Running Head: Spatial and temporal language

On the experiential link between spatial and temporal language

Teenie Matlock, Michael Ramscar, and Lera Boroditsky

Department of Psychology, Stanford University

Contact information:

Teenie Matlock

Psychology Department, Jordan Hall

Stanford University

Stanford, CA 94305

Email: *tmatlock@psych.stanford.edu*

Keywords: metaphor, mental representation, semantics, spatial language, imagery

Abstract

How do we understand time and other entities we can neither touch nor see? One possibility is that we tap into our concrete, experiential knowledge, including our understanding of physical space and motion, to make sense of abstract domains such as time. To examine how pervasive an aspect of cognition this is, we investigated whether thought about a non-literal type of motion called *fictive motion* (as in *The road runs along the coast*) can influence thought about time. Our results suggest that fictive motion utilizes the same structures evoked in understanding literal motion, and that these literal aspects of fictive motion influence temporal reasoning.

1. Introduction

Language is full of references to abstract things. Whether we are musing on the passage of time, speculating on the motives of others, or hypothesizing about the behavior of subatomic particles, our everyday endeavors require us to conceptualize and talk about things we can neither see nor touch. One way that we do this is by analogically extending conceptual structure from richer, experience-based domains to structure our understanding of relatively more abstract domains (Boroditsky, 2000; Boroditsky & Ramscar, 2002; Clark, 1973; Gibbs, 1994; Lakoff & Johnson, 1980). This is apparent in everyday language, in which we use language about physical objects and actions to describe intangible, unperceivable things. For instance, when we talk about abstract things such as emotions, thought, and time, we often use motion verbs, as in *She runs hot and cold, I follow what you're saying,* and *Spring break is coming.* We do the same in talking about static spatial scenes, as in *The tattoo runs down his back, The fence follows the coastline,* and *The road comes all the way from El Portal*.

Experimental work supports the idea that experience in a physical domain can influence thought about abstract, non-physical concepts such as time. In a study by Boroditsky and Ramscar (2002), participants answered the ambiguous question in (1) after thinking about themselves or another entity moving through space.

(1) "Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?"

Participants' answers depended on how they conceptualized time. If they thought of themselves as moving forward (*ego-moving* perspective), then moving a meeting "forward" entailed moving it further along in their direction of motion—from Wednesday to Friday. If, however, they

thought of time as coming toward themselves (*time-moving* perspective), then moving a meeting "forward" meant moving it "closer" to themselves—from Wednesday to Monday (see Boroditsky, 2000; McGlone & Harding, 1998). In the task by Boroditsky and Ramscar (2002), participants were asked to imagine moving toward a stationary object or to imagine an object moving toward them. When they thought about themselves moving, they were more likely to respond "Friday" to the question in (1), but when they thought about something else moving, they were more likely to respond "Monday." No linguistic priming is necessary to get these effects. When the question was posed to people in airports, those who had just gotten off a plane were more likely to respond "Friday" than those who had been sitting around, waiting to pick somebody up (Boroditsky & Ramscar, 2002).

Results such as these suggest that the abstract domain of time (lacking any kind of inherent structure, invisible, intangible) borrows structure analogically from relatively more concrete, often physical, concepts. If so, what is the relationship between conceptual domains that borrow structure and those that lend structure? To date researchers have failed to find any effect from "borrower" to "lender" or among borrowers that share a lender. For example, in Boroditsky (2000), spatial primes influenced both ambiguous temporal questions and ambiguous spatial questions, but temporal primes only influenced ambiguous temporal questions (Figure 1). But did those differences stem from the intrinsic properties of the particular borrowing and lending domains (i.e., time, space), or from the intrinsic properties of the tasks? On re-examining Boroditsky's target tasks, we found that although unprimed participants were at chance in responding "Monday" or "Friday" to the ambiguous temporal question in (1), they overwhelmingly adopted a single interpretation of Boroditsky's ambiguous spatial question in Figure 1: Of 24 participants, 95.8% believed the largest of the objects was ahead.

This raises questions about how far we can generalize the relationships among borrowing and lending domains, such as time and motion (or space). Is there always a unidirectional relationship between these, namely, from lender to borrower (as evidenced by the way motion primes temporal "motion" but not vice versa)? Or is the failure to find priming from borrower to lender because the very "concreteness" of the more experiential-based lender domains makes them less ambiguous, and thereby more resistant to priming? Does the fact that time fails to prime space reveal a strictly unidirectional relationship between lending and borrowing domains? Or is it because borrowing domains are, by their very nature, ambiguous and more difficult to grasp, and that knowledge structures in these domains are more receptive to priming than similar, related structures associated with concrete domains?

One way to address these issues is to see whether there is priming between two domains that borrow structure from the same lender domain. As noted earlier, our concrete ideas about the motion of objects through space has been abstracted to allow us not only to structure our ideas about time, but to describe the positions of objects even in the absence of any real motion, as in *The tattoo runs along his spine* or *The road goes along the coast*. These non-literal, *fictive* uses of motion language are somewhat paradoxical because they include a motion verb (e.g., *go*) and a physical scene (*coast*), but involve no actual movement (no explicit mover and no state change) (Langacker, 2000; Talmy, 2000). Moreover, they have been shown to involve implicit mentally simulated motion, for instance, along the path described by the subject noun phrase (e.g., *road* in *The road goes along the coast*) (Matlock, in press), and to systematically evolve from literal uses, which *do* describe physical movement, as in *The bus goes along the coast* (Radden, 1996). This phenomenon allows us to pose an intriguing question: Can the structure borrowed from understanding actual motion that is used in understanding of fictive motion be

used to influence similar borrowed structures in the temporal domain, thereby affecting people's conceptions of time?

Both our understanding of time and our conception of fictive motion appear to borrow structure from literal motion. So will the representations used in comprehending fictive motion language affect conceptions of time? We conducted three experiments to examine this question. Experiment 1 investigated how fictive and non-fictive motion sentences would influence people's responses to the temporally ambiguous question in (1). Experiment 2 investigated whether various "magnitudes" of fictive motion would lead to different responses. Experiment 3 examined whether fictive motion involves some abstract amodal sense of motion, or some sense of directionality.

2. Experiment 1: Fictive motion and time

Does fictive motion use the same structures involved in thinking about actual motion? If so, it too should influence the way people think about time. In our task, participants read a fictive-motion sentence, such as *The road runs along the coast*, or a comparable no-motion sentence, such as *The road is next to the coast*; drew a picture to demonstrate understanding, and then answered the ambiguous question, "Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?"

2.1 Method

A total of 142 Stanford undergraduates participated for credit in a psychology course. They completed a questionnaire on a single page in a booklet containing a variety of unrelated materials. Participants first read these instructions, "In the space below, please sketch the image

conveyed to you by the following sentence." Then they read either a FM-sentence (fictive motion sentence) (e.g., *The tattoo runs along his spine*) or a non-FM-sentence (non-fictive motion sentence) (e.g., *The tattoo is next to this spine*), and drew a picture to represent what they imagined. Next, they went on to answer the ambiguous question, "Next Wednesday's meeting had been moved forward two days. What day is the meeting now that it has been rescheduled?" The drawing was included to make sure participants read and understood the sentence. This and the other experiments used sentences judged as semantically sensible by 12 Stanford undergraduates who rated sentences on a scale of 1 to 7, where 1 indicated "makes no sense" and 7, "makes total sense." The means were 6.59 for non-FM-sentences and 6.58 for FM-sentences. Table 1 displays the sentences along with their mean ratings.

2.2 Results and discussion

As predicted, responses to the ambiguous time question varied according to the type of sentences people read and depicted beforehand. FM-sentences led to more Fridays than Mondays, but non-FM-sentences yielded no difference, $\chi^2(1) = 6.05$, $p < 0.01$. Of the 74 participants with FM-sentences, 70% said the meeting was Friday, and 30% said Monday, and of the 65 participants with non-FM-sentences, 51% said Friday, and 49% said Monday. (See Figure 2 for examples of drawings.) Three participants' responses were not considered because they were neither Monday nor Friday.

The results of Experiment 1—in which participants' answers to the ambiguous question were strongly biased towards Friday after fictive motion primes but were at chance after no-motion primes—suggest that fictive motion can influence the way people think about time. Precisely, when people think about the fictive motion of, for example, a highway running along

the coast, they apply the same perspective to their conception of time in answering the ambiguous question. This encourages them to conceptually "move" forward in time and provide a Friday response.

3. Experiment 2: Fictive motion magnitude

Experiment 2 used the same procedure as Experiment 1, but employed fictive motion sentences that varied only on the number of scan points along a path (e.g., *Four versus Eight versus Twenty versus Over eighty pine trees run along the edge of the driveway*). Here we were interested in whether more scan points (trees) would lead to more Friday responses to the ambiguous time question. If fictive motion recruits conceptual structure from actual motion, including simulated motion or scanning along a path (see Matlock, in press; Talmy, 2000), more motion should be evoked with more scan points along a path. And with more motion, people should be more likely to adopt an ego-moving perspective when thinking about the ambiguous time question, and be more likely to provide a Friday response (versus Monday). This is exactly what we expected as the number of scan points increased from 4 to 8 to 20. However, we anticipated that the capacity to represent scan points could be finite. Accordingly, in keeping with the old saying about not seeing the forest for the trees, we predicted that if people were asked to represent an indeterminately large number of trees in conceptualizing the FM-sentence, such that they would tend to conceive of them as a group or cluster, then this representation would serve as a poor prime because it would incorporate too few scan points. Thus, we expected the effect might diminish as the number of trees increased to a large number such as 80.

3.1 Method

A total of 127 Stanford undergraduates participated for credit in a psychology course. The procedure was identical to Experiment 1, except participants read one of these sentences: *Four pine trees run along the edge of the driveway, Eight pine trees run along the edge of the driveway, Twenty pine trees run along the edge of the driveway, Over eighty pine trees run along the edge of the driveway.* Twelve other undergraduates rated the sentences as semantically sensible, with means of 5.5, 5.9, 5.8, and 5.7, respectively.

3.2 Results and discussion

Consistent with Experiment 1, FM-sentences promoted a forward, ego-moving perspective overall. Of 124 responses, 39% were Monday and 61% were Friday. But, as predicted, the effect varied according to number of scan points (i.e., trees) along the path (i.e., driveway), $\chi^2(3) = 7.14$, $p = .008$. As the number of trees rose from 4 to 8, 20, and 80, the number of participants who chose Friday was 55%, 80%, 61%, and 50%. (The other participants chose Monday.) These percentages are based on 35, 27, 32, and 30 participants. One incorrect response was discarded because the response was neither Monday nor Friday. Figure 3 shows examples of drawings.

Participants were more likely to say Friday with a "just-right" number of trees in the FM-sentence – 8 or 20 trees, but at chance with too few or too many – 4 or over 80 trees. This suggests that participants scanned along a set of points in reading and drawing the sentence, and that this influenced the way they conceptually "moved" through time when answering the ambiguous time question. When the number of points was conducive to scanning along a line of

trees (i.e., 8 or 20) in thinking about and depicting the FM-sentence, people were likely to adopt an ego-moving perspective, but when the number of points was not conducive to scanning (i.e., 4 or over 80), they were at chance.

4. Experiment 3: Fictive motion direction

So far, fictive motion appears to influence temporal understanding, but it is unclear whether it involves a diffuse (i.e., undirected) sense of motion or a defined (i.e., directed) sense of motion. Experiment 3 investigated whether fictive motion includes direction, a key conceptual property of actual motion (Miller & Johnson-Laird, 1976). The experiment had the same set-up as Experiment 1 and Experiment 2, but here we gave participants either an FM-sentence about a road that started at an unspecified location (default is Stanford because that is where participants did the task) and terminated at an explicitly stated distal location (New York), or a FM-sentence that started at the explicitly stated distal location and terminated at the unspecified location (Stanford), to see whether they would construct a representation in which they were either at the start or the end of a path. We expected that engaging in thought about a road "going" from Stanford to New York would encourage a Friday response, consistent with the ego-moving perspective in which individuals conceptualize themselves moving forward through time toward temporal landmarks (e.g., *We are quickly approaching the deadline, They reached their 50th anniversary*). This is analogous to the ego-moving perspective in actual motion, where when individuals conceptualize themselves moving through space, the "front" object is the one furthest away. In contrast, thinking about the road "coming" from New York should encourage a Monday response, consistent with a time-moving perspective, in which events, dates, or other temporal entities do the moving (*Our deadline is quickly approaching, Their 50th anniversary is coming*).

This is analogous to the object-moving perspective in actual motion, where when individuals conceptualize objects as moving towards them, the "front" object seems closest to them (see Boroditsky, 2000).

4.1 Method

Seventy-four Stanford undergraduates participated. The procedure was identical to Experiment 1, but participants read either an ego-moving FM sentence, *The road goes all the way to New York*, or an object-moving FM sentence, *The road comes all the way from New York*. Twelve other participants rated both sentences as sensible, with means of 6.9 and 6.6, respectively.

4.2 Results and discussion

As predicted, when people thought about fictive motion going away from them, they were more likely to provide a Friday response, and when they had thought about fictive motion coming toward them, they were more like to provide a Monday response. Of the 37 participants with ego-moving sentences, 62% responded with Friday, and 38% responded with Monday, and of the 34 participants with object-moving sentences, 68% responded with Monday, and 32% responded with Friday, $\chi^2(1) = 4.27$, $p = .038$. One response was discarded because the answer was neither Monday nor Friday.

The results suggest that when people thought about and depicted fictive motion away from themselves (Stanford) and toward some distal landmark (New York), they adopted an ego-moving perspective and conceptually "moved" in a forward direction through time. In contrast, when they thought about and depicted fictive motion starting at a distal landmark and coming

toward them (Stanford), they conceptualized time as "moving" toward them while they remained stationary. The results suggest that fictive motion, like actual motion, includes a defined sense of direction, and that it, too, is capable of influencing people's conceptions of time.

5. General Discussion

Three experiments showed that fictive motion influenced temporal understanding. In Experiment 1, our participants were more likely to conceptually "move" forward in answering an ambiguous question about time after reading and drawing spatial descriptions including fictive motion (versus other spatial descriptions without fictive motion). Their tendency to conceptually "move" forward with fictive motion was shown to be sensitive to certain factors, including number of scan points along path – few to many, as shown in Experiment 2 – and the direction of path – toward or away, as shown in Experiment 3.

Why did fictive motion have such a robust effect on how people thought about and responded to the ambiguous time question? One explanation is that fictive motion recruits structure from the conceptual domain of actual motion. That is, thinking about fictive motion encouraged our participants to adopt an ego-moving perspective and "move" forward through time (Experiments 1 and 2). This would also explain why people were more likely to conceptually move forward through time with path representations with an optimal number of scan points but not those with a suboptimal number of scan points (too few or two many) (Experiment 2), and why people were more likely to conceptually move forward through time with "going away" fictive motion paths but not "coming toward" fictive motion paths (Experiment 3). Another possibility, however, is that the motor actions involved in drawing contributed to different responses to the ambiguous question. Based on our data, we cannot rule

out this possibility because in all experiments all participants had to draw a picture. It seems unlikely, however, that drawing alone could have led to the effects we observed. In all cases, before participants even began drawing, they first had to read the ambiguous question, make sense of it , form a mental image, and then think about how to depict that image. Further research will examine the extent to which drawing may have contributed to how people responded to the ambiguous question. In the meantime, what is remarkable here is that experience with motion – thinking about fictive motion, drawing an external representation of fictive motion, or some combination of the two – consistently influenced the way time was understood.

Our results add to other results that show that experiential based domains, such as space and motion, can dramatically influence the understanding of time (Boroditsky, 2000; Boroditsky & Ramscar, 2002). The difference in this case is that there was never any mention or demonstration of explicit motion (e.g., nobody imagined being pulled in a chair, nobody got off a plane). Our results also shed light on how domains deriving structure from a single more experiential-based domain relate to each other. Specifically, it appears that one borrowing domain (time) can be susceptible to the influence of another borrowing domain (fictive motion) when those domains are linked through some experiential-based lending domain (actual motion). The results provide additional evidence that fictive motion involves mentally simulated motion (see Matlock, in press). This is especially apparent in Experiment 2, in which more scan points led to more Fridays (unless an adequate path representation could not be constructed, as with over 80 trees), and in Experiment 3, in which direction of fictive motion influenced participants' default perspective and reasoning about when an event would be held.

Acknowledgements

We thank Herbert Clark and Daniel Yarlett for providing many useful suggestions on earlier drafts of this paper, and Laura Nowell for assisting with data collection and analyses. A special thanks goes to the reviewers and action editor Jim Greeno.

References

Boroditsky, L. (2000). Metaphoric Structuring: Understanding time through spatial metaphors. *Cognition, 75(1*), 1-28.

Boroditsky, L., & Ramscar, M. (2002). The Roles of Body and Mind in Abstract Thought. *Psychological Science, 13(2),* 185-188.

Clark, H.H. (1973). Space, time, semantics, and the child. In T. E. Moore (Ed.), *Cognitive development and the acquisition of language*. San Diego: Academic Press.

Gibbs, R. W. (1994). *The poetics of mind: figurative thought, language, and understanding*. New York: Cambridge.

Lakoff, G., Johnson, M. (1980). *Metaphors we live by*. Chicago, IL: Chicago University Press.

Langacker, R.W. (2000). Virtual reality. *Studies in the Linguistic Sciences 29,* 77–103.

McGlone, M.S. & Harding, J.L. (1998). Back (or forward?) to the future: the role of perspective in temporal language comprehension. *Journal of Experimental Psychology: Learning Memory and Cognition, 24(5),* 1211-1223.

Matlock, T. (in press). Fictive motion as cognitive simulation. *Memory & Cognition*.

Miller, G. A., & Johnson-Laird, P.N. (1976). *Language and perception*. Cambridge, MA: Harvard University Press.

Radden, G. (1996). Motion metaphorized: The case of ‘coming’ and ‘going’. In E. Casad (Ed.), *Cognitive Linguistics in the Redwoods: The Expansion of a New Paradigm in Linguistics* (pp. 423–458). Berlin, New York: Mouton de Gruyter.

Talmy, L. (2000). *Towards a Cognitive Semantics, Volume I: Conceptual Structuring Systems*. Cambridge: MIT Press.

Table 1. Experiment 1. Fictive motion and non-motion sentences, along with average scores for semantic sensibility ratings. N = 12.

FM Sentences

6.9	*The bike path runs alongside the creek*
6.9	*The highway runs along the coast*
6.7	*The county line runs along the river*
6.6	*The tattoo runs along his spine*
5.8	*The bookcase runs from the fireplace to the door*

non-FM Sentences

7	*The bike path is next to the creek*
6.6	*The highway is next to the coast*
6.5	*The county line is the river*
6.1	*The tattoo is next to his spine*
6.8	*The bookcase is between the fireplace and the door*

Figure 1.

The “ambiguous” spatial target from Boroditsky (2000)

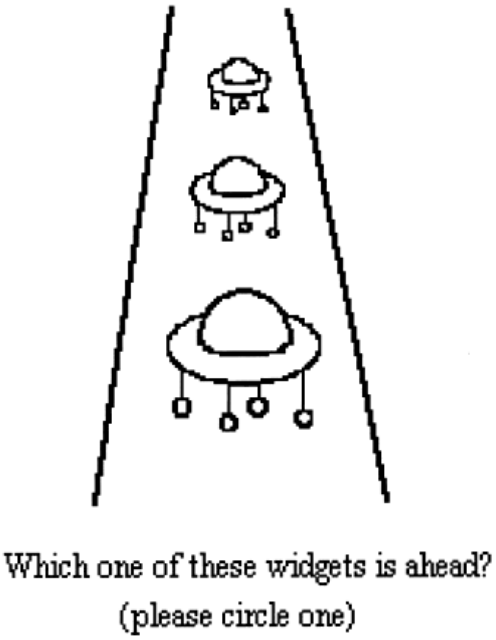
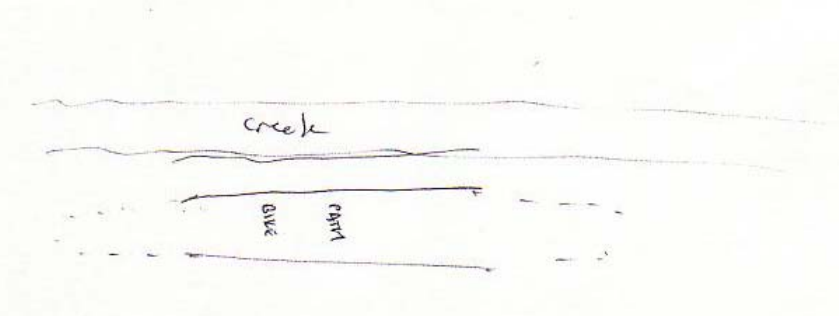


Figure 2.

Examples of drawings with non-FM-sentences and FM-sentences from Experiment 1.

(1) Non-fictive motion: *The bike path is next to the creek*



(2) Fictive motion: *The bike path runs alongside the creek*

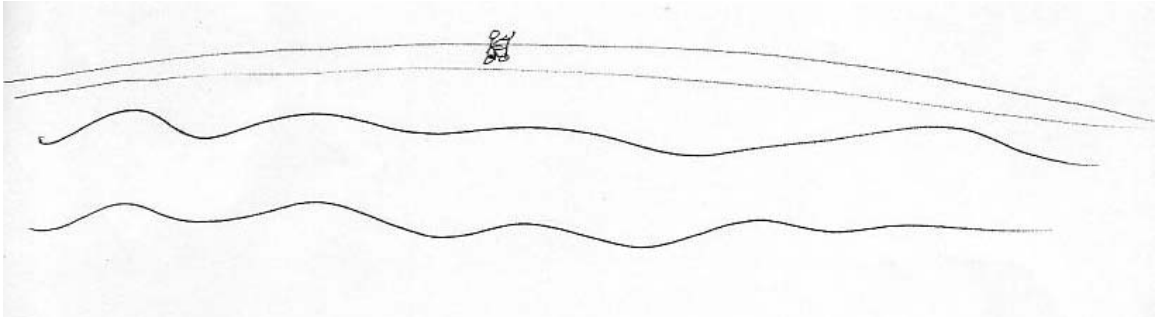
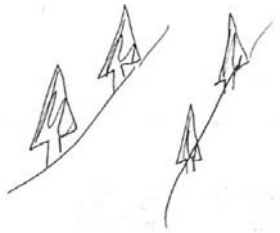


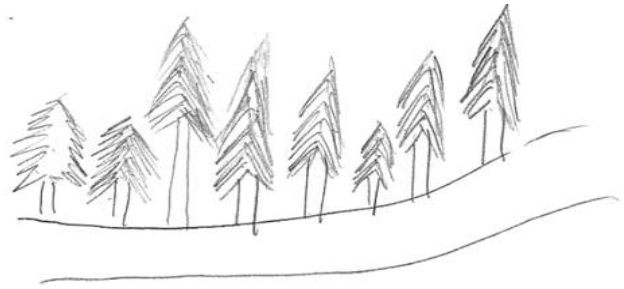
Figure 3.

Examples of drawings in Experiment 2.

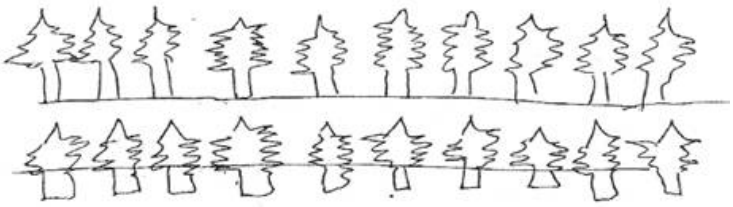
Four pine trees run along the edge of the driveway



Eight pine trees run along the edge of the driveway



Twenty pine trees run along the edge of the driveway



Over eighty pine trees run along the edge of the driveway