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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Permalink

<https://escholarship.org/uc/item/3bg923m0>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 27(27)

ISSN

1069-7977

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Publication Date

2005

Peer reviewed

Even the Most Abstract Motion Influences Temporal Understanding

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Introduction

When people count or think about sequences of symbols, they rely on spatial conceptual structures based on their experience with physical motion. This kind of *abstract motion* is found in language such as *Five comes before six* and *Let's go through the alphabet* (Lakoff & Nunez, 2001; Langacker, 1987). People appear to rely on similar structures in understanding abstract domains like time, where dates are metaphorically structured in terms of space (see Boroditsky, 2000; Clark, 1973).

Previously, we showed that understanding time is facilitated and directed by conceptualizations of space, including thinking about physical motion (Boroditsky & Ramscar, 2002), and even fictive motion, a simulated type of motion instantiated in figurative language, such as *The road runs along the coast* (Matlock, 2004; Matlock, Ramscar, & Boroditsky, 2005). Here we examine how pervasive this representational interdependence is by testing whether non-spatial motion, which arises in sequential processing of numbers and letters (Lakoff & Nunez, 2001; Langacker, 1987), can influence temporal understanding.

Experiment 1

Eighty-two Stanford undergraduates answered this ambiguous temporal question: *Next Wednesday's meeting has been moved forward two days. When is the meeting now that it has been re-scheduled?* They answered it after counting either forward, 5 to 17, or backward, 17 to 5. With forward counting, 25 percent responded "Monday", and 75 percent responded "Friday". With backward counting, 61 percent responded "Monday" and 39 percent, "Friday". A chi-square test showed the effect was reliable, $\chi^2(1) = 9.19$, $p < .002$. It appears that counting forward led to forward "movement" through time, whereas counting backward did the opposite. The results suggest that direction of sequential "movement" in counting led to a consistent direction of "movement" in thinking about time ("backward" to Monday or "forward" to Friday).

Experiment 2

Here we used the same task except that instead of counting, participants used the alphabet. Ninety-five students recited

part of the alphabet, either forward, G to P, or backward, P to G, and then answered the question. With forward recitation, 26 percent of the participants said "Monday" and 74 percent, "Friday". With backward, 53 percent said "Monday" and 47 percent, "Friday". A chi-square test showed the effect was reliable, $\chi^2(1) = 6.34$, $p < .012$. So, forward recitation brought on more Fridays, and backward did the reverse, suggesting that direction of "movement" in reciting the alphabet led to a consistent direction of "movement" in thinking about time.

General Discussion

The results suggest that people evoke tacit spatial structures even while counting, accessing the sequential structure of the alphabet, or doing other sequential activities that do not involve physical space. This "sequential motion" also appears to influence their understanding of time. The work supports the idea that people draw on their understanding of space in reasoning about abstract domains (Boroditsky, 2000; Boroditsky & Ramscar, 2002; Matlock et al., 2005).

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