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Verbal and embodied priming in schema mapping tasks

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Abstract

The question of whether language influences thought or not has been much discussed and disputed in the cognitive science literature. A recent proposal by Lakoff and Johnson (1999) adds an interesting slant to this debate by arguing that although language can influence thought via conceptual metaphors, the overall shape of the human conceptual system is determined by its embodied, perceptual nature. In this way, language is ultimately the slave of thought.

We present an experiment aimed at exploring this question empirically. Exploiting evidence that has shown that schema consistent priming can bias the outcome of reasoning tasks, we performed a study in a well mapped conceptual domain in order to examine whether embodied experience or language is the greater determinant of conceptual inferences. In this study, we found that language, rather than thought, is maybe what counts.

Introduction

Concepts are an essential part of cognition. The ability to group things together   whether as edible, dangerous, or even friendly   confers many benefits, both in terms of cognitive economy and, perhaps ultimately, evolutionary advantage. The relationship between concepts, the cognitive capabilities that facilitate grouping, and words, the labels that are the primary manifestation of categorisation is close, somewhat controversial, and goes to the heart of cognitive science. The question of whether thought influences language or language influences thought is an old one, with powerful adherents on either side of the argument. In this paper, we explore a recent proposal by Lakoff and Johnson (1999) which adds an interesting slant to this debate by arguing that although language can influence thought via conceptual metaphors, the overall shape of the human conceptual system is determined by its embodied, perceptual nature. In this way, language is ultimately the slave of thought. We present an experiment aimed at exploring this question empirically. Exploiting evidence that has shown that schema consistent priming can bias the outcome of reasoning tasks, we describe a study in a well mapped conceptual domain in order to examine whether embodied experience or language is the greater determinant of conceptual inferences.

Space And Time - A "Conceptual Domain"

There is a great deal of overlap in the lexical terms we use in talking about space and time. A number of researchers have noted systematic correspondences between the words we use in talking about space and time (McTaggart, 1908; Clark, 1973; Traugott, 1978; Lakoff and Johnson, 1980; Boroditsky, 1998). We often use phrases like "Christmas is *coming*" or "Our vacation is *ahead* of us," or "The honeymoon *followed* the wedding" without being aware of the spatial metaphors that appear to underpin our temporal speech. We employ this type of metaphor with such frequency that they have acquired a ubiquity that tends to hide their origins.

As Gentner and Imai (1992) note time is usually seen as unidirectional and unidimensional because it moves in one direction and in a linear form. For this reason the terms that are borrowed from the domain of space and used to express time are also unidimensional, such as forward/backward, and front/back rather than multidimensional terms like shallow/deep, narrow/wide.

The *motion of time* represents one framework for how spatio-temporal metaphors are comprehended and is determined by the future moving to the past. This is explained by a simple example. In the month of February, Christmas is now in the future; in a few months it will soon be moved to the present and then to the past. The individual is a stationary observer as time "flows" past him, as in the example *The party is after the seminar.* This system is known as the *Time Moving* metaphor (in this metaphor, temporal events are seen as moving past an observer like "objects", hence its spatial equivalent is the *Object Moving* metaphor).

The second system is the *Ego-Moving* metaphor where the ego or the individual moves from the past to the future such as the sentence *His vacation at the beach lies before him* (in this metaphor, the observer is seen as moving forward through time, passing temporal events which are seen as stationary points, hence it is the temporal equivalent of the spatial *Ego Moving* system, where the observer moves forward through space).

These spatial metaphors for understanding time appear to represent an instance of the kind of conceptual scheme proposed by Lakoff and Johnson (1980) in their Conceptual Metaphor hypothesis. According to this hypothesis, metaphors are not just a 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 as the Conceptual Metaphor (see also Gibbs, 1992). 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 a subordinate metaphor such as *Your claims are indefensible*.

Lakoff and Johnson extend the idea of Conceptual Metaphor to spatio-temporal metaphors by invoking the 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. (for a critique of this view see McGlone, 1996; Murphy, 1996).

Embodiment Theory

The notion of Conceptual Metaphor is part of a deeper theory concerning the way we process and categorise objects around us (Lakoff and Johnson, 1999). Lakoff and Johnson introduce the idea of *embodiment*, which incorporates our experiences as an integral part in the formation of concepts (see also Barsalou, in press). They claim that categorisation is not a product of conscious reasoning or the intellect but results instead as a product of our embodied experiences. It is our interaction with the circumstances in which we are immersed that, according to this view, helps us to formulate the structures that enable us to function in, and comprehend the everyday situations in which we find ourselves.

The embodiment theory can be summed up in the following statement: "An embodied concept is 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).

Although the embodiment theory makes much reference to neural structure, Lakoff & Johnson cite no neurophysical evidence to confirm their theory (but c.f. Pulvermüller, in press). Instead they make exclusive reference to language to support the embodiment theory. For example, our use of words like *front, back, forward* are all contingent on our bodies and its interaction with things around us. Because of our dependence on our bodily projections to conceptualise objects, this theory is labelled as a "phenomenological embodiment" (Lakoff and Johnson, 1999, p.36).

Lakoff and Johnson go further to claim that this notion of embodiment blurs the distinction between perception and conception. It has previously been assumed that the formulation of concepts is based purely on reason and that, while perception may influence reason and cause motion, neither perception or movement is considered part of reason. On the other hand, perception has been associated with movement and separate from conception or mental processes. However, according to the embodiment theory, perception and movement are fundamental to conception as well, because of the important role embodiment plays in categorisation.

Our spatial-relation words (*ahead, under, forward*) depend on our embodied perception and movement, which allow us to conceptualise actions or events. Thus the theory of Embodiment is intimately connected to the theory of Conceptual Metaphor because it is our experiences that drive our formulation of Complex Metaphors such as LOVE IS A JOURNEY or ARGUMENT IS WAR. From our daily experiences, we form an understanding of events and cluster them in a category that serves to allow us to function more effectively in daily life.

The Schema-Mapping Hypothesis

Gentner and Boronat (1991) have observed that since metaphors are processed from a common base schema to a common target schema, such processing should be fluent because of important similarities in the underlying metaphoric schemas. On the other hand, if metaphors from different schemas are presented, the processing time should increase because the individual has to shift between different perspectives.

Gentner and Boronat tested this idea by presenting participants with consistent and inconsistent metaphors. They discovered that there was a significant decrease in reading time when an inconsistent metaphor was presented after a series of consistent metaphors. Gentner and Boronat suggested that this time decrease was a result of remapping because the metaphors were processed as schema consistent mappings. Thus the schema consistency paradigm suggests that when an individual is presented with a metaphor from a different schema, they have to make a shift from one schema to the other and this shift causes a lapse or disturbance in processing.

The idea that schema consistency could increase mapping efficiency has been extended to encompass spatio-temporal metaphors. Gentner and Imai (1992)

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

propose that these particular types of metaphors are processed via two distinct internally consistent systems. Gentner and Imai carried out several experiments to test this hypothesis. Participants were presented with either *ego-moving* or *time-moving* metaphor materials that used words like *before, ahead,* or *behind* to serve as locative prepositions. Subsequently, participants were asked to respond to questions that were either consistent or inconsistent with the type of metaphor embodied in these priming materials.

Gentner and Imai found that participants responded faster to questions that were consistent with the 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 was passed two days ago"; in each case, 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).

These experiments offer some support to the embodiment theory, with its concomitant claim that embodiment in the world affects conceptualisation. They appear to show that participants ' perception of space has a direct effect on their conceptualisation of time.

Lakoff and Johnson (1999) cite experiments carried out by Boroditsky (1998) in support of the embodiment theory. Boroditsky (1998) suggests that there is an explicit analogy between two schemas for organising space and time. On this analogy, *ego-moving* schemas are defined - for both space and time in respect to an observer's direction of motion. The 'front' is assigned as the furthest forward point in the observer's direction of motion: thus in time, 'front' is assigned to the future, and in space, if objects are conceived of in linear fashion along a path, then 'front' is assigned to the objects that are furthest forward - relative to the observer's direction of motion along the path. For *time-* and *object-moving* schemas, front is set to the furthest forward point in the direction of the movement of time or objects. Since time is usually conceived of as moving from future to past, 'front' is assigned to past, or earlier events. By analogy, in space, if two objects are moving (whether they have intrinsic 'fronts' or not),[4] then front is assigned to the leading part of the leading object.

Boroditsky presented participants with the phrase *Next Wednesday's meeting has been moved forward two days* together following either *ego-moving* metaphor or *time-moving* metaphor primes and asked them what day the meeting would be on. Her findings suggest that participants were not influenced by primed temporal schemas in responding to a problem about space; but spatial schemas had an effect in their responses to temporal questions.

Of central concern to us in this paper is the assertion by Lakoff and Johnson that Boroditsky's findings (and those of Gentner and Imai, 1992, and McGlone and Harding, 1998) should be accounted for by an *embodied* theory of conceptual understanding. In arguing for embodiment as the basis for our concepts, Lakoff and Johnson (1980; 1999) argue that language through metaphoric representation, or Conceptual Metaphors influences thought; and equally, they imply that ultimately it is thought manifest in embodied perception that influences language.

The Saphir-Whorf hypothesis

A different perspective on the language-thought debate the theory that language is primary - is put forward in the Saphir-Whorf hypothesis. This can take numerous forms: the strong version of the Saphir-Whorf hypothesis claims that language *determines* thought, whilst weaker versions suggests that language *affects* perception (and hence thought). Other theorists have taken even stronger positions: Wittgenstein (1953) explicitly questions and rejects the idea that "thought" as we understand it as linguistic animals - can exist independently of language at all.

A significant portion of the evidence for the Saphir-Whorf hypothesis is anthropological. For example, it has been claimed that languages indigenous to several different Native American Indian groups (such as Hopi, Nootka, Apache, and Aztec) each have a unique vocabulary that allows them to express events or spatial movement differently to what is possible in English. According to

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[2] Although McGlone and Harding (1998) criticise some aspects of Gentner and Imai's methodology, their corrected replication of the original study confirms its findings.
[3] All trials were conducted on a Wednesday.

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[4] Thus, when a car reverses, for instance, the back of the car is in front.

the Saphir-Whorf hypothesis this difference in vocabulary suggests that these cultures perceive events and space differently.

Proponents of the Saphir-Whorf hypothesis would also claim that grammatical differences document a pattern of how attention is attributed to particular objects. For example, in Navaho the endings of verbs correspond with the shape and rigidity of the object in mention. This grammatical distinction may well be a consequence of the attention that Navahos give to the properties of objects; it is claimed that the prominence of these forms of verb and verb endings are is indicative of deeper ways of thinking among the Navaho Indians. Fillmore (1971) suggests that our understanding of space is indicated in a similar way by language. He cites several different cultural and language groups to support the theory that language reveals our categorisation of time (or systems of spatial-relations concepts as Lakoff and Johnson refer to it). In English the different uses of the prepositions *on* and *in* are indicative of different spatial features. Fillmore claims that the use of *on* is reserved for surface words like *on the lawn*, and when used as a phrase like *on the earth*, it denotes the surface of a three-dimensional object. The word *in* applies to three-dimensional spaces (e.g., *in the yard*); so *in the earth* refers to the three-dimensional area of the earth as opposed to just the surface area. In other languages such as Samal (spoken in the Philippines), there are single terms that refer to concepts such as *near me, near you* or *away from all of the above*. The prevalence of these expressions reveals how speakers of languages in this particular group locate people spatially, and thus, according to Fillmore, how they perceive the spatial world.

Thought and Language

On the one hand, the Saphir-Whorf hypothesis suggests that by studying the language of a culture, we can begin to understand that culture's cognitive processes. On the other, the embodiment theory presents a very different notion. Lakoff and Johnson (1999) suggest that in the final analysis, thought influences language language is ultimately the slave of our (universal) embodied thought.

Clearly the results of the experiments described above, which are based upon the schema consistency paradigm, (Gentner and Imai, 1992; McGlone and Harding, 1998; Boroditsky, 1998) are consistent with either view. It could be the case - as the embodiment theory would predict - that our understanding of space and time is causally determined by the embodied shape of our perceptions. On the other hand, it may be that language is the final arbiter of our concepts, and whatever words and metaphors we choose to employ in talking about space and time is by far the greater determinant of the way we conceptualise them. In either case, schema consistency would be promoted by the experimental conditions that obtained in the studies reviewed above.

Unfortunately, as their mutual compatibility with the evidence shows, a major problem with speculations about the ontogeny of temporal and spatial concepts is finding any way of empirically distinguishing between them. The following experiment was designed as an attempt to disentangle these competing accounts. We aimed to determine what is more important in ensuring schema consistent reasoning - embodied thought, or explicit language.

Experiment 1

Participants in Boroditsky's (1998) experiment were given visual primes that also included an explicit linguistic element. Participants were presented with a diagram of an observer moving towards some objects, and had to answer the question

[OBJECT] IS AHEAD OF ME   TRUE/FALSE

Thus it is hard to distinguish whether it was participants' embodied perception of the movement in the stimuli, or their reaction to the explicit linguistic elements that played the predominant role in determining their schema consistent inferences.

By fully involving participants in a non-linguistic task that was heavily biased towards a particular space metaphor schema, we aimed to explore the respective influences of simple immersion in such a task, and immersion with explicit linguistic priming, on schema consistency.

Participants

Sixty-eight undergraduate students of the University of Edinburgh, all native English speakers, served as volunteers. They were not aware of the nature of the experiment.

Materials

In order to immerse participants in a task that embodied a particular spatial schema we utilised a video game where the individual was stationary and had to defend himself against approaching attacks. Thus the game embodied the *object-moving* metaphor. The game was mouse-controlled and was uncomplicated. The participants controlled a stationary anti-aircraft gun at the bottom of the computer screen and had to shoot parachuters that came from the sky. At the end of each level, participants were able to replenish their ammunition The levels did not differ in their objective.

Movement in this game was limited, in that the parachutists that came towards the stationary subject were the only moving objects. Thus consistent with the moving-object schema, participants were stationary, with FRONT being assigned to the furthest point forward in the direction of the movement of objects (so that the parachutist that had travelled furthest towards the gun was "in front").

Next to the computer was a box with a three-way switch with attached light bulbs. No attention was directed to this box until the middle of the game.

Procedure

All participants were tested individually and apart from the control group were required to play the video game for five minutes. (Instructions given to the participants

were that they were required to progress to level 4 without being eliminated.) There were three groups of participants.

The first group acted as a control group. They were simply presented with the target task the switch box - whilst performing an unrelated task, and then asked to

"move the switch forwards"

The second group played the game for the requisite five minutes. Once they had completed their session, they were instructed to:

"move the switch forwards"

to indicate that they had completed playing. Two further questions were designed to check the effectiveness of the prime. At the end of the computer game, participants were asked an open-ended question, which required them to describe which parachuters (as described by screen location) they perceived to be the biggest threat.

As a final priming check, they were then asked to determine if the following statement was true or false:

During the game, it was more important to first shoot the parachuters in the front.

These questions evaluated whether participants had represented the parachuters that were closer to the ground as being in front. This would be consistent with an *object-moving* schema and in a schema-consistent mapping should determine their assignment of forward in moving the switch as well. Since participants were mapping FRONT to objects moving towards themselves (in their role as the gun controller), they should move the switch towards themselves when moving it *"forward"*.

The third group of participants also played the game for the requisite five minutes, but they received an explicit linguistic assignment of FRONT during their session. Instead of being asked about the game after they had finished playing, as in condition 2, participants were posed the priming check questions (identical to those for condition 2) during the course of their game playing session. That is, participants were required to explicitly verbalise their priming whilst they were immersed in the task.

Once again, at the end of level four in the game, these participants were instructed to *Move the switch forward* on the switch board.

In all conditions, a light bulb indicated which direction the switch had been moved.

Hypotheses

Since the switch moving task was inherently ego-centric (the actor in the task being the subject) we expected in the control condition that participants, when asked to perform the task of moving a switch forward with no additional priming, would assign FRONT to the direction they were facing, and hence *"move the switch forward"* would map to FRONT in the *ego-moving* system, with *forward* being assigned the direction away from the subject. Since we expected the natural bias of interpretation in the switch task to be against the bias of

the priming, we expected to be able to measure the relative strength of embodied versus verbal priming by gauging the extent to which this natural bias could be defeated.

In the two game playing conditions, we hypothesised the following:

• If embodiment was the most significant determinant of thought, then participants primed in the *ego-moving* system by the task should tend to prefer schema consistency and hence reassign FRONT to objects coming towards them, mapping *"move the switch forward"* to FRONT in the *object-moving* system, with *forward* being the direction towards the subject

• If language was a more significant determinant of thought, then participants primed in the *ego-moving* system by the task *with* verbal priming should tend to prefer schema consistency and reassign FRONT to objects coming towards them, and hence map *"move the switch forward"* to FRONT in the *object-moving* system, with *forward* being the direction towards the subject. To the extent which verbal priming contributes to the adoption of a particular schema, participants in this condition should be more likely to be primed, compared to those primed only by the embodied task.[5]

Results

Data from all of the participants that responded incorrectly to the prime testing questions in the primed conditions was rejected. The overall error rate was 9% and it was equally distributed between the embodied prime and embodied-plus-explicit-verbal prime conditions.

As predicted, in the control condition, 100% of participants mapped FORWARD in *"move the switch forward"* to FRONT in the *ego-moving* system, and moved the switch on the switch-board away from themselves.

In the embodied prime condition, only 16% of participants responded in a prime consistent manner (assigning front according to the *object-moving* system), whereas 84% of participants continued to respond in a way consistent with the *ego-moving* system. This change was not significant when considered together with the result from the control group.

In the linguistic prime condition, 50% of participants responded in the embodied prime consistent manner (assigning front according to the *object-moving* system), whilst 50% of participants continued to respond in a way consistent with the *ego-moving* system. A chi-squared[6] analysis showed this to be significantly different from the distribution found in the control group χ (1, N=43) = 12.314, p<.0.001.

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[5] Since Lakoff and Johnson allow for both linguistic and embodied influences on concepts, the experiment was designed to separate the effects of embodied priming against linguistic priming, but not vice versa.

[6] Because of the low numbers (0) in the cells in the control, this analysis used Yates' corrected chi.

Discussion

Our results showed that language - in the form of explicit verbal acknowledgements of primes in the *object-moving* metaphoric system could significantly reverse participants' natural bias to assign FORWARD in an *ego-moving* manner. However, no such reversal was evident when the primes were solely of an embodied nature, despite the fact that subsequent tests showed that participants had been affected by that priming.

If, as Lakoff and Johnson (1999) suggest, thought influences language and therefore 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 embodied plus verbal priming. However, the effects of pure embodied priming were negligible.

The Saphir-Whorf hypothesis, on the other hand, maintains that language influences thought. Our finding that participants that were required to explicitly verbalise the concept of FRONT they had assigned as a result of the *object-moving* metaphor were more likely to be primed is consistent with this. Our experiment suggests that linguistic priming might be the key factor in overriding the natural bias of an individual to assign FRONT based on himself. This is an interesting twist in the relationship between language and thought and we look forward to pursuing further research in this area.

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