Journal of Experimental Child Psychology 153 (2017) 57–73

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

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

Children's representations of another person's spatial perspective: Different strategies for different viewpoints?

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ARTICLE INFO

Article history:
Received 26 October 2015
Revised 1 September 2016

Keywords:
Spatial perspective taking
Strategy use
Development
Mental self-rotation
Inverting strategy
Children

ABSTRACT

The current study investigated development and strategy use of spatial perspective taking (i.e., the ability to represent how an object or array of objects looks from other viewpoints) in children between 8 and 12 years of age. We examined this ability with a task requiring children to navigate a route through a model city of wooden blocks from a 90° and 180° rotated perspective. We tested two hypotheses. First, we hypothesized that children's perspective-taking skills increase during this age period and that this process is related to a co-occurring increase in working memory capacity. Results indeed showed clear age effects; accuracy and speed of perspective-taking performance were higher in the older age groups. Positive associations between perspective-taking performance and working memory were observed. Second, we hypothesized that children, like adults, use a mental self-rotation strategy during spatial perspective taking. To confirm this hypothesis, children's performance should be better in the 90° condition than in the 180° condition of the task. Overall, the results did show the reversed pattern; children were less accurate, were slower, and committed more egocentric errors in the 90° condition than in the 180° condition. These findings support an alternative scenario in which children employ different strategies for different rotation angles. We propose that children mentally rotated their egocentric reference frame for 90° rotations; for the 180° rotations, they

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http://dx.doi.org/10.1016/j.jecp.2016.09.001

inverted the left–right and front–back axes without rotating their mental position.

Introduction

The focus of the current study was on children's spatial perspective taking, the ability to mentally represent how objects in space appear to another person. Developmental research has shown that children's reconstructions of another person's spatial perspective become much more accurate during the elementary school years (e.g., Coie, Costanzo, & Farnill, 1973; Frick, Mohring, & Newcombe, 2014; Phinney & Nummedal, 1979). Much less is known, however, about the strategies used by children for solving perspective-taking problems. Studies showed that adults employ a mental self-rotation strategy during spatial perspective taking. They rotate their own reference frame in order to align the own reference frame with the reference frame of the other (i.e., they put themselves in the shoes of the other) (Kessler & Thomson, 2010; Kozhevnikov & Hegarty, 2001; Michelon & Zacks, 2006). The current study tested two main hypotheses, namely that children's perspective-taking ability improves with age and is related to age-related increases in working memory capacity (Hypothesis 1) and that children, like adults, use a mental self-rotation strategy during spatial perspective taking (Hypothesis 2).

Development of spatial perspective taking

Spatial perspective taking has been assessed by a variety of tasks, beginning with Piaget's Three Mountains task (Piaget & Inhelder, 1956). This task required children to look at a model layout of three mountains and to judge the way a doll would see this layout from a specific position, either by rebuilding the layout or by choosing the correct view from a set of photographs. In general, children up to the age of 10 years frequently committed egocentric errors on this task. That is, their answers resembled their own view of the mountains. Subsequent studies used variations of this task to investigate children's difficulties with spatial perspective taking more specifically. By doing so, Flavell (1992) differentiated between two levels of perspective-taking ability developing sequentially. The relatively simple "Level 1" perspective taking (i.e., the ability to judge whether, from a different position, a given object can be seen or not) was found to emerge before the age of 4 years (e.g., Sodian, Thoermer, & Metz, 2007). More exact computations ("Level 2") of *how* a given object can be seen (e.g., right side up or upside down) and *where* it is located (e.g., in the left or right of the visual field) was found to develop after the age of 4 years (see also Newcombe, 1989).

Level 2 perspective taking involves the construction of a mental representation that equals the view of the other person. Developmental studies demonstrated that these representations become more accurate during the elementary school years in that the number of purely egocentric errors (i.e., the child's reconstruction equals the own perspective) and the number of reconstruction errors (i.e., the child's reconstruction does not equal the own perspective but contains front–back and/or left–right reversals) decrease. For example, the study of Frick and colleagues (2014) demonstrated a decrease in egocentric errors between 4 and 8 years of age. These authors presented children with scenes of toy photographers taking pictures of layouts of objects (one, two, or four) from different angles (0°, 90°, or 180°) and asked them to choose which one of four pictures could have been taken from a specific viewpoint. Results showed that scenes with one object were easier than scenes with multiple objects. The 4-year-olds performed near chance level, even in the simple layouts with only one object, whereas nearly all the 8-year-olds performed above chance level. The number of egocentric errors (i.e., selecting the picture that represented their own perspective) decreased significantly with age; a steep decline was observed between 7 years (∼70% of errors egocentric in the more complex layouts) and 8 years (∼40% of errors egocentric). These findings corroborate other studies showing that spatial