Cogn Process (2013) 14:193–195
DOI 10.1007/s10339-013-0541-9

SHORT REPORT

Collaborating in spatial tasks: how partners coordinate their spatial memories and descriptions

Alexia Galati · Marios N. Avraamides

Received: 7 December 2012 / Accepted: 16 January 2013 / Published online: 15 February 2013

Abstract We summarize findings from a study examining whether the availability of the conversational partner's spatial viewpoint influences the speaker's spatial memories, description strategies, their joint efficiency and accuracy on the task, as well as the partner's resulting spatial memories. In 18 pairs, Directors described to a misaligned Matcher arrays that they learned while either knowing their Matcher's viewpoint or not. Memory tests preceding descriptions revealed that Directors represented their Matcher's viewpoint when known in advance. Moreover, Directors adapted the perspective of their descriptions according to each other's cognitive demands, given their misalignment. The number of conversational turns pairs took to coordinate suggested that pairs' strategies were effective at minimizing their collective effort. Nonetheless, in terms of accuracy on the task, pairs reconstructed more distorted arrays the more partner-centered descriptions Directors used. The Directors' descriptions also predicted Matchers' facilitation for their own perspective in memory tests following the description. Together, these findings demonstrate that partners in collaborative spatial tasks adapt their respective memory representations and descriptions contingently with the aim of optimizing coordination.

Keywords Perspective-taking · Spatial memory · Audience design · Coordination · Spatial descriptions

This article is part of the special issue on "Spatial Learning and Reasoning Processes", guest-edited by Thomas F. Shipley, Dedre Gentner and Nora S. Newcombe. Handling editor of this manuscript: Thomas F. Shipley.

A. Galati (✉) · M. N. Avraamides
Department of Psychology, University of Cyprus,
P.O. Box 20537, 1678 Nicosia, Cyprus
e-mail: galati@ucy.ac.cy

M. N. Avraamides
Centre for Applied Neuroscience, University of Cyprus,
Nicosia, Cyprus

We summarize findings from a study in which we examined the relationship between the coordination of partners in collaborative spatial tasks and the memory representations supporting that coordination. Our goals were to examine (a) whether information about the partner's misaligned viewpoint influences the perspective from which speakers organize spatial information in memory and subsequently describe it, (b) whether speakers' spatial representations and description choices influence how effectively they coordinate with their partner, and (c) whether speakers' descriptions influence their partner's resulting the memory representations.

In 18 pairs, one participant (the Director) first studied a tabletop array of seven objects. This took place across three blocks that varied in terms of what Directors knew about their partner's (the Matcher's) viewpoint. In the first block, Directors did not know that they would later describe the array to a Matcher. In the subsequent blocks, Directors either knew they would describe the array to a Matcher but did not know the Matcher's viewpoint or knew the Matcher's viewpoint as the Matcher was co-present in the room during learning. After studying the array, the Director's memory of it was assessed through two tasks: one involved *judgments of relative direction* (JRDs), which required imagining a specific location and orientation, and pointing with a joystick to another object from that imagined perspective (e.g., *Imagine being at the vase, facing the orange. Point to the button.*) In a second task, the Director drew the array by indicating the position of each object on a grid circle representing their table. After the memory tests, the Director described the array from memory to the Matcher, who was misaligned by 90°, 135°, or 180°. The Matcher reconstructed the array on the basis of the Director's descriptions, and their memory of the reconstructed array was assessed through the same memory tasks.

Several important findings emerged as follows:

1. As we have reported elsewhere, speakers represented the partner's viewpoint in memory when it was available (Galati et al. 2013). When Directors did not know their Matcher's viewpoint in advance, they encoded arrays egocentrically, being faster in the JRD task to imagine orienting to and to respond from perspectives aligned with their own. When they did know the Matcher's viewpoint in advance, they encoded it in memory: They rotated their array drawings toward the Matcher's known viewpoint and, in the JRD task, took longer to imagine orienting to headings aligned with their Matcher's viewpoint (at least for 90° and 135°). These longer orienting times could indicate that Directors related these imagined headings to an episodic representation containing the Matcher's external viewpoint.
2. Speakers also adapted their descriptions according to the cognitive demands of perspective-taking on themselves and their partner (Galati et al. 2013). They did so primarily based on their misalignment, which was perceptually available during the description. When perspective-taking was relatively easy (at the small offset of 90°), Directors used Matcher-centered expressions more frequently, whereas when perspective-taking was more computationally demanding for them (at the oblique 135°), they opted for their own perspective. Knowing the partner's viewpoint in advance enabled both partners to recognize when perspective-taking would be most difficult for the Director: advance knowledge that they would be misaligned by 135° led to more explicit agreements to use the Director's perspective.
3. We have also found evidence that speakers' description strategies were successful at reducing their collective effort when coordinating was difficult (Galati and Avraamides 2012). Taking the number of conversational turns to indicate pairs' effort, pairs were numerically more efficient (taking fewer turns) when they knew in advance that they would be misaligned by the oblique 135° than by the other, orthogonal offsets. Despite the computational demands of perspective-taking at 135°, the pairs' relative efficiency at this offset is contextualized by Directors' preference for their own perspective (as reported above). In fact, the more egocentric expressions Directors used when they knew their Matcher's viewpoint in advance, the fewer turns partners took to reconstruct the array.
4. A novel finding here is that adopting the partner's perspective was actually not a beneficial strategy in this task. New bidimensional regression analyses comparing the Matcher's photographed reconstruction to the original configuration revealed that the greater the proportion of Matcher-centered expressions in Directors' descriptions, the more distorted the relationships between objects were in the reconstruction. This may be because Directors who described arrays from their Matcher's perspective, despite their intentions to be accommodating, introduced more errors in their descriptions due to the working memory demands of computing spatial relations and selecting spatial terms from another perspective. When partners were counter aligned and the mappings of spatial terms could be easily computed (e.g., *my left = your right*), the reconstructed arrays were less distorted than at other offsets.
5. Speakers' descriptions influenced their partners' resulting memory representations (Galati and Avraamides 2012): the perspective of Directors' descriptions predicted the heading facilitated in Matchers' JRD performance, particularly when partners knew each other's viewpoint in advance. The more Matcher-centered expressions Directors used in their descriptions, the faster Matchers were to orient to and respond from headings aligned with their own (see Fig. 1). And conversely, the more egocentric expressions Directors used, the slower Matchers were to orient to and respond from headings aligned with their own.

This synthesis of our findings highlights the nuanced and complex ways in which people adapt their memory representations and descriptions in order to coordinate in spatial tasks. They underscore that people adapt their behavior according to the attributions they make about their partner's ability to contribute to the task, with the aim of maximizing the efficiency of communication (see also Duran et al. 2011; Brennan 2005; Clark and Wilkes-Gibbs 1986). Indeed, when better able to recognize that coordinating would be difficult, partners select description strategies that successfully minimized their collective effort. Like adaptation in non-spatial perspective-taking, adaptation in spatial perspective-taking emerges from cognitive constraints acting on memory representations for shared experiences (e.g., Horton and Gerrig 2005; Metzing and Brennan 2003): when partner-specific information is available and relevant, it gets encoded in spatial memory.

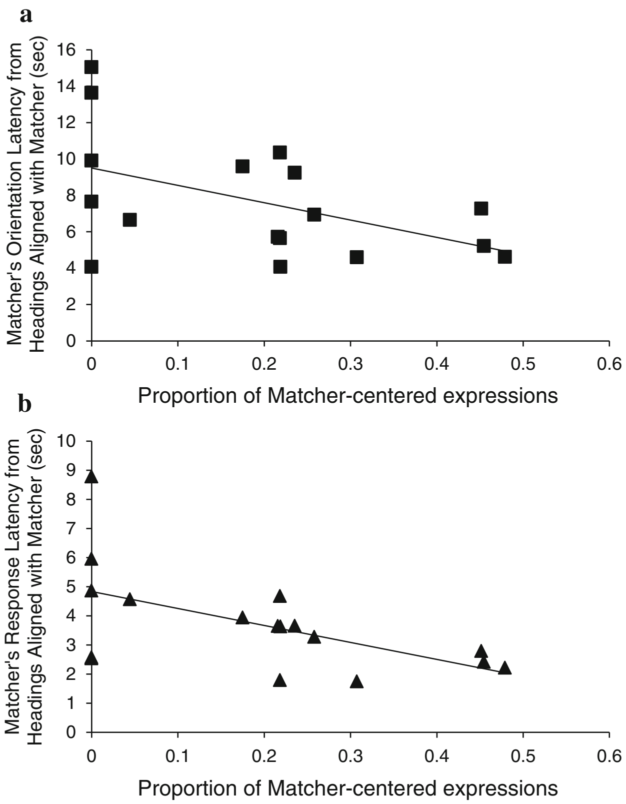

Fig. 1 The Matchers' mean orientation latencies (**a**) and response latencies (**b**) for trials that involved headings aligned with their own as a function of the proportion of Matcher-centered expressions in the Directors' descriptions. When partners knew each other's viewpoints in advance, the proportion of Matcher-centered expressions was negatively correlated with the Matcher's orientation latencies (Pearson's $r = -.49$, $p < .05$) and response latencies (Pearson's $r = -.55$, $p < .05$) from these headings

Overall, partners align their spatial memory contingently: one partner's viewpoint influences the other's memory representations and descriptions, which in turn influence the other's memory representations.

Acknowledgments This material is based upon work supported by the European Research Council under grant 206912-OSSMA to Marios Avraamides. We are grateful to Christina Michael and Chrystalleni Nicolaou for assistance with data collection and coding, and to Nathan Greenauer and Catherine Mello for assistance with data analysis and helpful discussions.

References

Brennan SE (2005) How conversation is shaped by visual and spoken evidence. In: Trueswell J, Tanenhaus M (eds) Approaches to studying world-situated language use: bridging the language-as-product and language-action traditions. MIT Press, Cambridge, pp 95–129

Clark HH, Wilkes-Gibbs D (1986) Referring as a collaborative process. Cognition 22:1–39

Duran ND, Dale R, Kreuz RJ (2011) Listeners invest in an assumed other's perspective despite cognitive cost. Cognition 121:22–40

Galati A, Avraamides MN (2012) Collaborating in spatial tasks: partners adapt the perspective of their descriptions, coordination strategies, and memory representations. In: Stachniss C, Schill K, Uttal D (eds) Lecture notes in artificial intelligence: spatial cognition, vol. 7463. Springer, Heidelberg, pp 182–195

Galati A, Michael C, Mello C, Greenauer NM, Avraamides MN (2013) The conversational partner's perspective affects spatial memory and descriptions. J Mem Lang 68:140–159

Horton WS, Gerrig RJ (2005) The impact of memory demands on audience design during language production. Cognition 96: 127–142

Metzing C, Brennan SE (2003) When conceptual pacts are broken: partner-specific effects in the comprehension of referring expressions. J Mem Lang 49:201–213