The experiential basis of meaning

Teenie Matlock (tmatlock@psych.stanford.edu)
Department of Psychology, Stanford University
Stanford, CA 94305 USA

Michael Ramscar (michael@psych.stanford.edu)
Department of Psychology, Stanford University
Stanford, CA 94305 USA

Lera Boroditsky (lera@mit.edu)
Department of Brain and Cognitive Sciences, MIT
Cambridge, MA 02139-4307 USA

Abstract

How are abstract ideas acquired and structured? One idea is that people's understanding of abstract domains is constructed using more basic, experiential knowledge that is acquired directly. For instance, a series of studies (Boroditsky 2000, Boroditsky & Ramscar, 2002) has shown that people's understanding of time supervenes on their physical conceptions of space, to the extent that manipulations of people's spatial knowledge have predictable affects on their temporal reasoning. In this paper we explore just how widespread this phenomenon is. To see whether basing abstract knowledge on concrete knowledge is a pervasive aspect of cognition, we investigate whether thought about an abstract, non-literal type of motion called *fictive motion* (Matlock, 2003a; Talmy, 1996) can influence the way people understand time. Our results suggest that, contrary to previous claims (Jackendoff, 2002), abstract, metaphorical knowledge about motion involves the same structures used in understanding literal motion, and that the activation of these "literal" aspects of fictive motion serve to influence temporal reasoning. The results provide further evidence of the intimate connection between abstract and concrete knowledge.

Introduction

How are we able to think about things that we've never been able to see or touch? Be it theorizing about invisible forces, reasoning about the behaviors of atoms, or attempting to characterize the nature of private mental experience, much scientific progress depends on finding ways to conceptualize and describe imperceptible phenomena. We face the same problems in our everyday thoughts about time, justice, and love, and other relatively abstract domains. How is it that we are so good at reasoning about and representing abstract domains despite the dearth of sensory information available to us?

One suggestion is that abstract domains are understood through analogical extensions from richer, more experience-based domains, about which knowledge is acquired directly (Boroditsky & Ramscar, 2002; Gentner, Imai & Boroditsky, in press; Gibbs, 1994; Holyoak & Thagard, 1995; Lakoff & Johnson, 1980, 1999). For instance, a series of studies (Boroditsky 2000; Boroditsky & Ramscar, 2002) have shown that people's understanding of time supervenes on their physical conceptions of space, to the extent that manipulations of their spatial knowledge have predictable affects on their temporal reasoning. In these studies, participants were asked the ambiguous question shown in (1) while engaging in spatial thought.

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

The answer to this question depends on how individuals choose to think about time. If they think of themselves as moving forward through time (ego-moving perspective), then moving a meeting "forward" is moving it further in their direction of motion—that is, from Wednesday to Friday. If, however, they think of time as coming toward them (time-moving perspective), then moving a meeting "forward" is moving it closer to themselves —that is, from Wednesday to Monday (Boroditsky, 2000; McGlone & Harding, 1998; McTaggart, 1908). Most people have strong intuitions about which answer to this question is correct. As will become clear in this paper, the question is indeed ambiguous and intuitions about the answers can change dramatically depending on context (though their feelings of certainty towards their answers generally remain intact). In a neutral context, people are equally likely to think of themselves as moving through time as they are to think of time as coming toward them, and so are equally likely to say that the meeting has been moved to Friday (ego-moving answer) as to Monday (time-moving answer) (Boroditsky, 2000; McGlone & Harding, 1998).

The way in which the ambiguous question can reveal the intimate relationship between space and time is illustrated in a study by Boroditsky and Ramscar (2002), in which people imagined being in one of two conditions. In the ego-moving condition, people imagined sitting in a chair while moving toward a specific point. In the time-moving condition, people imagined standing at a specific point while pulling a chair (attached to a rope) toward them. The results showed that people's responses were influenced by whether they had imagined moving toward something or imagined something move toward them. People were more likely to say "Friday" after imagining themselves moving, and "Monday" after imagining the chair moving toward them.

In another study, Boroditsky and Ramscar (2002) had people answer the ambiguous question in (1) in an airport. If people had just flown in and gotten off a plane, they were more likely to take an ego-moving perspective than people who were sitting in the airport waiting to pick somebody up. A further study posed the ambiguous question to people on a train. If people were at the beginning or end of a journey (highlighting the awareness of travel), they were more like to take an ego-moving perspective than if they were in the middle of a trip. Finally, Boroditsky and Ramscar (2002) asked the same question of people standing in a long lunch-line. In this case, individuals at the front of the line (closer to the goal) were more likely to respond in a way that was consistent with an ego-moving perspective than individuals at the back of the line.

Taken together, the results of Boroditsky and Ramscar (2002) demonstrate the intimate relationship between abstract thinking and more experience-based forms of knowledge. Specifically, people's understanding of time is closely linked to their thoughts about and experiences with physical space. When people engage in particular types of spatial thinking (e.g., thinking about a journey on a plane or train, or standing in a lunch-line), they also unwittingly and dramatically change how they think about time. Further, Ramscar and Boroditsky's findings demonstrate that actual spatial motion is neither necessary nor sufficient to influence people's thinking about time. People merely traveling on a train were at chance in their answers to the ambiguous question, whereas people who had cause to *think* about their journeys–either because they were about to depart or arrive–showed significant space-to- time transfer. Thus, it appears that *thinking about* spatial motion is what underlies thought about time, and that, as shown by Ramscar and Boroditsky, thought about abstract domains is built on mental representations of more experience-based domains functionally separable from those directly involved in sensorimotor experience (see also Boroditsky, 2000).

Boroditsky and Ramscar's findings suggest that the representations underpinning abstract thought supervene on representations underpinning basic experiential concepts, such as space and motion. But how widespread is this phenomenon? Does it apply to all abstract thought? Or is it specific to concepts of space and time?

One might be tempted to generalize, and assume that the meaning (and therefore underlying representation) of all non-literal motion is linked to the representational structures underlying the understanding of actual motion. But this is by no means an obvious or even a motivated connection. For instance, what sort of representation is activated when people try to make sense of *fictive motion* sentences (discussed in detail in next section), such as *The tattoo runs along his spine* or *The road goes along the coast*? The underlying representations of these sentences has been argued by Talmy (1996) and other cognitive linguists to be temporal, dynamic, and similar to those of actual motion (e.g., *The bus goes along the coast*). At first, this might seem counterintuitive, especially given that in the real world, tattoos are incapable of moving independently of the skin upon which they are inked, and roads incapable of getting up and leaving the ground upon which they were laid. Thus, it seems reasonable to argue that the representations underlying the understanding of tattoos running along spines and roads running along coasts cannot be the same as those that underly the understanding of situations in which mobile agents, such as people, vehicles, and so on move. This is exactly the position taken by Jackendoff (2002). For Jackendoff, the representation underlying a sentence such as *The tattoo runs along his spine* is static and atemporal, in contrast to representations underlying sentences that describe actual motion, which are dynamic and temporal. On this view, such sentences involve simultaneous activation of all points along a path or figure (e.g., *tattoo*, *road*).

Before discussing a study aimed at determining whether there is indeed "motion" in fictive motion, some background on motion verbs is in order.

Actual motion and fictive motion

Actual motion verbs such as *go* and *run* describe situations in which an animate agent moves from one location in physical space to another, as in *Julio runs from Cardiff to Solana Beach* or *The train goes up the hill*. Implicit in such literal uses of motion verbs is a noticeable state change, the passage of time, and a path connecting starting point and end point (Talmy, 1975; Miller & Johnson-Laird, 1976).

Motion verbs can also describe situations with no observable physical motion. For instance, motion verbs often specify a state change, as in *She went from beer to vodka* and *His argument ran all over the place*, or a temporal shift, as in *Christmas went by quickly this year* and *Have we passed Christmas yet*? Such metaphorical extensions of motion verbs are not limited to English and do not evolve in a random fashion. They occur in language after language and show consistent, parallel diachronic developments, even in unrelated languages (Radden, 1996, 1997; Sweetser, 1990). Metaphorically extended motion verbs also occupy a prominent place in the core vocabulary of every language (Miller & Johnson-Laird, 1976). The ubiquity and regularity of these uses of motion verbs has been attributed to people's natural tendency to draw on their experience with space and other basic experiential domains when thinking about abstract concepts such as time (Clark, 1973; Gibbs, 1994; Lakoff & Johnson, 1980).

Non-literal uses of motion verbs also describe spatial scenes lacking both motion *and* state change, as in *The tattoo runs along his spine* and *The road goes past several alpine lakes*. With these metaphoric extensions, which Talmy (2000) refers to as *fictive motion*, a figure (e.g., *tattoo, road*) is conceptualized relative to a landmark (e.g., *spine*) or set of landmarks (e.g., *alpine lakes*) in a stationary scene. According to Talmy and other cognitive linguists, understanding sentences such as *The tattoo runs along his spine*, requires "moving" or "scanning" from one part of a scene to another, most notably, along the figure (e.g., spine, road). On this view, this type of dynamic imagery enables or facilitates spatial computation about the placement and alignment of objects, for instance, a tattoo relative to a spine, a road relative to a series of alpine lakes (see also Talmy, 1983, 1996; Langacker, 1986, 2000; Matsumoto, 1996; Matlock, in press b). (Our study focuses on only one type of fictive motion schema, Talmy's *co-extension path*.)

Recent experimental work provides evidence for the idea that understanding fictive motion involves simulated motion. Matlock (2003a) had people read a fictive motion sentence (hereafter, FM-sentence), such as *The trail goes through the desert*, in the context of a story about a protagonist traveling through a spatial region (e.g., desert). In reading the FM-sentence, people had to make a speeded decision about whether it related to the story. To make this decision, people had to think about the travel as it was described in the story, for instance, how fast the person was going, what obstacles they encountered, and so on. The results show that processing information about fast travel made for quicker FM-sentence reading times than did processing information about slow travel. Similar results were found for reading about traveling a short distance (versus long distance) and for reading about travel through an uncluttered terrain (versus cluttered terrain). Together, the results suggest that the way people understand space and motion influences the way they understand fictive motion language. Namely, they simulate movement along a path or scanning along a trajectory.

Other experimental results further support the idea that fictive motion involves simulation. Matlock (in press a) had people think about and draw pictures to represent scenes for FM-sentences, such as *The road goes along the coast,* and comparable (at least on the surface) NFM-sentences (non-fictive motion sentences), such as *The road is next to the coast*. People generally drew longer figures (e.g., road) to depict their understanding of FM-sentences than they did for NFM-sentences. The difference did not simply arise with traversable paths or objects metonymically associated with motion (i.e., roads are associated with motion). People also tended to draw longer figures (lakes) for FM-sentences such as *The lake runs between the golf course and the railroad tracks* than they did for comparable NFM-sentences such as *The lake is between the golf course and the railroad tracks*. In addition, people drew longer lines to represent roads in FM-sentences with fast-manner verbs such as *jet*, as in *The road jets through the city,* than with slow-manner verbs, such as *creep*, as in *The road creeps through the city*. The same trend was observed for actual motion sentences, such as *The bus jets through the city* and *The bus crawls through the city*, suggesting that fictive motion construal and actual motion construal are similar (see also Matlock, 2003b).

Together, these findings suggest that people's experience with space, including knowing how things move and how terrain impedes or facilitates motion, influences their understanding of stationary spatial scenes as described by FM-sentences. However, it is not obvious from these findings alone whether there is an actual "motion" component to the representations underlying fictive motion.

To determine whether engaging in fictive motion processing involves using the structures involved in processing actual motion, the following experiment examined whether engaging in thinking involving fictive motion would influence people's understanding of time. Specifically, will thinking about and drawing a picture to represent the meaning of an FM-sentence, such as *The road goes along the coast,* influence the way people answer the ambiguous question about the Wednesday meeting that had "been moved forward two days" (shown in (1))?

Experiment

The following study investigated the possibility that engaging in thought about fictive motion could influence people's reasoning about time. Participants were asked to (a) to read a fictive-motion sentence (e.g., *The road runs along the coast*) or a non-fictive motion sentence (e.g., *The road is next to the coast*), (b) sketch what they imagined, and (c) then answer the ambiguous question, "Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?"

As mentioned, answers to this question were split evenly between Monday and Friday when people were not engaged in spatial reasoning per se. However, if participants were thinking about themselves moving, or about people or objects moving through space towards a distant goal, they tended to adopt the perspective of the moving person or object and were significantly more likely to answer Friday (Boroditsky 2000; Boroditsky & Ramscar 2002).

We predicted that if people interpreted a fictive motion sentence in terms of actual motion involving the figure (referred to by the subject noun phrase, for instance, tattoo, in *The tattoo runs along his spine*), they would be more likely to answer "Friday" to the ambiguous question. Thus people who have processed a fictive motion sentence ought to be more likely to "move" forward in time when asked an ambiguous question about "moving" a meeting date than those who have processed a non-fictive motion sentence (e.g., *The road is next to the coast*).

Participants

One hundred thirty-nine Stanford University psychology students participated in return for course credit.

Method and materials

The study materials comprised a one-page questionnaire that was completed as part of a packet of unrelated materials. The questionnaire contained three apparently unrelated questions. The first asked, "In the space below, please sketch the image conveyed to you by the following sentence." Immediately below that was a fictive motion (FM) sentence (e.g., *The tattoo runs along his spine*) or a no –motion (NFM) sentence (e.g., *The tattoo is next to his spine*), and below that, a blank space 4.5 (height) inches by 11 (length) inches in which the participant was to draw the image. Table 1 shows the complete list of these stimuli. The second question was the ambiguous question, "Next Wednesday's meeting had been moved forward two days. What day is the meeting not that it has been rescheduled?" Each participant was given only a single page (i.e., each read a single FM- or NFM-sentence, drew a single picture, and responded only once to the ambiguous question).

The final question was a filler question related to the origins of denominal verbs.

Table 1: Fictive motion and non-motion stimuli

FM Sentences

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

NFM Sentences

The bike path is next to the creek
The highway is next to the coast
The county line is the river
The tattoo is next to his spine
The bookcase is between the fireplace and the door

Results

The task provided two sources of data for analysis, both the participants' answers to the ambiguous question, and also the pictures that were drawn to illustrate the prime sentences.

Question data. As predicted, the way people thought about time while processing a fictive motion or a non-fictive motion sentence influenced their reasoning about time (see Figure 1). In particular, participants were more likely to respond with "Friday" (ego-moving) to the question about when the meeting was than with "Monday" (time-moving) after fictive motion thinking than after non-fictive motion thinking. Of the participants primed with fictive motion, 70% indicated that they thought the meeting was on Friday, and 30% thought it was on Monday. Of the participants not primed with fictive motion, 51% thought it was Friday, and 49% thought it was Monday ($\chi^2(1) = 5.56$, $p < 0.02$.)

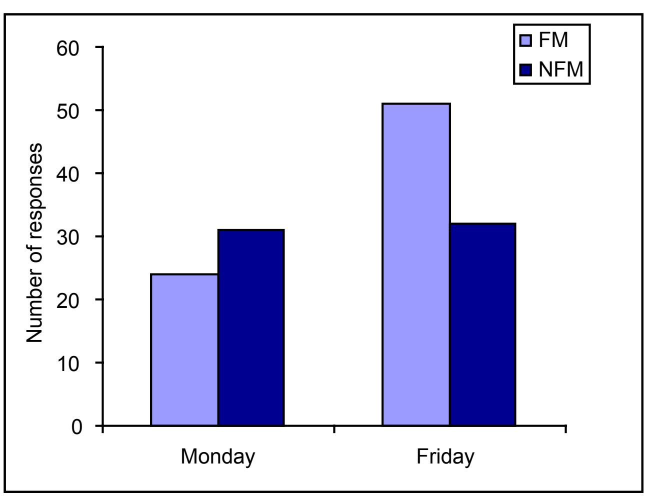

Figure1. Responses to the ambiguous question by condition.

Drawing data. We wanted to see if there would be any difference in length for the figures drawn in FM and NFM sketches. First, the absolute length of figures (e.g., tattoo, road) were measured in centimeters, as were the absolute widths of figures. (By "absolute" we mean length regardless of curves or undulations in shape.) Length scores for each figure were then calculated by dividing length by width.

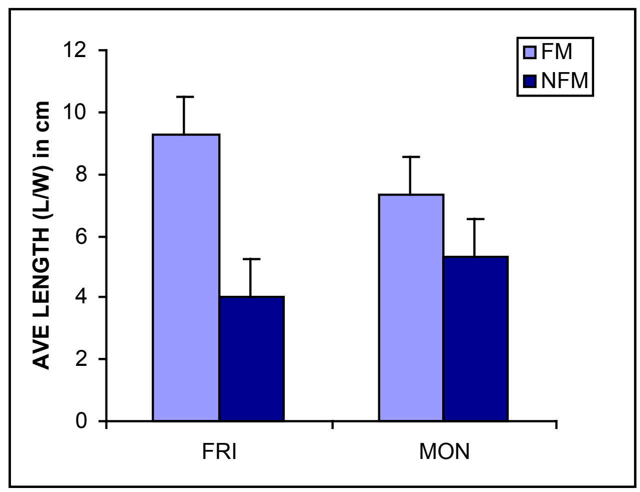

Figure 2. Mean length scores for figures in drawings.

Overall, people drew longer figures in depictions of FM-sentences (M = 8.30) than in depictions of NFM-sentences (M = 4.67), $t_{(9)} = 3.69$, $p < .005$, as shown in Figure 2. Interestingly, the effect size was much larger for people who went on to answer Friday to the ambiguous question (FM, M=9.3, NFM M=4.0; $t_{(4)} = 3.89$, $p < .01$) than for those who went on to answer Monday (FM, M=7.3, NFM M=5.3; $t_{(4)} = 1.82$, $p < .07$). Moreover, participants who answered Friday drew longer pictures after an FM prime than did those who answered Monday (FM-Friday, M=9.3, FM-Monday, M=7.3, $t_{(4)} = 2.06$, $p < .05$). Table 2 displays the mean figure lengths for all FM and NFM sentences. Figure 3 shows two sample drawings for *The* *tattoo runs along his spine* (FM) and *The tattoo is next to his spine* (NFM).

Table 2: Mean length score per prime sentence.

FM Sentences

12.56	The bike path runs alongside the creek
7.78	The highway runs along the coast
11.68	The county line runs along the river
8.4	The tattoo runs along his spine
2.77	The bookcase runs from the fireplace to the door

NFM Sentences

7.73	The bike path is next to the creek
6.21	The highway is next to the coast
4.81	The county line is the river
1.3	The tattoo is next to his spine
1.19	The bookcase is between the fireplace and the door

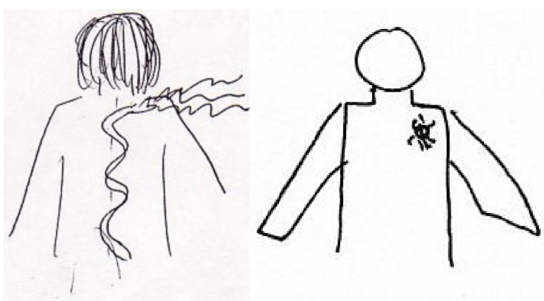

Figure 3. Examples of FM and NFM depictions. *The tattoo runs along his spine* (left) and *The tattoo is next to his spine* (right).

Discussion

Our results---in which participants' answers to the ambiguous question were at chance after non-fictive motion primes, but strongly biased towards Friday after fictive motion primes---indicate that thought about fictive motion does indeed influence the understanding of time. When people think about a spatial description involving fictive motion, they subsequently apply the same motion perspective to thinking about time. In this case, they adopt the perspective of the subject of the fictive motion sentence moving through space, and accordingly activate an ego-moving temporal schema that in turn produces a Friday answer to the ambiguous question. When people think about a spatial description without fictive motion, which does not relate to a particular a motion schema, their temporal thinking is unaffected (as there is nothing in such a static spatial description to influence it). Thus, in answering an ambiguous question about time, responses are at chance.

Further support comes from considering the drawing data and question data together. The drawing results are consistent with earlier results (Matlock, in press b). Namely, when people draw pictures to depict the meaning of spatial sentences, they draw longer figures with fictive motion sentences than with comparable non-motion sentences (even when chance is factored into the analysis). This reflects a natural tendency to simulate motion or scanning as people build up a mental representation. Moreover, if we take these drawings as providing insight into the *level* of activation of actual motion structures resulting from fictive motion comprehension, then what is interesting is that although our participants drew longer figures after fictive motion primes as compared to non-motion primes *irrespective* of how they answered the ambiguous question, those participants who went on to answer Friday to the ambiguous question showed more activation (revealed by significantly longer figures in their bdrawings) than did those who went on to answer Monday. Consistent with the priming hypothesis put forward by Boroditsky (2000; Boroditsky & Ramscar, 2002) it appears that while the fictive motion sentences always succeeded in priming actual motion, as the activation of the actual motion structures that this priming produced increased (as evidenced by the drawings) so too did the likelihood that spatial structures would subsequently be activated.

Thus, these results are consistent with Borodistky and Ramscar's (2002) finding that the representations that give rise to abstract thinking are directly related to the experience-based representations from which they recruit their structure.

General Discussion

Since the structures that underpin our systems of temporal knowledge are explicitly construed in terms of motion, it seems that the only way that fictive motion thought could influence the motion perspective that underpins a particular way of thinking about time is if fictive motion thinking served to activate a representation of the same motion perspective. That is, understanding fictive motion appears to activate a motion schema in which "forward" movement is conceptualized along a path or trajector, which has in turn activated the analogous temporal motion schema.

As discussed, it is not obvious that thinking about fictive motion *should* involve any representation of actual motion. Indeed, it has been argued that it does not. Because the entities that the subject-noun phrases of fictive motion sentences refer to do not *actually* move, it is plausible to suppose that the representations underlying the understanding of expressions of fictive motion are fundamentally different from those supporting understanding of actual motion (which unlike the representations associated with fictive motion, *do* actually represent movement).

Based on the evidence presented here, however, it appears that language theories that appeal to the notion of dynamic representation or mentally simulated action (e.g., Talmy, 2000) can better account for fictive motion than can theories that advocate a purely static representation (e.g., Jackendoff, 2002). Our results indicate that some sort of dynamic imagery is invoked when people process sentences such as *The tattoo runs along his spine* or *The highway runs along the coast*. Were this not the case, it is unlikely that we would have seen the effects on people's representations of time in response to fictive motion primes that we did.

Metaphors enable people to take knowledge from more experienced-based domains, such as actual motion through space, to talk about more abstract domains, such as time and the abstract spatial information described using fictive motion. Consistent with this idea, the results reported here suggest that people's representations of both time and fictive motion both share a common base and ancestor: actual motion. As is usually the case when metaphors go beyond what can be observed in experience, these abstract ideas make use of the structures involved in talking about the concrete domain, suggesting that some abstract knowledge can be constructed and shaped by language (Boroditsky, 2001). All this makes the task of characterizing abstract thought even more of a challenge. The evidence suggests any such characterization will have to take in not only what comes from innate wiring and physical experience, but also the ways in which languages and cultures have allowed us to go beyond these to make ourselves us smart and sophisticated as we are.

References

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

Boroditsky, L. (2001). Does language shape thought? English and Mandarin speakers' conceptions of time. Cognitive Psychology, 43(1), 1-22.

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.

Gentner, D., Imai, M., & Boroditsky, L. (2002). As time goes by: Evidence for two systems in processing space time metaphors. *Language and cognitive processes, 17(5),* Oct 2002, 537-565.

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

Holyoak, K.J. & Thagard, P. (1995). *Mental leaps: Analogy in creative thought.* Cambridge, The MIT Press.

Jackendoff, R (2002). *Foundations of language.* New York: Oxford University Press.

Lakoff, G. (1986). *Women, fire, and dangerous things: What categories reveal about the mind. Chicago, IL: University of Chicago Press.*

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

Lakoff, G., Johnson, M. (1999*). Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought*. New York, NY: Basic Books.

Langacker, R.W. (1986). Absract motion. *Proceedings of the Twelfth Annual Meeting of the Berkeley Linguistics Society,* 455–471.

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. (2003a). Fictive motion as cognitive simulation. Journal submission under review.

Matlock, T. (2003b). Looking at fictive motion. Eighth Annual International Cognitive Linguistics Conference. University of La Rioja, Spain.

Matlock, T. (in press a). The conceptual motivation of fictive motion. In G. Radden and R. Dirven (Eds.), *Motivation in grammar*. Amsterdam: John H. Benjamins.

Matlock, T. (in press b). Depicting fictive motion in drawings. In J. Luchenbroers, (Ed.), *Cognitive Linguistics: Investigations across languages, fields, and philosophical boundaries.* Amsterdam: Benjamins.

Matsumoto, Y. (1996). Subjective motion and English and Japanese verbs. *Cognitive Linguistics, 7*, 183-226.

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.

Radden, G. (1997). Time is space. In: B. Smieja and M. Tasch (Eds.), *Human Contact through Language and Linguistics* (pp. 147–66). New York, NY: P. Lang.

Sweetser, E.E. (1990). *From etymology to pragmatics: The mind-as-body metaphor in semantic structure and semantic change.* Cambridge: Cambridge University Press.

Talmy, L. (1975). Semantics and syntax of motion. In J. P. Kimball (Ed.), *Syntax and Semantics*, Volume 4 (pp.181–238). New York, NY: Academic Press.

Talmy, L. (1983). How language structures space. In H. Pick, & L.P. Acredolo (Eds.), *Spatial orientation: Theory, research, and application* (pp. 225-282). New York: Plenum Press.

Talmy, L. (1996). Fictive motion in language and "ception". In P. Bloom, M.A. Peterson, L. Nadel, & M.F. Garrett (Eds.), *Language and space* (pp. 211-276). Cambridge, MA: MIT Press.

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