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Frames of reference in spatial language acquisition

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ABSTRACT

Languages differ in how they encode spatial frames of reference. It is unknown how children acquire the particular frame-of-reference terms in their language (e.g., left/right, north/south). The present paper uses a word-learning paradigm to investigate 4-year-old English-speaking children's acquisition of such terms. In Part I, with five experiments, we contrasted children's acquisition of novel word pairs meaning left-right and north-south to examine their initial hypotheses and the relative ease of learning the meanings of these terms. Children interpreted ambiguous spatial terms as having environment-based meanings akin to north and south, and they readily learned and generalized north-south meanings. These studies provide the first direct evidence that children invoke geocentric representations in spatial language acquisition. However, the studies leave unanswered how children ultimately acquire "left" and "right." In Part II, with three more experiments, we investigated why children struggle to master body-based frame-of-reference words. Children successfully learned "left" and "right" when the novel words were systematically introduced on their own bodies and extended these words to novel (intrinsic and relative) uses; however, they had difficulty learning to talk about the left and right sides of a doll. This difficulty was paralleled in identifying the left and right sides of the doll in a non-linguistic memory task. In contrast, children had no difficulties learning to label the front and back sides of a doll. These studies begin to paint a detailed account of the acquisition of spatial terms in English, and provide insights into the origins of diverse spatial reference frames in the world's languages.

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1. Introduction

1.1. Background

How does language acquisition interact with conceptual development? Amid a resurgence of exploration and debate about the Whorfian hypothesis (Bloom & Keil, 2001; Boroditsky, 2003; Christie & Gentner, 2012; Gleitman & Papafragou, 2013; Pinker, 2007; Whorf, 1956; Wolff & Holmes, 2011), the domain of spatial cognition has provided fertile ground for examining language-thought interactions (e.g., Bloom, Peterson, Nadel, & Garrett, 1996; Bowerman & Choi, 2003; Dasen & Mishra, 2010; Hespos & Spelke, 2004; Hickmann & Robert, 2006; Landau, Dessalegn, & Goldberg, 2010; Li & Gleitman, 2002; Pederson et al., 1998; Pyers, Shusterman, Senghas, Spelke, & Emmorey, 2010; Shusterman, Lee, & Spelke, 2011). The development of frame-of-reference (FoR) concepts represents one particularly interesting case study. Languages vary widely in the availability and frequency of FoR terms (Levinson, 1996, 2003; Majid, Bowerman, Kita, Haun, & Levinson, 2004; Pederson et al., 1998). For example, whereas English prefers egocentric terms (“left”, “front”) for describing small-scale tabletop arrays, some languages (e.g., Tseltal, Haillom, Guugu Yimitirr) disprefer or even lack such terms and prefer geocentric (sometimes called ‘absolute’) terms instead, like “north” or “uphill”. This cross-linguistic diversity raises questions about how such concepts are acquired in the first place, and how children come to understand the terms and concepts that they will need to communicate in whichever culture they are raised.

Early philosophers (Kant, 1768) and developmental researchers (Acredolo, 1977; Piaget, 1928) argued that children’s spatial representations are primarily egocentric. In contrast to this position, the reports of cross-linguistic variation in spatial language, especially the evidence that some cultures prefer geocentric FoR, raises skepticism about the claim that children’s initial FoRs are predominantly egocentric rather than geocentric (Majid et al., 2004). Furthermore, a number of studies have indicated a correlation between the dominant FoRs in a specific language community, and the availability of FoR representations in non-verbal cognitive tasks in members of that community (Haun & Rapold, 2009; Haun, Rapold, Call, Janzen, & Levinson, 2006; Pyers et al., 2010; cf. Li, Abarbanell, Gleitman, & Papafragou, 2011), suggesting that language experience might causally influence the conceptual representation of FoRs. Collectively, these findings have raised a number of questions. First, what are the conceptual origins of these FoR representations: how robustly are they represented in children prior to substantial input from their culture and language? Second, how does experience with language and culture interact with early-arising conceptual representations?

The current studies investigate children’s ability to learn frames of reference words, using a novel-word training paradigm, in order to begin to address these questions about language acquisition and conceptual abilities in the spatial domain. To set up our study, we must first introduce some terminology regarding the range of reference frames that are discussed in previous literature and characterize the cross-linguistic variations that appear in the world’s languages.

1.2. Frames of reference

1.2.1. Defining entities and coordinate axes

We use spatial language every day, but we do not normally think about the different types of spatial expressions available to us. Consider a child hearing a novel spatial expression for the first time (“The apple is ZIV of the doll”). The child could attribute numerous meanings to the novel spatial word “ZIV.” For example, the speaker could mean the apple is to the north of the doll. In this case, the speaker would be using an *environment-based* (or *geocentric*) frame of reference, where she is describing the relationship between the doll and the apple using a constant fixture of the environment (e.g., the North Pole). Alternatively, the speaker could describe the position of the doll using an expression with an *object-centric* frame of reference, where the meanings of the expressions depend on the orientation of an object not anchored to earth (e.g., the doll or the speaker).

In essence, frame-of-reference (FoR) concepts are abstract mental structures—coordinate frameworks that organize a set of spatial relations. These coordinate frameworks can be derived from