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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 38(0)

Author

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Publication Date

2016

Peer reviewed

Verbalizing navigation: Explicit and implicit concepts

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Keywords: Cognitive Discourse Analysis; spatial cognition; verbalization; cognitive processes; reference frames

Introduction

Every day, we navigate our environments with astonishing ease. Most of our paths are familiar to us and can be navigated without (much) conscious thought; in other cases, we use various strategies to find our way (Tenbrink & Wiener, 2007). Since these processes are at the heart of human spatial cognition they have been researched extensively, often based on route directions as the most common verbalizations of navigation. Our research extends this tradition across various wayfinding contexts, addressing street network scenarios (Hölscher, Tenbrink, & Wiener, 2011), complex buildings (Tenbrink, Bergmann, & Konieczny, 2011), alpine environments (Egorova, Tenbrink, & Purves, 2015), and including effects of automatic systems as producers (Tenbrink & Winter, 2009) or recipients (Moratz & Tenbrink, 2006; Tenbrink et al., 2010) of spatial directions. In all of these studies natural language data are used to address concepts of navigation, some of which are expressed explicitly, while others remain implicit and only indirectly reflected through the ways in which speakers use language in spatial navigation contexts.

Navigation and language

Whenever we use language, we reveal something about our thoughts and concepts – in part intentionally and explicitly, and in part without being aware of it, reflected in the use of language in a particular way. In the context of navigation, even a common route segment description like *Go straight on the main road until you cross the traffic lights* reflects a wealth of concepts. For instance, the recipient is expected to infer relevant movement directions from *straight on* (e.g., what is the initial orientation from which to move straight on? Is it still 'straight on' if there's a bend in the road? Etc.) and *cross* (in which direction should the road be crossed?), and to identify suitable referents for *the main road* and *the traffic lights*, drawing on world knowledge and current perception of the environment. The two definite articles reveal the speaker's consideration of these references as unambiguous, clearly without conceptualizing any competing main roads or traffic lights. The term *until* highlights the concept of an end point of the segment in question, marked by the traffic lights as a recognizable landmark in the environment.

Route givers do not necessarily consciously consider all of these concepts, or their possible alternatives; they use language as it comes to mind, spontaneously and naturally.

Nevertheless, features such as these are frequent and systematic in route descriptions. Patterns can be (and have been) identified by close cognitive-linguistic data analysis (e.g., Allen, 2000; Denis, 1997; and others), enhanced by theories and findings from a wealth of research in linguistics, psychology, and more.

Building on such findings and related studies across domains, Cognitive Discourse Analysis (CODA, Tenbrink, 2015) was developed to support the systematic analysis of language reflecting various levels of thought. Using CODA, Hölscher et al. (2011) identified explicitly verbalized strategies on route choices along with linguistic indicators that highlighted how route givers accounted for the needs of the wayfinder (see also Tenbrink & Winter, 2009). Crucially, our results highlighted the strategy of heading into a particular direction while navigating, as opposed to orienting towards the street network while planning ahead and explaining the route in advance.

Other studies examining the verbalization of spatial navigation concepts include Klippel et al. (2013), who showed how speakers intuitively conceptualize intersections differently depending on how they are used for navigation, focusing on either structure or function. Here, different linguistic expressions systematically reflect the underlying relevance of an intersection concept. Mast et al. (2014) recognized patterns of categorization in speakers' directional concepts that were reflected through grouping behavior as well as verbalization. They identified two principles of categorizing directions such as *left* and *right*, one based on a prototype structure and the other on discrete boundaries. Both exist in parallel in cognition and in language, with distinct linguistic expressions associated with different types of categories. Tenbrink & Seifert (2011) identified explicit and purposefully formulated strategies for tour planning along with implicitly represented conceptual switches between maps and real environments. Together, these studies demonstrate that language is a powerful representation tool that reflects different levels of cognition, accessible through systematic analysis of linguistic patterns.

Navigation in virtual space

Our recent research in virtual space (Tenbrink & Salwiczek, in press) addressed a fundamental distinction frequently encountered in navigation contexts – orientation on the basis of an *allocentric* vs. an *egocentric* reference frame. We reasoned that if verbal data reliably convey navigation concepts at several levels of awareness (as in the studies cited above), this should also be true for something as pervasive and basic as reference frames. To address this we used a task that has, in various variations, frequently been

used to differentiate between humans' preferred reference systems (e.g., Goeke et al., 2015; Gramann et al., 2005).

Participants were presented with a simple, perceptually sparse virtual tunnel shown on a computer screen (similar to common virtual reality scenarios in research and gaming contexts), and were asked to indicate the direction of the tunnel's entrance after the journey ended. They were asked to *think aloud* while doing this task, and also produced retrospective reports after a set of tunnel journeys. Mirroring previous results, directional responses in our study fell into two major categories. One of these had in previous studies been interpreted as an allocentric conceptualization of the journey, and the other as an egocentric one. Since these two reference frames generally have clear reflections in language across task settings, our analysis addressed the extent to which speakers conceptualized and verbalized these basic reference frames in this scenario.

Surprisingly, the expected correspondence between verbalizations and behavioral response patterns could not be verified in the data. In fact, the verbalizations only corresponded to a limited extent to *any* kinds of previously reported reference systems in the literature. Instead, they indicated a multitude of conceptual strategies and concepts emerging in this simple navigation scenario, reflecting the participants' struggles to maintain orientation in this perceptually sparse scenario. These results challenge previous assumptions that the two kinds of behavioral responses to the navigation task consistently and reliably reflect basic allocentric and egocentric reference systems.

Spatial cognition, trivially, depends on *space* – which (non-immersive) virtual reality can only simulate. While visual perception may be similar to real navigation, other sensory input (most prominently proprioception) is lacking – and this can pose major complications for orientation in virtual space. Sparse orientation task settings may thus not be suitable for assessing reference frame preferences that are normally at work in far richer real world contexts.

Acknowledgments

Funding by the DFG for I5-[DiaSpace] and I6-[NavTalk] as part of the SFB/TR8 Spatial Cognition, Bremen/Freiburg, and by the Volkswagen Foundation for a Tandem Project (with J. Wiener, 2007-2009) is gratefully acknowledged.

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