are being tracked. Results of experiment 1 showed that 6.5-month-old infants could identify at least one of two objects based on shape and experiment 2 found that this ability holds for only one, the last object hidden.

We propose that at this age, infants' working memory capacity is limited to one occluded object if there is a second intervening hiding. If their attention is distracted by an intervening object during the memory maintenance period, the memory of the first object identity appears to be lost. Results of experiment 3 supported this hypothesis with a simpler one-screen setup. Finally, results of experiment 4 show that temporal decay of the memory trace (without an intervening hiding) by itself

* Corresponding author. Tel.: +1 617 287 6393; fax: +1 617 287 6336.
E-mail addresses: zsuzsa.kaldy@umb.edu (Z. Káldy), aleslie@ruccs.rutgers.edu (A.M. Leslie).

0022-2860/$ - see front matter
doi:10.1016/j.cognition.2004.09.009

cannot explain the observed pattern of results. Taken together, our findings suggest that at six months of age infants can store but a single object representation with bound shape information, most likely in the ventral stream. The memory span of one may be due to immaturity of the neural structures underlying working memory such that intervening items overwrite the existing storage.

Keywords: Infant; Object identification; Shape; Serial task; Working memory

1. Introduction

Research in the past two decades has revealed that human infants demonstrate significant competence in regard to the physical world early on. Infants assume that objects are solid, bounded, spatiotemporally unique entities (Baillargeon, 1986, 1987; Baillargeon, Spelke, & Wasserman, 1985; Spelke, 1988, 1994; Spelke, Breinlinger, Macomber, & Jacobson, 1992); they appreciate object numerosity (Wynn, 1992); and they recognize the causal roles of objects in actions (Leslie & Keeble, 1987). On the other hand, infants also show some remarkable limitations in using perceptual features to individuate and identify objects (Simon, Hespos, & Rochat, 1995; Tremoulet, Leslie, & Hall, 2000; Wilcox & Baillargeon, 1998; Xu & Carey, 1996). Here we investigate object identification in young, 6.5-month-old infants, at which age evidence for this ability is relatively sparse.

1.1. Individuation versus identification of objects

Leslie, Xu, Tremoulet, and Scholl (1998), drawing upon the literature on adult attention, introduced to infancy researchers a distinction between the *individuation* and *identification* of objects. Individuation refers to the detection of a novel object and the resulting establishment of an object representation (OR). Detection of further objects results in the establishment of additional OR's. Identification, on the other hand, requires the further step, following individuation, of entering information into an already established OR. Unless information is entered into, or 'bound' to, the OR, such information will not be available later for determining the identity of that object.

Gratch and his colleagues in the seventies were among the first to study object identification in infants (Gratch, 1976; LeCompte & Gratch, 1972; Saal, 1976). He highlighted the problem as "whether what we see now was different, similar or the same as what we once saw and, comparably, will be the same, similar or different from what we will see" (Gratch, 1976, p. 173). In a typical experiment, they would first hide a particular toy in a box and let the infant find it. After a few such trials, a trick followed: after hiding the original toy, as usual, infants when searching actually found a different toy in the box. The experimenters scored the infant's reactions to the new object (puzzlement, search) on an ordinal scale. In the Saal (1976) study, a complex featural difference was contrasted with a single featural (color) difference. She found that there is a noticeable change in infants' behavior between 6 and 9 month, regardless of the nature of the difference between the old and the new toy: 9-month-olds, but not 6-month-olds reacted with mild puzzlement.

Unfortunately, these early studies by Gratch and his colleagues had some methodological flaws. First, infants were not systematically familiarized to the features