The Roles of Thought and Experience in the Understanding of Spatio-temporal Metaphors

Tracy Packiam Alloway (Tracy.Alloway@ed.ac.uk)
Department of Psychology
University of Edinburgh, 7 George Square Edinburgh EH8 9JZ, UK

Michael Ramscar (michael@cogsci.ed.ac.uk)
School of Cognitive Science, Division of Informatics
University of Edinburgh, 2 Buccleuch Place, Edinburgh, EH8 9LW

Martin Corley (Martin.Corley@ed.ac.uk)
Department of Psychology
University of Edinburgh, 7 George Square Edinburgh EH8 9JZ, UK

Abstract

Spatial and temporal metaphors are often used interchangeably, and thus, offer a unique way of exploring the relationship between language and thought. Both spatial and temporal speaking incorporates two systems of motion. The first is an ego-moving system, when the individual moves from one point to another, spatially, or from the past to the future, temporally. The second is the object- (or time-) moving system, when the individual is stationary and observes objects, or time, moving towards him/her. This study explored the effect of a spatial environment on the ambiguous temporal question: *Next Wednesday's meeting has been moved forward two days--What day is the meeting now?* Results reveal that when participants are immersed in an ego-moving spatial environment, such as a virtual reality game, and receive a prime that causes them to think in an object-moving way, they are more likely to perform a target task in a way consistent with the way they have been primed to think, although it contradicts the spatial motion they subsequently experience in the testing environment.

Introduction

What is the relationship between language and sensory experience? According to one recent claim (Lakoff and Johnson, 1999), abstract concepts, such as time, are substrated in concrete concepts like space that can be experienced directly. The representations of these concrete concepts are formed directly, by experience. Thus, our spatial experiences form "a neural structure that is actually part of, or makes use of, the sensorimotor system of our brains. Much of conceptual inference is, therefore, sensorimotor inference" (Lakoff and Johnson, 1999, p. 20). On this view, our understanding of concepts such as time is predicated on our spatial experiences, and thus the idea of motion in time relies on our understanding of motion in space.

There is evidence for this relationship between motion in space and time in the structure of language. We can talk of *putting things forward* in time, as well as *moving forward* through space (see Lakoff & Johnson, 1999; 1980). According to Lakoff and Johnson's (1980; 1999) Conceptual Metaphor hypothesis, metaphors are not justa manner of speaking but a deeper reflection of human thought processes. Metaphoric speaking is reflective, say Lakoff and Johnson, of deeper conceptual mappings that occur in our thinking and is depicted as an over-arching and general metaphor termed asthe Conceptual Metaphor. Consider the following statements:

Your claims are *indefensible*.

He *attacked every weak point* in my argument.

He *shot down* all of my arguments.

According to the Conceptual Metaphor (metaphoric representation) hypothesis when we use statements such as these we are making use of a larger conglomerate metaphor, in this instance, ARGUMENT IS WAR.[1]

The thrust of the Conceptual Metaphor argument is as follows: arguments are similar to wars in that there are winners and losers, positions are attacked and defended, and one can gain or lose ground. The theory of Conceptual Metaphor suggests that we process metaphors by mapping from a base domain to a target domain. In this particular example, the base domain is ARGUMENT IS WAR and the target domain is asubordinate metaphor such as *Your claims are indefensible.*

Motion in Space and Time

Lakoff and Johnson extend the idea of Conceptual Metaphor to spatio-temporal metaphors by invoking the

[1] Following Lakoff and Johnson's convention (1980), all Conceptual Metaphors are typed in the uppercase to distinguish them from the subordinate metaphors

locative terms of FRONT/BACK to represent how we view time and space. FRONT is assigned on the assumption of motion (Fillmore, 1978). According to this theory, in the *ego-moving* system, FRONT is used to designate a future event because the ego is moving forward and encounters the future event in front of him. In the *time-moving* system, the FRONT term denotes a past event where the ego or the individual is stationary but the events are moving. Thus it is possible to define (at least) two schemas of motion in space.

1) Object-Moving Metaphor (OM)

In this schema of motion,the individual is seen as stationary and objects seem to come towards him/her. For an example of this schema, consider an individual waiting at a bus stop and observing vehicles coming towards him/her. In this schema of motion, the individual assigns the term FRONT to the object closest towards him. In the diagram below, the term FRONT would be assigned to the white rock.

Figure 1

2) Ego-Moving Metaphor (EM)

Inthis schema of motion, the objects are stationary and it is the individual that is in motion. Here, the term FRONT would be assigned to the object furthest away from the individual. In the picture below, it is the black rock that would be labeled as FRONT.

Figure 2

Thus in the EM system, *front* is used to designate an object furthest away from the individual, as the trajectory of motion is in that direction. While in the OM system, the term *front* is assigned to the object closest to the individual.

Motion in Time

The schemas of motion represented in the domain of time reflect the representation of motion in the domain of space.

1) Time Moving metaphor (TM)

The motion of time provides the framework in which temporal metaphors are comprehended. In this schema, *front,* or *ahead* is determined by thefuture moving to the past. For example, in the month of February, Christmas is now in the future. In time it will move to the present and then to the past (e.g. Christmas is *coming*). The individual is a stationary observer as times "flows" past. This schema is the temporal equivalent of the OM metaphor in the domain of space.

2) Ego-Moving metaphor (EM)

The ego or the individual moves from the past to the future such as the sentence His vacation to the beach lay *ahead* of him . In this metaphor, the observer is seen as moving forward through time, passing temporal events that are seen as stationary points. It is thus the temporal equivalent of the spatial EM system, where the observer moves forward through space

When discussing motion in time, temporal events are viewed as points or locations in space, and a similar rationale is used when assigning deictic terms such as *front* and *back*. For example, in the EM system, FRONT is used to designate a future event because the ego is moving forward and encounters the future event in front of him, while in the TM system the FRONT term denotes a past event where the ego or the individual is stationary but the events are moving.

Studies of Spatio-temporal Metaphors

Gentner and Imai (1992), and McGlone and Harding (1998) confirmed the idea that the different schemas of motion (EM and TM in the domain of time) are indeed psychologically real systems.Gentner and Imai found that participants responded faster to questions that were schema consistent with regards to temporal schemas in priming than to questions that were inconsistent with their primes. Gentner and Imai argue that this supports the theory that metaphors are mapped in distinct schemas: the shift from one schema to another causes a disruption in the processing, reflected in increased processing time. They argue that their study indicates that the relations between space and time are reflective of a psychologically real conceptual system as opposed to an etymological relic.[2]

A study by McGlone and Harding (1998) involved participants answering questions about days of the week - relative to Wednesday - which were posed in either the *ego-moving* or the *time-moving* metaphor. *Ego-moving* metaphor trials comprised statements such as We passed the deadline two days ago , whilst *time-moving* metaphor trials involved statements such as The deadline passed us two days ago ; in each case,

[2] Although McGlone and Harding (1998) criticised some aspects of Gentner and Imai s methodology, their corrected replication of the original study confirms its findings.

participants read the statements and were then asked to indicate the day of the week that a given event had occurred or was going to occur. At the end of each block of such priming statements, participants read an ambiguous statement, such as The reception scheduled for next Wednesday has been moved forward two days [3] and then were asked to indicate the day of the week on which this event was now going to occur. Participants who had answered blocks of priming questions about statements phrased in a way consistent with the*ego-moving* metaphor tended to disambiguate moved forward in a manner consistent with the *ego-moving* system (they assigned forward - the front - to the future, and hence thought the meeting had been re-scheduled for Friday), whereas participants who had answered blocks of questions about statements phrased a way consistent with the *time-moving* metaphor tended to disambiguate moved forward in a manner consistent with the *time-moving* system (they assigned forward - the front - to the past, and hence thought the meeting had been re-scheduled for Monday).

This work has been further developed in a recent set of experiments by Boroditsky (2000) which explicitly explored the relationship between the domains of space and time. Boroditsky found that temporal priming significantly influenced temporal reasoning in a cross-domain extension of the paradigm used in earlier experiments. Spatially priming participants with the ego moving schema led them to infer that an ambiguous meeting ("Next Wednesday's meeting has been moved forwards two days") had been moved to Friday, whereas spatially priming participants with the object moving schema led them to assign the meeting to Monday. This study provides good evidence to support the notion that our representation of motion in space is mapped on to our understanding of motion in time, although it leaves open the question of what is directing this representational mapping spatial representations that are contiguous with our embodied experience, or functionally separable, abstract conceptual representations of space and time.

Experiment 1

This experiment directly explores the claim that our embodied experiences in space direct our conceptual understanding of time. Participants were immersed in an embodied environment, a virtual reality game, and were presented with an ambiguous spatial task, either after either a purely embodied prime, or after embodied priming during which a linguistic prime had cued them to *think* in terms of a contrary spatial schema. The experiment was designed to explore the role of experience and thought between the two schemas of motion in the domain of space.

[3] All trials were conducted on a Wednesday.

Participants

61 University of Edinburgh students volunteered to take part in this experiment.

Materials

In order to create a particularly convincing Ego Moving environment, participants played a slightly modified version of a pre-existing section of the virtual reality computer game, *UnReal*. This is a first person perspective game and involves the participant walking through a courtyard environment to complete a task. All monsters and other artifacts of the game that were not relevant to the experiment were removed from this section of the game. The objects in the target task appeared upon completion of the game. These were two chests, with no discernible front or back (unlike other objects, such as a car, or a TV), one of which was closer to the player than the other. The game was projected onto a 368cm by 282cm size screen in order to magnify the virtual effects of the game.

Procedure

Pre-Test

25 participants were tested individually seated in front of the projector screen. The game was set at the point in front of the two chests. Participants did not play the game and were only instructed to *Move to the front chest* . In this condition, the target task was performed in isolation, and the results provided a baseline for how the term *front* in this task is interpreted.

Out of the twenty-five subjects, twelve of them interpreted the term *front* to refer to the chest closest to them, while the rest assigned front to the chest furthest from them, confirming the ambiguity of the assignment of *front* in the target task.

Experimental Conditions

36 participants were tested individually. They were asked to fill in a brief questionnaire requesting demographic information, as well as familiarity with video games and computers. At the end of the questionnaire were the following instructions: Your task is to find the location of a young woman. Try your best to navigate around the environment in order to find her. During this game, it is important to try to remember some key landmarks, such as a **pair of brightly coloured pillars as you enter a path,** as well as the **doors on the buildings.** After you have been playing for some time, you will hear a question requiring a true or false answer. This question will be about the game. Try to answer it correctly and speak your answer loudly."

The participants were then shown how to use the arrow keys on the keyboard when navigating through the environment and then left alone to play the game. (The experimenter was on hand, should the volunteers

have any difficulty maneuvering around the environment; however, all volunteers seemed adequately proficient at navigating around the environment.)

There were two experimental conditions. In the first condition, volunteers received a pre-recorded true/false question specific to the assignment of the term *front* approximately four minutes into playing the game. The question they were posed -- During the game, the green pillar is in front of the red pillar — prompted them to think in an Object Moving manner about space (the green pillar was closer to the participants than the red pillar in the game environment, thus this question is true from an OM perspective).[4] We were interested to see if the thinking in an OM way in answering the question would result in a different assignment of *front* from the EM perspective that was embodied in the game.

The order of the pillars in the question was reversed for half of the participants to counter-act an affirmative response bias. Thus, half the participants answered the true/false question: During the game, the red pillar is in front of the green pillar . The answer to this question was false from an OM perspective.

In the second condition, volunteers received a pre-recorded non-spatial question rather than a spatial prime approximately four minutes into playing the game. They had to provide a true or false answer to the following question: During the game, most of the doors are open". The correct answer to this question was true, however, the amount of doors the volunteer saw depended on the route he or she chose in navigating around the environment to complete the task. However, the question was also presented in the inverse to avoid any particular response bias, and half of the participants in this condition answered the following question: During the game, most of the doors are closed". The question in this condition served as a control to ensure that simply answering a question would not cause people to re-represent their perspective of front or back (but that rather a question must cause people to specifically think in a way that involves a representation of front/back for this to occur).

Playing the EM game served as the embodied prime in this condition.

Once the participants had completed the task, the virtual young woman they sought congratulated them and they were asked to complete the target task: "*Move to the front chest*". The two chests were located on the left of the virtual woman and were added from the *UnReal* directory of furniture to maintain continuity in the environment. Upon completion of the target task, participants were given a short debriefing.

[4] Pre-testing had shown that this question, which is true from an OM perspective, was unambiguous and ordinarily answered from the OM perspective. Out of 20 participants, 90% allocated the term *front* in an OM perspective. A binomial test confirmed this as significant; $p<.001$.

Results

Participants responses for the target task are shown in Figure 3. Out of the total 36 participants, two (5%) did not answer the prime question consistently (i.e., to the OM prime: During the game, the green pillar is in front of the red pillar , they answered false when the correct answer was true). Their data were not used in the following analyses.

Analysis showed that when participants received the OM prime, requiring them to specifically think in a way that represented a particular schema of motion, 75% of them interpreted the *front* chest in an OM consistent manner, despite playing the EM game for a further 2-3 minutes *after* answering the prime question. However, when participants were simply immersed in a game which embodied EM motion, and were not required to specifically (or explicitly) think about that motion (instead, they were required to think about doors), 83%of them were influenced by the nature of motion in the game and interpreted the *front* chest command in an EM schema consistent manner.

A chi-square analysis revealed a significant effect of the type of prime participants received on how they interpreted the term *front* to apply to an ambiguous target task: $\chi^2(1)=11.691$; $p<0.001$.

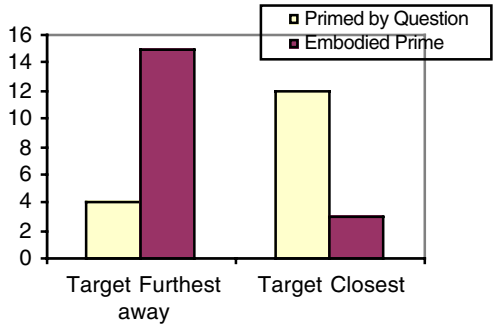

Figure 3: Target responses in each prime condition

Discussion

This experiment seems to suggest that thinking about space can override the role of spatial experience in our understanding of spatial concepts. Participants who were cued to think using a particular schema of motion (OM), overcame the schema of motion they were experiencing (EM), and responded ina consistent manner with the way they had been cued to think about space. Participants who received a random question, unrelated to any system of motion, were influenced by the schema of motion in the game (EM) and responded to the spatial task consistently with their experience.

Although the video prime in this experiment involved the participant in an EM schema of motion, there might be some criticism against the embodied prime as participants only perceived the visual environment, rather than physically experienced it. Such criticism seems unjustified in this case. As Lishman and Lee (1973) argue, perception is powerful enough to direct kinaesthesis or movement. They claim that a person relies heavily on visual kinaesthesis, in many situations, for example, driving, and swimming in a current, a person is *dependent* on vision to sense how he is moving relative to the static environment (p. 288, emphasis theirs). They also argue that individuals experience a sensation of motion when visual scenes change, but they are stationary. They conducted a series of experiments where individuals were placed in a stationary trolley in a moving room. The room was moved independently from the trolley located in it, so the participants saw the room move, although thetrolley they were standing in was completely stationary. Lishman and Lee record participants as perceiving the trolley to move as well, eventhough they were stationary. The participant also swayed together with the room in an apparent attempt to keep himself stable with respect to his static environment (p.292). Participants felt the experience was like being on a boat, and several felt quite nauseated afterwards.

In this virtual reality experiment, several participants had similar experiences and even commented on feeling rather ill after playing the video game for a few minutes. One participant asked if she could leave because she felt so nauseated. Often, participants shoulders were seen to move in sync with a right or left turn they made in the virtual environment, and many participants remarked on feeling dizzy after completing the experiment. This confirms the importance of perception in directing our sense of motion, and suggests that visually experiencing motion in virtual reality provides a similar sensation to a physical experience of motion.

Experiment Two

While the first experiment examined the influence of simple experience versus explicit thought in our understanding of motion in space, this experiment explored whether simple spatial experience or thinking about space would be more influential in mapping information about motion from the domain of space to time. Participants were immersed in an embodied environment and were presented with an ambiguous target temporal task after receiving either a purely embodied priming, or embodied priming during which a linguistic prime had cued them to think in terms of a contrary spatial schema.

Participants

Thirty-nine Edinburgh University students volunteered to take part in this experiment.

Materials

The participants played the same video game as described in Experiment 1.

Procedure

All trials were conducted on a Wednesday. Participants were tested individually in the virtual reality lab and were asked to fill in a brief questionnaire containing the same instructions given in Experiment 1. They were also informed that they would be required to return next Wednesday if they were successful in accomplishing the task in the game. This information provided a connection between the target question (see below) and the experiment, as the participants would interpret Next Wednesday s meeting in the target question as a further experiment, rather than an unrelated question.

Participants were then shown the game and began playing. There were two conditions. Approximately four minutes into playing the game, the participants in the first condition received the linguistic prime cueing them to think the in an OM perspective. Again, they had to respond with either true or false to the question During the game, the green pillar is in front of the red pillar . (Once again, half of the participants in this condition received the inverse question.)

In the second condition, instead of receiving a prime that cued spatial thinking, the participants received the non-spatial question approximately four minutes into playing the game During this game, most of the doors are open . (Again, half of the participants in this condition received the question in the inverse.)

Once participants had successfully completed the game task (finding a virtual young woman; all participants were successful), the experimenter congratulated them and then informed them that "*Next Wednesday's meeting has been moved forward two days* and asked *What day is the meeting now that is has been rescheduled?*" (the ambiguous temporal question used in McGlone and Harding, 1988, and Boroditsky, 2000). After participants had given their answer, they were given a short debriefing.

Results

Out of the total 39 participants, three of the participants (8%) did not answer the prime question consistently (i.e., to the OM prime: During the game, the green pillar is in front of the red pillar , they answered false when the correct answer was true). Data from those participants who provided incorrect answers to the prime were eliminated from the analyses.

Participants responses to the ambiguous target question were examined, and once again, the results revealed that the type of prime participants were presented with significantly affected their disambiguation of the target temporal question. The participants who received the cued OM prime during the game (which required them to adopt an OM schema for thinking of motion in answering the question) were more likely to interpret the term *forward* from Wednesday as Monday (65%) rather than Friday. In comparison, 74% of the participants who were influenced by the embodied EM game, but did not have to explicitly think about schemas of motion in answering the in-game question considered the new meeting day to beFriday rather than Monday (see figure 4).

A chi-square revealed that the type of prime the participants received significantly affected how they disambiguated *forward* in the temporal target task: $\chi^2(1)=5.355$; $p<0.05$ (one-tailed).

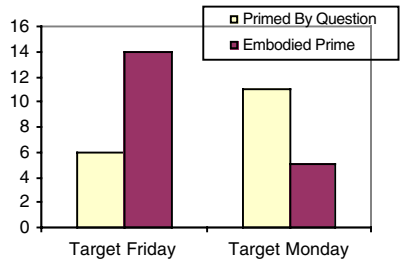

Figure 4: Target responses in each prime condition

Discussion

These results suggest that our concepts of motion in the domain of space can influence how we understand motion in the domain of time. However, while the embodied position suggests that it is our experiences in space that ultimately affect how we think of time, this experiment reveals that how you *think* about motion — even in abstract terms, such as in response to a question — also plays a significant role in influencing our concept of time. Although they participants continued to play a game which embodied an EM spatial perspective *after* they answered their question, participants who answered questions which required them to think in an OM manner answered an ambiguous temporal question in a TM (and thus OM, see Boroditsky, 2000) consistent manner, whereas participants who had played the EM game but not been required to explicitly think about time answered the ambiguous temporal question in an EM consistent manner. This indicates that although spatial experience can influence temporal thought, this influence can be over-ridden by explicitly thinking about space, suggesting that people s conceptual representations of space and time are functionally separable from their embodied experiences of space and time (see also Boroditsky, Ramscar, & Frank, this volume).

General Discussion

In two experiments, we have shown that explicitly thinking about space — in order to provide answers to questions cueing the *object-moving* metaphoric system - could significantly reverse a task bias to assign FORWARD in an *ego-moving* manner.

If, as Lakoff and Johnson (1999) suggest, language is ultimately the slave of our (universal) embodied thought, then we would have expected pure embodied priming to have at least as much an influence as abstract thought. However, this was not the case (see also Boroditsky et al, this volume).

These results suggest that a proper characterization of conceptual thought will need to look beyond the information that comes from physical experience, and consider as well the ways in which languages and cultures affect thought.

Acknowledgements

We thank Lera Boroditsky for many insightful discussions, and Jon Sykes for his assistance in programming the virtual environment.

References

Alloway, T.P., Ramscar, M., & Corley, M. (1999). Verbal and Embodied priming in schema mapping tasks. In *Proceedings of the Twenty First Annual Conference of the Cognitive Science Society.* New Jersey:Lawrence Erlbaum Associates, Pub.

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

Boroditsky, L., Ramscar, M. & Frank, M. (2001). The roles of body and mind in abstract thought. This volume.

Gentner, D., & Imai, M. (1992). Is the future always ahead? Evidence for system mappings in understanding space-time metaphors. In *Proceedings of the Fourteenth Annual Conference of the Cognitive Science Society*, Bloomington, Indiana, 510-515.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by.* Chicago: Univeristy of Chicago Press.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the Flesh.* New York: Harper Collins Publisher.

McGlone, M., & Harding, J. (1998). Back (or Forward?) to the Future: The Role of Perspective in Temporal Language Comprehension. *Journal of Experimental Psychology, 24,* 1211-1223.

McTaggart, J. (1908). The unreality of time. *Mind, 17*, 457-474.