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Time, Motion, and Meaning: The Experiential Basis of Abstract Thought

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In our everyday language, we often talk about things we can neither see nor touch. Whether musing on the passage of time, speculating on the motives of others, or discussing the behavior of subatomic particles, people's endeavors constantly require them to conceptualize and describe things that they cannot directly perceive or manipulate. This raises a question: how are we able to acquire and organize knowledge about things in the world to which we have no direct access in the first place? One answer to this conundrum is to suppose that abstract domains may be understood through analogical extensions from richer, more experience-based domains (Boroditsky & Ramscar 2002; Boroditsky 2000; Clark 1973; Gibbs 1994; Lakoff & Johnson 1980). Supporting evidence for this proposal can be seen in the way people talk about concrete and abstract domains. Everyday language is replete with both literal and metaphorical language that follows this broad pattern. Take, for instance, motion language. In its literal uses, it is descriptive of paths and trajectories of objects, as in 'Bus 41 *goes* across town', 'A deer *ran* down the trail', and 'The boys *raced* up the stairs'. In its metaphoric uses, which are pervasive in everyday speech, motion language is descriptive of emotions, thought, time, and other abstract domains, as in 'He *runs* hot and cold', 'My thoughts were *racing*', and 'Spring break *came* late'. Similarly, representational structure from the domain of object motion appear to be borrowed to organize our ideas about space, including static scenes, as in 'The trail *goes* through town', 'The fence *follows* the river', or 'The tattoo *runs* down his back'.

The hypothesis that the structure of abstract knowledge is experience-based can be formulated in several strengths. A strong 'embodied' formulation might

be that knowledge of abstract domains is tied directly to the body such that abstract notions are understood directly through image schemas and motor schemas (Lakoff & Johnson 1999). A milder view might be that abstract knowledge is based on representations of more experience-based domains that are functionally separable from those directly involved in sensorimotor experience.

In this chapter we review a number of studies that indicate that people's understanding of the abstract domain of time supervenes on their more concrete knowledge and experience of the motion of objects in space. First, we show that people's representations of time are so intimately dependent on real motion through space that when people engage in particular types of thinking about things moving through space (e.g. embarking on a train journey, or urging on a horse in a race), they unwittingly also change how they think about time. Second, and contrary to the very strong embodied view, we show that abstract thinking is more closely linked to *representations* of more experience-based domains than it is to the physical experience itself.

Following from this, we explore the extent to which basing abstract knowledge on more concrete knowledge is a pervasive aspect of cognition, examining whether thought about one abstract, non-literal type of motion called 'fictive motion' can influence the way people reason about another, more abstract concept, time. Once again, our results suggest that metaphorical knowledge about motion appears to utilize the same structures that are used in understanding literal motion. Further, it appears that the activation of these 'literal' aspects of fictive motion serve to influence temporal reasoning. The results we describe provide striking evidence of the intimate connections between our abstract ideas and the more concrete, experiential knowledge on which they are based.

4.1 Representations of space and time

Suppose you are told that 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 you choose to think about time. If you think of yourself as moving forward through time (the ego-moving perspective), then moving a meeting 'forward' is moving it further in your direction of motion—that is, from Wednesday to Friday. If, on the other hand, you think of time as coming toward you (the time-moving perspective), then moving a meeting 'forward' is moving it closer to you—that is, from Wednesday to Monday (Boroditsky 2000; McGlone & Harding 1998; McTaggart 1908). In a neutral context, people are about 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 (the ego-moving answer) as to Monday (the time-moving answer) (Boroditsky 2000; McGlone & Harding 1998).

But where do these representations of time come from? Is thinking about moving through time based on our more concrete experiences of moving through space? If representations of time are indeed built on representations of space, then activating different types of spatial representation should influence how people think about time.

To investigate the relationship between spatial experience and people's thinking about time, Boroditsky & Ramscar (2002) asked 333 visitors to San Francisco International Airport the ambiguous question about Wednesday's meeting described above. After the participants answered, they were asked whether they were waiting for someone to arrive, waiting to depart, or had just flown in. Two questions were of interest: (1) whether a recent, lengthy experience of moving through space would make people more likely to take the ego-moving perspective on time (think of themselves as moving through time as opposed to thinking of time as coming toward them), and (2) whether this effect required the actual experience of motion, or if just thinking about motion was enough.

As shown in Figure 4.1, people who had just flown in were much more likely to take the ego-moving perspective (think of themselves as moving through time and answer 'Friday') (76%) than people who were just waiting

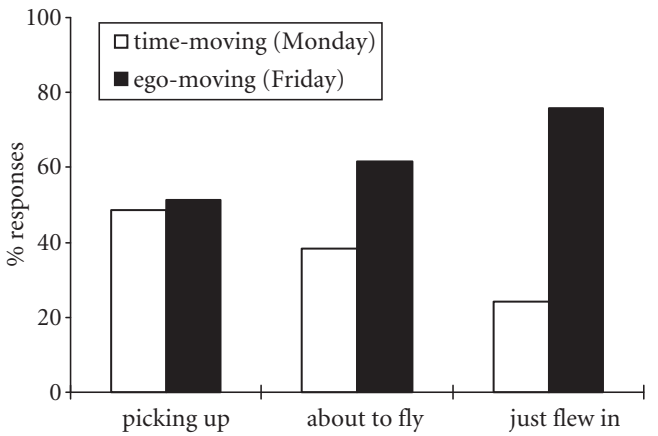


FIGURE 4.1. Responses of 333 people queried at the airport. People who had just flown in were most likely to produce an ego-moving response (say that next Wednesday's meeting had been 'moved forward' to Friday).

for someone to arrive (51%). Further, even people who had not yet flown, but were only waiting to depart were already more likely to think of themselves as moving through time (62%) (Boroditsky & Ramscar 2002). This set of findings suggests that (1) people's ideas about time are indeed intimately related to their representations of space, and (2) just thinking about spatial motion is sufficient to change one's thinking about time. But this also raises an interesting question: why were people who had just flown in more likely to take an ego-moving perspective than people who were only about to depart? Was it because they had spent more time actually moving through space, or was it just because they had had more time to think about it?

To investigate this question, Boroditsky & Ramscar (2002) posed the ambiguous question about Wednesday's meeting to 219 patrons of CalTrain (a commuter train line connecting San Francisco and San Jose). Of these, 101 were people waiting for the train, and 118 were passengers actually on the train. All of them were seated at the time that they were approached by the experimenter. After participants answered the question, they were asked how long they had been waiting for (or been on) the train, and how much further they had to go.

It turned out that both people waiting for the train and people actually riding on the train were more likely to take the ego-moving perspective (63%) than the time-moving perspective (37%). Interestingly, the data from people waiting for the train looked no different from those of people actually on the

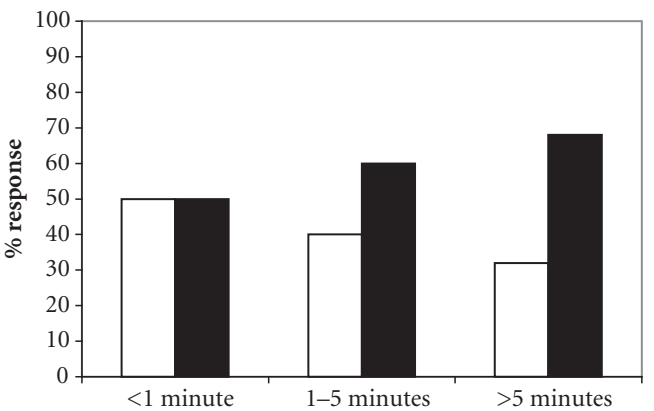


FIGURE 4.2. Responses of 101 people waiting for the train plotted by time spent waiting. The more time people had to anticipate their journey, the more likely they became to adopt the ego-moving perspective on time (say that next Wednesday's meeting has been 'moved forward' to Friday).

train (61% and 64% ego-moving response respectively), suggesting that it is not the experience of spatial motion *per se*, but rather thinking about spatial motion that underlies our representation of time.

Boroditsky & Ramscar (2002) then examined people's responses on the basis of how long they had been waiting for the train (see Figure 4.2). The longer people sat around thinking about their journey, the more likely they were to take the ego-moving perspective for time. People who had waited less than a minute were equally as likely to think of themselves as moving through time as they were to think of time as coming toward them. People who had had five minutes of anticipating their journey were much more likely to take the ego-moving perspective on time (68%) when compared to people waiting less than a minute (50%).

Finally, the responses of people on the train were analyzed on the basis of whether they had answered the ambiguous time question at the beginning, middle, or end of their journey. The conjecture was that people should be most involved in thinking about their journey when they had just boarded the

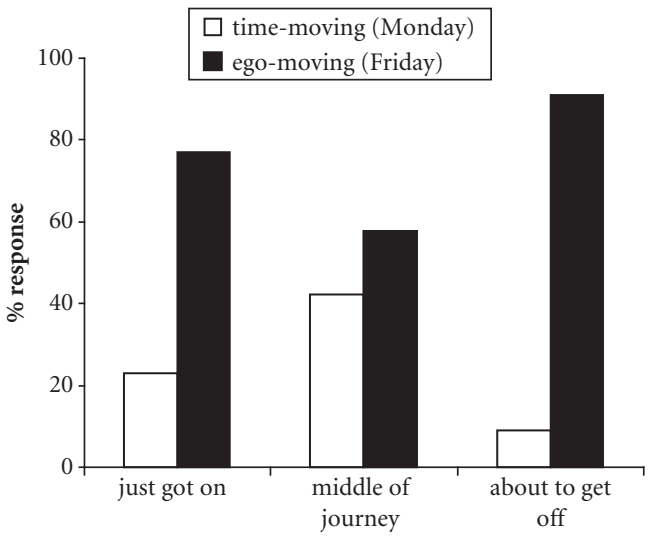


FIGURE 4.3. Responses of 118 passengers on the train plotted by point in journey. People became much more likely to adopt the ego-moving perspective for time (say that next Wednesday's meeting has been 'moved forward' to Friday) when they were most engaged in thinking about their spatial journey (at the beginnings and ends of the trip). In the middle of their journey, people were about equally likely to adopt the ego-moving perspective (say the meeting has been 'moved forward' to Friday) as the time-moving perspective (say the meeting has been 'moved forward' to Monday).

train, or when they were getting close to their destination. In the middle of their journey, people tend to relax, read, talk loudly on cellphones, and otherwise mentally disengage from being on the train.

It turned out that people's biases for thinking about time perfectly mimicked their patterns of engaging in and disengaging from spatial-motion thinking (see Figure 4.3). Within five minutes of getting on the train, people were very likely to be taking the ego-moving perspective on time (78%) when compared to people in the middle of their journey, who showed no significant ego-moving bias (54% ego-moving). However, people were likely to readopt the ego-moving perspective when they were within ten minutes of arriving at their destination (80% showed an ego-moving bias). Once again, it appears that people's thinking about time was affected by their engaging in thinking about spatial motion, and not simply by their experience of motion itself. Although all three groups of passengers were having the same physical experience (simply sitting on the train), the two groups that were most likely to be involved in thinking about their journey showed the most change in their thinking about time (Boroditsky & Ramscar 2002).

So far, we have only looked at people who themselves were moving or planning to move. Could thinking about spatial motion have a similar effect even when people are not planning any of their own motion? To investigate this question, we asked the 'Next Wednesday's meeting…' question of 53 visitors to the Bay Meadows racetrack. We predicted that the more involved people were in the forward motion of the racehorses, the more likely they would also be to take the ego-moving perspective on time (and say that the meeting has been moved to Friday). After asking people the question about next Wednesday's meeting, we also asked them how many races they had watched that day and how many races they had bet on. Both indices turned out to be good predictors of people's answers to the 'Next Wednesday's meeting…' question. As shown in Figure 4.4, people who had not bet on any races were as likely to think of themselves as moving through time (50% said 'Friday'), as they were to think of time as coming toward them (50% said 'Monday'). In contrast, people who had bet on three races or more were three times more likely to think of themselves as moving through time (76% said 'Friday') than they were to think of time as coming toward them (24% said 'Monday') when compared to people who had not bet on any races (50%). It appears that simply thinking about forward motion (without planning to actually go anywhere) is enough to change people's thinking about time.

The experiments described so far indicate that people's thinking about spatial motion is a good predictor of their thinking about time, and that actual physical motion may not necessarily influence co-occurrent thinking about

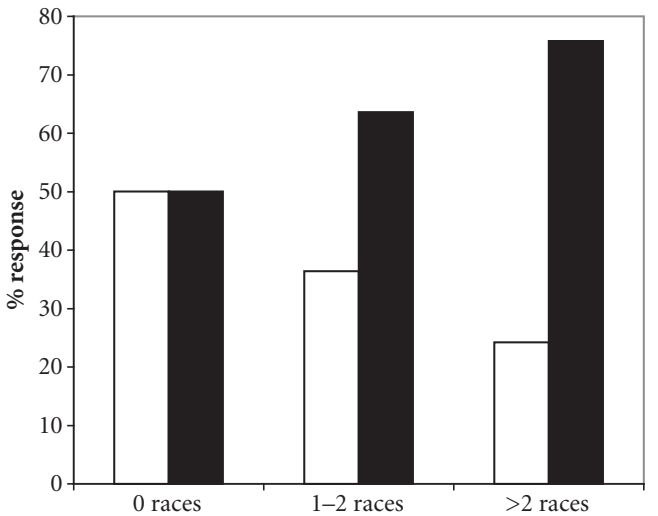


FIGURE 4.4. Responses of 53 visitors to the racetrack plotted by number of races bet on. People who had bet on more races (and so were more involved in the forward motions of the racehorses) also became much more likely to adopt the ego-moving perspective for time (say that next Wednesday's meeting has been 'moved forward' to Friday).

time. This then raises the question of whether actual motion is even *sufficient* to influence people's thinking about time, even in the absence of involved spatial thinking.

To address this question, we set up a 25-ft track outside the Stanford University Bookstore and invited students to participate in an 'office chair rodeo'. Half of the participants were asked to ride an office chair from one end of the track to the other (the ego-moving prime), and half were asked to rope the chair in from the opposite end of the track (the time-moving prime) (see Figure 4.5 for an illustration of the basic experimental set-up). The track was marked out in the asphalt using colored masking tape, with one end of the track marked in red and the other in yellow. Fifty Stanford undergraduates participated in the study in exchange for lollipops. The verbal instructions were the same in both conditions. Participants riding the chair sat in an office chair at one end of the track and were asked to 'maneuver the chair to the red/yellow line' (whichever was at the opposite end of the track). Participants roping the chair were given a rope that was connected to the office chair at the opposite end of the track and were likewise instructed to 'maneuver the chair to the red/yellow line' (whichever was where the participant was standing).

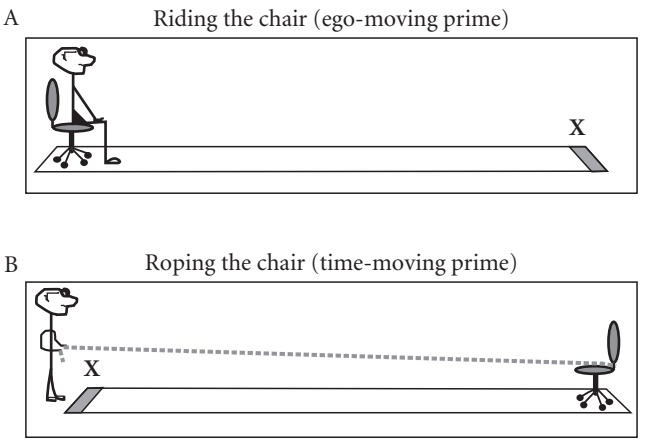


FIGURE 4.5A. The ego-moving priming materials used in the 'imagined motion' study. Participants were given the following instructions: 'Imagine you are the person in the picture. Notice there is a chair on wheels, and a track. You are sitting in the chair. While sitting in the chair, imagine how you would maneuver the chair to the X. Draw an arrow indicating the path of motion.'
FIGURE 4.5B. In this condition participants were asked to, 'Imagine you are the person in the picture. Notice there is a chair on wheels, and a track. You are holding a rope attached to the chair. With the rope, imagine how you would maneuver the chair to the X. Draw an arrow indicating the path of motion.'

Immediately after the participant completed the motion task (either riding or roping the chair), they were asked the question about next Wednesday's meeting. We found that performing these spatial motion tasks had no effect on subjects' thinking about time. People riding the chair (actually moving through space) were as likely to think of themselves as moving through time (56% said the meeting would be on Friday) as were people roping the chair (actually making an object move toward them) (52% said the meeting would be on Friday).

In contrast, we found that asking people to *think* about this task affected the way they subsequently thought about time. We asked 239 Stanford undergraduates to fill out a one-page questionnaire that contained a spatial prime followed by the ambiguous 'Next Wednesday's meeting …' question described above. The spatial primes (shown in Figure 4.5) were designed to get people to think about themselves moving through space in an office chair (see Figure 4.5a) or about making an office chair come toward them through space (see Figure 4.5b). In both cases, participants were asked to imagine how they would 'maneuver the chair to the X', and to 'draw an arrow indicating the path of

motion'. The left-right orientation of the diagrams was counterbalanced across subjects. After our subjects completed the spatial prime, they were asked the ambiguous 'Next Wednesday's meeting …' question.

Our results indicated that in contrast to *actually* moving, *imagining* themselves as moving through space, or *imagining* things coming toward them, did cause our participants to think differently about time. Subjects primed to think of objects coming toward them through space were more likely to think of time as coming toward them (67% said Wednesday's meeting had moved to Monday), than they were to think of themselves as moving through time (only 33% said the meeting had moved to Friday). Subjects primed to think of themselves as moving through space showed the opposite pattern (only 43% said Monday, and 57% said Friday) (Boroditsky & Ramscar 2002).

It appears that just moving through space, without thinking much about it, is not sufficient to influence people's thinking about time. In contrast, imaging the self-same experience does influence people's thinking about time. This finding is especially striking when taken in conjunction with previous evidence that just thinking about spatial motion (in the absence of any actual motion) is enough to influence people's thinking about time (Boroditsky 2000).

Taken together, the studies described so far demonstrate an intimate relationship between abstract thinking and more experience-based forms of knowledge. People's thinking about time is closely linked to their spatial thinking. When people engage in particular types of spatial thinking (e.g. thinking about their journey on a train, or urging on a horse in a race), they also unwittingly and dramatically change how they think about time. Further, and contrary to the very strong embodied view, it appears that this kind of abstract thinking is built on representations of more experience-based domains that are functionally separable from those directly involved in sensorimotor experience itself (see also Boroditsky & Ramscar 2002).

4.2 Fictive representations of space and their influence on the construction of time

So far we have seen that *thinking* about objects moving through space can influence the way people conceptualize the 'motion' of time. That is, thinking about concrete motion seems to have affected the way people subsequently thought about a more abstract domain that borrows structure from that more concrete parent domain. We now turn to the relationship between fictive motion and thinking about time.

Fictive motion sentences (e.g. 'The tattoo runs along his spine' or 'The road goes along the coast') are somewhat paradoxical because they include a

motion verb ('run', 'go') and physical scene ('spine', 'coast'), but they describe no physical movement or state change (Matlock 2004; Talmy 1996). However, in language after language they systematically derive from literal uses, which *do* describe physical movement (e.g. 'Bus 41 goes across town'; Radden 1996; Sweetser 1990; Miller & Johnson-Laird 1976). The ubiquity and diachronic regularity of fictive-motion language provides further support for the idea that people recruit experiential concepts acquired from the physical world to make sense of more abstract domains. Further, it allows us to pose and explore an intriguing question: Can the borrowed structures from real motion understanding—used to flesh out our understanding of spatial relations in fictive motion—be used to influence similar borrowed structures in the temporal domain, so as to affect people's conceptions of time?

Does fictive motion involve the same conceptual structures as real motion? If so, manipulating people's thinking about fictive motion should also influence their temporal thinking. To examine this, in a series of apparently unrelated questionnaire tasks we asked 142 Stanford University students to: (a) read either a fictive motion sentence (hereafter, FM-sentence) (e.g. 'The road runs along the coast') or a comparable no-motion sentence (hereafter, NM-sentence) (e.g. 'The road is next to the coast'), (b) sketch the spatial scene described by the sentence (the drawing task made sure participants paid attention to and understood the sentence), and (c) answer the ambiguous temporal question 'Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?' We wanted to see whether sentence type would influence response (Monday versus Friday). Critically, if participants mentally simulate scanning along a path (see Matlock 2004; Talmy 1996; 2000), this would be congruent with an ego-moving actual motion perspective (Boroditsky 2000); if they are simulating motion with fictive motion, it ought to encourage them to think of themselves (or some other agent—see Boroditsky & Ramscar 2002) 'moving' through time as they scan motion, prompting a Friday response.

We found that the fictive motion primes did influence our participants' responses to the ambiguous temporal question. FM-sentences led to more Fridays than Mondays, but NM-sentences showed no difference. Of the participants primed with fictive motion, 70% went on to say the meeting would be Friday, and 30% said Monday. In contrast, 51% of those primed with no-motion went on to say Friday, and 49% said Monday—a close but statistically reliable difference (Matlock, Ramscar, & Boroditsky 2005).

These results indicate that thought about fictive motion does indeed influence thought about time. When people process fictive motion, it appears that they apply the same motion perspective to their thinking about time as when

they process actual motion. In this case, they appear to subjectively scan a path, and this accordingly activates an ego-moving schema, which in turn produces a Friday answer. When they think about a comparable spatial description without fictive motion and which does not relate to a particular motion schema, their temporal thinking is unaffected, and hence in answering an ambiguous question about time, their responses are at chance.

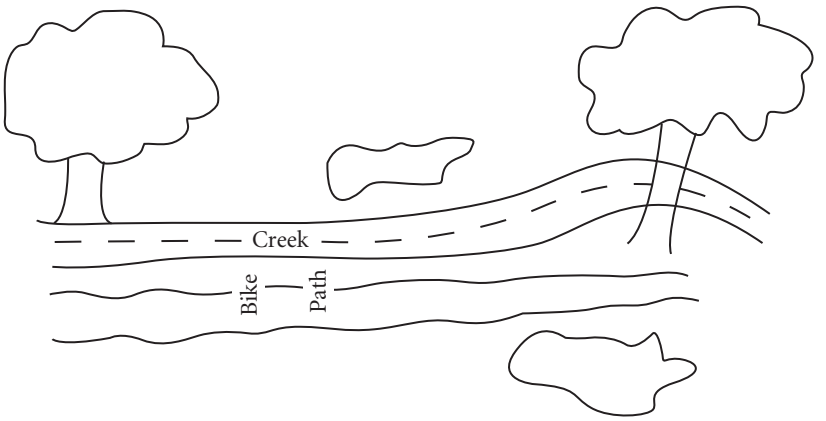
This raises the question of what it is about fictive motion that affects temporal thought. If fictive motion really is activating some abstract representation of concrete motion, then the effects we observed above might vary according to the amount of 'motion' in a given fictive motion prime. That is, we might expect the fictive motion effect to be more robust with a 'longer' fictive path than with a 'shorter' fictive path (see Figure 4.6).

To examine this, we examined 124 Stanford students using a procedure similar to the one described above. In this experiment, however, we varied the length of the path of the fictive motion by asking our participants to read one of the following sentences: 'Four pine trees run along 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'. We reasoned that if people activate conceptual structure about motion while thinking about fictive motion, then we should expect more (e.g. longer) motion simulation when people can conceptualize more points along the scan path. Further, given the finite resources available to people in working memory, we also predicted that (as the old saying about not seeing the wood for the trees suggests) if people had an indeterminately high number of trees to individuate as scan points in conceptualizing the over-80-tree FM-sentence, such that their representational capacities for individual trees were swamped, they might tend to conceive of 'many trees' as a mass entity. In this case, this might function as a poor prime because its representation would possess few scan points.

Since more scanning in simulation should be more likely to activate an ego-moving perspective when thinking about time, we expected that we would see more Fridays than Mondays in response to the question as the number of scan points increased from 4 to 8 to 20, but a drop in this effect as the number of trees increased to over 80.

This is what we found. As shown in Figure 4.7, there was a significant interaction between sentence type and number of pine trees. These results indicate that responses were differentially influenced by the way people had thought about fictive motion, in this case by the number of points along a path. As shown in sample drawings in Figure 4.8, 8 and 20 trees were sufficient in number (not too many, not too few) for people to build up an adequate path

(1) No motion: *The bike path is next to the creek*



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

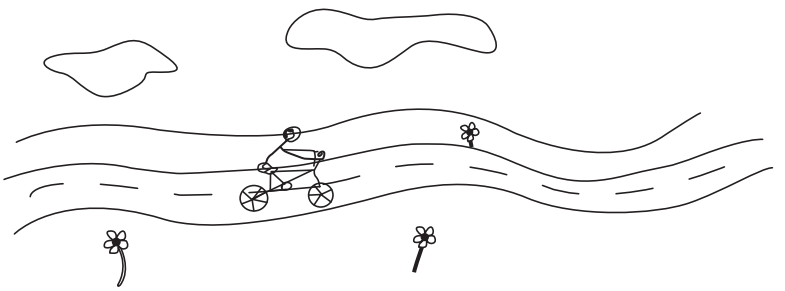


FIGURE 4.6. Examples of drawings with no motion sentences and fictive motion sentences
(a) No motion: *The bike path is next to the creek*
(b) Fictive motion: *The bike path runs alongside the creek*

representation—that is, one along which people could simulate motion or visual scanning. A total of 4 trees, however, did not allow people to produce an adequate path representation, and a total of over 80 trees was too many.

In sum, people were more likely to respond 'Friday' than 'Monday' when they could simulate motion along a just-right-sized path (when they had thought about 8 trees or 20 trees running along a driveway), but there was no reliable difference when people had thought about only 4 trees or over 80 trees. This suggests that people built a path representation upon reading a fictive motion sentence, and that this was then incorporated into the representations

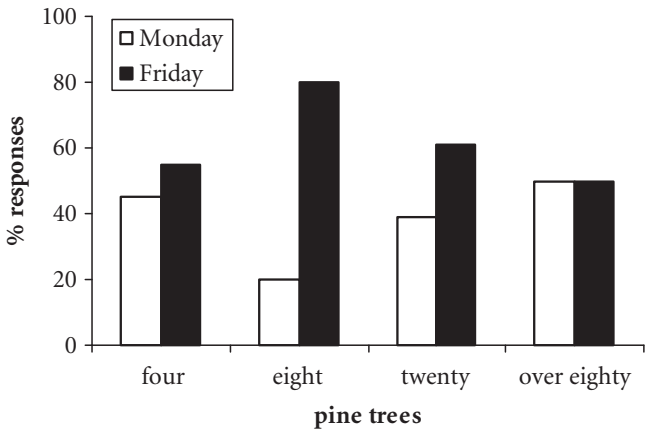
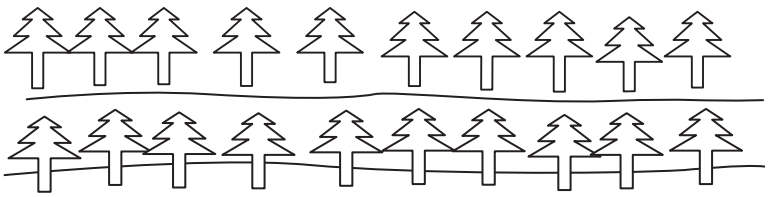


FIGURE 4.7. Responses to the ambiguous question plotted by the number of pine trees in the prompt

they used to reason about when the meeting would be held. When the number of trees was more conducive to building a representation that could be readily scanned (not too few, not too many), people were more prone to adopt an ego-moving perspective (see Matlock et al. 2005).

So far we have seen that thinking about fictive motion influences the way people think about time, but we have not ascertained whether fictive motion involves a diffuse or abstract sense of motion or a more defined sense of directed motion. To explore the extent to which fictive motion construal involves direction, an important conceptual property of motion construal (Miller & Johnson-Laird 1976), we primed 74 Stanford students with a FM-sentence about a road beginning at an unspecified location and terminating at a far-away location (New York), or a sentence that begins at the far-away location and 'moves' toward the unspecified location, to see whether people would construct a representation in which they were either the starting point or ending point of a path. If so, thinking about the road 'going' toward New York might encourage a 'Friday' response consistent with the ego-moving perspective where individuals see themselves moving through time ('Monday is ahead of me'). This is analogous to the ego-moving perspective in actual motion, where, when individuals construe themselves as moving through space, the 'front' object will be that which is furthest away. If participants thought about the road 'coming' to them, we expected a Monday response, consistent with a time-moving perspective in which the individual is seen as stationary, with events coming towards them ('Christmas is coming'). This is analogous to the

Twenty pine trees run along the edge of the driveway



Over eighty pine trees run along the edge of the driveway

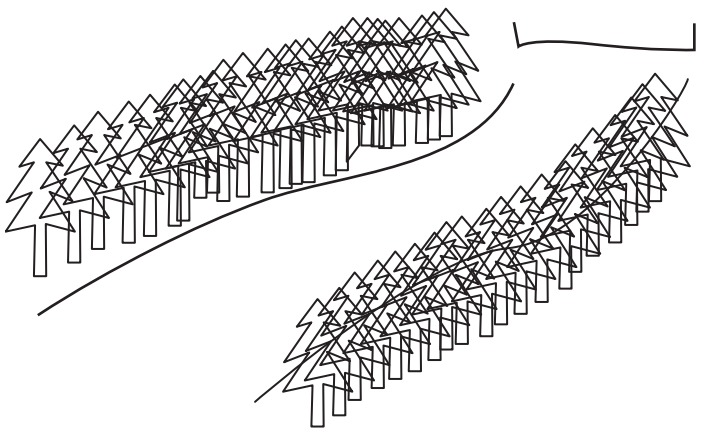


FIGURE 4.8. Examples of drawings for different numbers of trees
(a) *Twenty pine trees run along the edge of the driveway*
(b) *Over eighty pine trees run along the edge of the driveway*

object-moving perspective in actual motion, where, when individuals construe objects as moving towards themselves as moving, the 'front' object will be closest to an observer (Boroditsky 2000).

Of the participants primed with fictive motion 'towards themselves' ('The road comes all the way from New York'), 62% responded Monday and 38% Friday, and of the participants primed with fictive motion 'away from themselves' ('The road goes all the way to New York'), 33% responded Monday and 67% Friday (Matlock et al. 2005). The results indicate that people were influenced by their understanding of fictive motion. When people thought about fictive motion *going* away from themselves (Stanford), they appeared to adopt an ego-moving perspective and conceptually 'moved' while time remained

stationary. In contrast, when people engaged in thought about fictive motion *coming* toward them (and their location, Stanford), they appeared to adopt a perspective whereby they remained stationary and time moved toward them. These results suggest that fictive motion involves simulating motion along a path, and that that motion can be directed.

As we noted earlier, it is far from obvious that thinking about fictive motion *should* bring about any differences whatsoever in the way people think about time, especially given that nothing actually moves in a fictive motion description. In the real world, tattoos do not move independently of the skin upon which they are inked, and bookcases do not run around rooms. The subject noun phrase referents in fictive motion sentences, such as 'tattoo' in 'The tattoo runs along his spine', are in no way actually moving. Because of this, the question of whether fictive motion involves a dynamic conceptualization has long been controversial. Talmy (2000; 1996) and Langacker (2000) have proposed that the representation underlying fictive motion sentences may be temporal, dynamic, and involve structures akin to real motion. Matlock's (2004) results provide empirical evidence to support this idea. Counter to this, however, Jackendoff (2002) argues that sentences such as 'The road runs along the coast' are manifestations of static and atemporal representations, and as such, they *contrast* with sentences such as 'The athlete runs along the coast', whose semantic profile includes actual motion along a path. It appears that theories of comprehension advocating dynamic representations (including simulation) may be better suited to account for the way people comprehend fictive motion, and the way this has been shown to affect reasoning about time (see also Matlock 2004).

4.3 Conclusions

The results of all our experiments support the general idea that abstract domains—those many things that we as human beings seem to grasp without being able to touch—are understood through analogical extensions from richer, more experience-based domains (Boroditsky & Ramscar 2002; Boroditsky 2000; Clark 1973; Gibbs 1994; Lakoff & Johnson 1980). In particular, we have shown that people's thinking about the 'passage' of time is closely linked to their thinking about the way real objects move in space. It appears that when people engage in particular types of spatial-motion thinking (be it thinking about train journeys or horse races), they may also be unwittingly and dramatically affecting the structure of the representations they use to think about time. Further, and contrary to the very strong embodied view, our results suggest that abstract thinking is built on our representations of experience-based

domains, and that these representations are functionally separable from those directly involved in sensorimotor experience itself.

Our results also suggest that representations of both time and fictive motion share a common base and ancestor: actual motion. Moreover, because static spatial ideas and temporal understanding have no link to one another other than through their common ancestor, it seems reasonable to assume that thinking about one or another abstract 'child' domains involves some activation of the 'parent', or of some more general abstract idea of motion extracted from and shared with the parent. This seems the most parsimonious explanation for why comprehending a fictive motion sentence in the absence of real motion can subtly influence people's understanding of time: Comprehending a fictive motion sentence appears to recruit the same dynamic representations that are used in conceptualizing actual motion, and these in turn affect the representations underpinning our ideas about time. The idea that real motion is involved seems further underlined by the last experiment described, which showed not only that fictive motion affects temporal understanding, but also that the 'direction' of fictive motion could be manipulated to create a corresponding effect on the 'direction' of temporal understanding.

Metaphor and analogy allow people to go beyond what can be observed in experience, and to talk about things they can neither see nor touch. They allow us to construct an understanding of a more abstract world of ideas. The results we describe here add credence to the widely held belief that abstract ideas make use of the structures involved in more concrete domains. Moreover, insofar as these results suggest that it is our ways of *talking* about concrete domains that seems to be at the heart of this process, they lend support to the notion that abstract ideas can be constructed and shaped not just by language, but by particular languages (Boroditsky 2001). Further, these results suggest that the human conception will not easily be partitioned into neat compartmentalized domains. Abstract ideas may take their structure from more experiential domains, but insofar as they retain the links with their siblings, these data suggest they also retain links to their parents. It remains an open and intriguing question whether, and to what extent, our knowledge of the abstract world can feed back and shape our understanding of matters that appear, on the surface at least, to be resolutely concrete.

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