First-Language Thinking for Second-Language Understanding: Mandarin and English Speakers' Conceptions of Time

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Abstract

Does the language you speak affect how you think about the world? English and Mandarin speakers talk about time differently. Is this difference between the two languages reflected in the way their speakers think about time? The findings of two RT experiments show that different ways of talking about time lead to different ways of thinking. In Experiment 1, Mandarin-English bilinguals were compared to native English speakers. The results suggested that Mandarin speakers used a "Mandarin way of thinking" even when they were "thinking for English" In Experiment 2, native English speakers were trained to talk about time in "a Mandarin way" Results showed that even after a short training, native English speakers behaved more like Mandarin speakers than like untrained English speakers. It is concluded that language is a powerful tool in shaping thought.

Introduction

Does the language you speak shape the way you understand the world? Linguists, philosophers, anthropologists, and psychologists have long been interested in the role that languages might play in shaping their speakers' ways of thinking. This interest has been fueled in large part by the observation that different languages talk about the world differently. Does the fact that languages differ mean that people who speak different languages think about the world differently? Does learning new languages change the way one thinks? Do polyglots think differently when speaking different languages? Although all of these questions have long been issues of interest and controversy, definitive answers are scarce. This paper briefly reviews the empirical history of these questions and describes two experiments that demonstrate the role of language in shaping habitual thought.

The strong Whorfian view that thought is entirely determined by language has long been abandoned in the field. Rosch's (1972, 1975, 1978) work on color perception demonstrating that the Dani, despite having only two words for colors, had little trouble learning the English set of color categories was particularly effective in undermining the strong view (but see Lucy & Shweder, 1979). Although the strong linguistic determinism view seems untenable, many weaker (but still interesting) formulations can be entertained. For example, Slobin (1987, 1996) suggested that language may influence categorization during "thinking for speaking." In a similar vein, Hunt and Agnoli (1991) reviewed evidence that language may influence thought by making habitual distinctions more fluent. Recently, several lines of research have explored domains that appear more likely to reveal linguistic influences than such lower level domains as color perception. Among the new evidence have been studies of cross-linguistic differences in the object-substance distinction in Yucatec Mayan and Japanese (e.g. Imai & Gentner, 1997; Lucy, 1992), differences in thinking about spatial relations in Dutch, Korean, and Tzeltal (e.g. Bowerman, 1996; Levinson, 1996), and evidence suggesting that language influences conceptual development (e.g. Markman & Hutchinson, 1984; Waxman & Kosowski, 1990). It is possible that language is most powerful in determining thought for domains that are more abstract, i.e. ones that are not so closely tied to sensory experience (see Gentner & Boroditsky, in press for related discussion).

Although these new lines of evidence are suggestive, there are several limitations common to most of the studies. First, speakers of different languages are usually tested only in their native language. Any differences found in these kinds of comparisons can only show the effect of a language on thinking for that particular language. These differences cannot tell us whether experience with a language affects language-independent thought such as thought for other languages, or thought in non-linguistic tasks. Further, comparing results from studies conducted in different languages poses a deeper problem: there is simply no way to be certain that the stimuli and instructions are truly the same in both languages[1]. Since there is no way to know that subjects in different languages are performing the same task, it is difficult to deem the comparisons meaningful.

[1] This is a problem even if the verbal instructions are minimal. For example, even if the task is non-linguistic, and the instructions are simply "which one is the same?", one cannot be sure that the words used for "same" mean the same thing in both languages. If in one language the word for "same" is closer in meaning to "identical," while in the other language it's closer to "similar", the subjects in different languages may behave very differently, but due only to the difference in instructions not because of any interesting differences in thought. There is no sure way to guard against this possibility when tasks are translated into different languages.

A second limitation is that even when non-linguistic tasks (such as sorting into categories, or making similarity judgments) are used, the tasks themselves are quite explicit. Sorting and similarity judgment tasks require a subject to decide on a strategy for completing the task. How should I divide these things into two categories? What am I supposed to base my similarity judgments on? It is quite possible that when figuring out how to perform a task, subjects simply make a conscious decision to follow the distinctions reinforced by their language. For this reason, evidence collected using such explicit dependent measures as sorting preferences or similarity judgments is not convincing as non-linguistic evidence.

Showing that experience with a language affects thought in some broader sense (other than thinking for that particular language) would require observing a cross-linguistic difference on some implicit dependent measure (e.g. reaction time) in a non-language-specific task. The set of studies described in this paper does just that. The findings show an effect of first-language thinking on second-language understanding using the implicit measure of reaction time. In particular, the studies investigate whether speakers of English and Mandarin Chinese think differently about the domain of time even when both groups are "thinking for English."

Time

Across languages people use spatial metaphors to talk about time. Whether we are looking *forward* to a brighter tomorrow, proposing theories *ahead* of our time, or falling *behind* schedule, we are relying on terms from the domain of space to talk about time. Many researchers have noted an orderly and systematic correspondence between the domains of space and time in language (Clark, 1973; Lehrer, 1990; Traugott, 1978).

This paper will focus on the event-sequencing aspect of conceptual time, that is, the way events are temporally ordered with respect to each other and to the speaker (e.g. "The worst is *behind* us" or "Thursday is *before* Saturday.") There are many striking similarities in the types of spatial terms used to talk about time across languages. In order to capture the sequential order of events, time is generally conceived as a one-dimensional, directional entity. The spatial terms imported to talk about time are one-dimensional, directional terms such as *ahead/behind*, or *up/down*, rather than multi-dimensional or symmetric terms such as *shallow/deep*, or *left/right* (Clark, 1973). Although all languages use spatial terms to talk about time, there are some interesting differences in the types of spatial terms used.

Time in English In English, we predominantly use front/back terms to talk about time. We can talk about the good times *ahead* of us, or the hardships *behind* us. We can move meetings *forward*, push deadlines *back*, and eat dessert *before* we're done with our vegetables. On the whole, the terms used to talk about the order of events in English are the same terms that are used to describe asymmetric horizontal spatial relations (e.g. "he took three steps *forward*" or "the dumpster *behind* the store").

Time in Mandarin Chinese In Mandarin, front/back spatial metaphors for time are also common (Scott, 1989). Mandarin speakers use the spatial morphemes *qián* "front" and *hòu* "back" to talk about time. Figure 1 shows parallel uses of *qián* and *hòu* in spatial and temporal orderings in Mandarin and their English glosses. Examples were taken from Scott (1989).

(1) SPACE

zài zhuōzi qián-bian zhàn-zhe yí ge xuésheng
there is a student standing in front of the desk

TIME

hǔ nián de qián yí nián shì shénme nián?
what is the year before the year of the tiger?

(2) SPACE

zài zhuōzi hòu-bian zhàn-zhe yí ge lǎoshī
there is a teacher standing behind the desk

TIME

dàxué bìyè yǐ-hòu wǒ yòu jìn le yánjiūyuàn
after graduating from university, I entered graduate school

Figure 1: Examples of spatial and temporal uses of horizontal terms *qián* and *hòu* in Mandarin given with their English glosses

What makes Mandarin interesting for our purposes, is that in addition to these front/back or horizontal metaphors, Mandarin speakers also systematically use up/down or vertical metaphors to talk about time (Scott, 1989). The spatial morphemes *shàng* - "up" and *xià* "down" are frequently used to talk about the order of events, weeks, months, semesters, and more. Earlier events are said to be *shàng* or "up", and later events are said to be *xià* or "down" Figure 2 shows parallel uses of *shàng* and *xià* to describe spatial and temporal relations (examples taken from Scott, 1989).

(1) SPACE

māo shàng shù
cats climb trees

TIME

shàng ge yuè
last (or previous) month

(2) SPACE

tā xià le shān méi yǒu
has she descended the mountain or not?

TIME

xià ge yuè
next (or following) month

Figure 2: Examples of spatial and temporal uses of vertical terms *shàng* and *xià* in Mandarin given with their English glosses

Although in English vertical spatial terms can also be used to talk about time (e.g. "hand *down* knowledge from generation to generation" or "the meeting was coming *up*"), these uses are not nearly as common or systematic as is the use of *shàng* and *xià* in Mandarin (Scott, 1989). The closest English counterparts to the Mandarin uses of *shàng* and *xià* are the purely temporal terms earlier and later. Earlier and later are similar to *shàng* and *xià* in that they use an absolute framework to determine the order of events.

Relative versus absolute terms for time In Mandarin, *shàng* always refers to events closer to the past, and *xià* always refers to events closer to the future. The same is true in English for *earlier* and *later* terms respectively. This is not true, however, for the other English terms used to talk about time. Terms like *before/after*, *ahead/behind*, and *forward/back* can be used not only to order events relative to the direction of motion of time, but also relative to the observer. When ordering events relative to the direction of motion of time, we can say that Thursday is *before* Friday. Here, *before* refers to an event that's closer to the past. However, we can also order events relative to the observer as in "The best is *before* us." Here, *before* refers to an event closer to the future. The same is true for *ahead/behind* and *forward/back*. *Qián* and *hòu*, the horizontal terms used in Mandarin to talk about time, also share this flexibility. Unlike *before/after*, *ahead/behind*, and *qián/hòu*, terms like *earlier/later* and *shàng/xià* are not used to order events relative to the observer. For example, one cannot say that "the meeting is *earlier* than us" to mean that it is further in the future. *Earlier/later* and *shàng/xià* are absolute terms.

In summary, both Mandarin and English speakers use horizontal relative terms to talk about time. In addition, Mandarin speakers use the vertical absolute terms *shàng* and *xià* to talk about time. This way of talking about time is most conceptually similar to the English use of the purely temporal terms *earlier* and *later*.

Of interest to this study is whether this difference between the English and Mandarin ways of talking about time also leads to a difference in how the two groups think about time. The particular question is whether Native Mandarin speakers are more likely to rely on vertical spatial schemas to think about time in absolute terms, while Native English speakers are always more likely to rely on horizontal spatial schemas.

In order to answer the above questions, we will need a way of determining which spatial schemas Mandarin and English speakers are using when they are thinking about time. The schema-consistency paradigm developed by Boroditsky (1998) allows us to do just that. The basic rationale of the schema-consistency paradigm is as follows. If an appropriate spatial schema is primed, people should be faster to understand statements about time that employ that same schema. Therefore, if English speakers are thinking about time horizontally, then asking them to think about horizontal spatial relations right before they read a sentence about time should make them faster to understand that sentence than if they had just been thinking about vertical spatial relations. The reverse should be true for Mandarin speakers. When thinking about time in absolute terms, Mandarin speakers should be faster after vertical primes than after horizontal primes.

In Experiment 1, Mandarin and English speakers solved sets of spatial priming questions followed by a target question about time. The spatial primes were either about horizontal spatial relations between two objects (see Figure 3), or about vertical relations (see Figure 4). After solving a set of 2 primes, participants answered a TRUE/FALSE target question about time that either used relative terms (e.g. "March comes *before* April.") or absolute terms (e.g. "March comes *earlier* than April"). Of interest was whether the prime questions had a different effect on how long it took English speakers to answer the different target questions as compared to the Mandarin speakers.

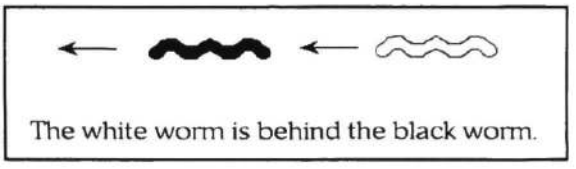

Figure 3: Example of a horizontal spatial prime used in Experiments 1 & 2

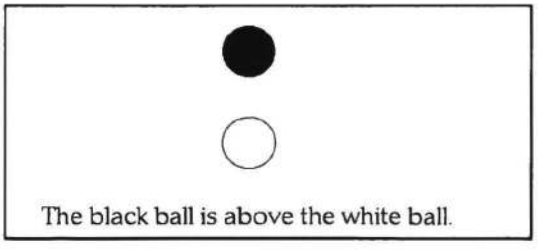

Figure 4: Example of a vertical spatial prime used in Experiments 1 & 2

If one's native language does affect how one thinks about time, then Mandarin speakers should be faster to answer absolute target questions about time after solving the vertical spatial primes than after solving the horizontal spatial primes. English speakers, on the other hand, should always be faster after horizontal primes because horizontal terms are predominantly used in English. Since both English and Mandarin speakers completed the task in English, this is a particularly strong test of the effect of one's native language on thought. If Mandarin speakers do show a vertical bias in thinking about time even when they are "thinking for English," then language must play an important role in shaping speakers' thinking habits.

Experiment 1

Method

Participants 26 native English speakers, and 20 native Mandarin speakers participated in this study. All participants were graduate or undergraduate students at Stanford University, and received either payment or course credit in return for their participation.

Design The experiment had a fully crossed within-subject 2 (prime-type) X 2 (target-type) design. Targets were statements about time: either *before/after* statements (e.g. "March comes *before* April"), or *earlier/later* statements (e.g. "March comes *earlier* than April"). Primes were spatial scenarios accompanied by a sentence description and were either horizontal (see Figure 3) or vertical (see Figure 4). Each participant completed a set of 6 practice questions and 64 experimental trials. Each experimental trial consisted of two spatial prime questions (both horizontal or both vertical) followed by one target question about time. Participants were not told that the experiment was arranged into such trials, nor did they figure it out in the course of the experiment. Participants answered each target question twice once after each type of prime. The order of presentation of all trials was randomized for each participant.

Materials A set of 128 primes and 32 targets, all TRUE/FALSE questions, was constructed.

Primes: 128 spatial scenarios were used as primes. Each scenario consisted of a picture and sentence below the picture. Half of these scenarios were about horizontal spatial relations (see Figure 3), and the other half were about vertical spatial relations (see Figure 4). Half of the horizontal primes used the "X is *ahead* of Y" phrasing and half used the "X is *behind* Y" phrasing. Likewise, half of the vertical primes used the "X is *above* Y" phrasing and have used the "X is *below* Y" phrasing. Primes were equally often TRUE and FALSE. All of these variations were crossed into eight types of primes. In addition, the left/right orientation of the horizontal primes was counterbalanced across variations.

Targets: 16 statements about the order of the months of the year were constructed. Half of these statements used the relative terms *before* and *after*, and half used the absolute terms *earlier* and *later*. All four terms were used equally often. All target questions were "TRUE".

Fillers: 16 additional statements about months of the year were used as fillers. These statements were similar in all respects to the target questions except that all of the fillers were "FALSE". This was done to insure that subjects were alert and did not simply learn to answer "TRUE" to all questions about time. Filler time questions (along with filler spatial scenarios drawn randomly from the list of all spatial primes) were inserted randomly in-between experimental trials to ensure that participants did not deduce the trial structure of the experiment. Responses to filler trials were not analyzed.

Procedure Participants were tested individually. All participants were tested in English with English instructions. Stimuli were presented on a computer screen, one question at a time. For each question, participants were asked to make a TRUE/FALSE response as quickly as possible by pressing one of two keys on a keyboard. Response times were measured and recorded by the computer. There was a response deadline of 5 seconds. If a participant did not provide a response within 5 seconds, the computer simply went on to the next question. There was no feedback for the experimental trials.

Results

Separate 2 (prime type) X 2 (target type) repeated measures ANOVAs were conducted for data collected from English and Mandarin speakers. Response times exceeding the deadline, incorrect responses, and those following an incorrect response to a priming question were omitted from all analyses.

As expected, native English speakers were faster to solve time questions after horizontal primes (M = 2128 msecs, SD = 545 msecs) than after vertical primes (M = 2300 msecs, SD = 682 msecs). The main effect of the prime was significant, $F(1, 25) = 13.76$, $p = 0.001$. There was no interaction between prime-type and target-type, $F(1, 25) = .75$, $p = 0.40$. English speakers were faster to solve all questions about time if they followed horizontal primes than if they followed vertical primes.

The data from Mandarin speakers looked very different. There was no main effect of prime, $F(1, 19) = .01$, $p=.92$. Overall, Mandarin speakers answered time questions just as fast after horizontal primes (M = 2422 msecs, SD = 493 msecs) as after vertical primes (M = 2428 msecs, SD = 443 msecs). However, there was a significant interaction between prime-type and target-type, $F(1, 19) = 4.55$, $p<.05$. Like the English speakers, Mandarin speakers were faster to answer the relative *before/after* target questions after horizontal primes (M = 2340 msecs) than after vertical primes (M = 2509 msecs). As predicted, the pattern was exactly reversed for the absolute *earlier/later* targets. Unlike the English speakers, Mandarin speakers were faster to solve *earlier/later* targets after vertical primes (M = 2347 msecs) than after horizontal primes (M = 2503 msecs).

Discussion

Native English and native Mandarin speakers were found to think differently about time. This was true even though both groups performed the task in English. In Experiment 1, English speakers were always faster to answer questions about time after horizontal primes than after vertical primes. Mandarin speakers showed a very different pattern. Like the English speakers, they were faster to answer the relative *before/after* targets after horizontal primes than after vertical primes. The reverse was true for the absolute *earlier/later* targets; unlike the English speakers, Mandarin speakers were faster to answer the absolute *earlier/later* targets after vertical primes than after horizontal primes. Overall these findings suggest that while English speakers relied on horizontal spatial schemas to think about both types of targets, Mandarin speakers relied on horizontal schemas only when thinking about the relative terms *before* and *after*. For the absolute *earlier/later* targets, Mandarin speakers relied on vertical schemas. This is exactly the pattern we would predict from the way Mandarin speakers talk about time since Mandarin uses vertical metaphors (*shàng* and *xià*) to talk about time in absolute terms, and horizontal metaphors (*qián* and *hòu*) to talk about time ir relative terms. In short, Mandarin speakers in our stud

showed a pattern of first-language thinking in second-language understanding.

Although these results are highly suggestive of an effect of language on thought, there are some concerns. First, the difference in the time metaphors used in English and Mandarin is clearly not the only difference between the two languages. Many other factors could conceivably have led to the differences we observed. One important factor to consider is that of writing direction. Whereas English is written horizontally from left to right, Mandarin was traditionally written in vertical columns that ran from right to left. Although this difference in writing direction is interesting, it cannot explain the results obtained in Experiment 1. The writing direction explanation would predict a main effect of prime since Mandarin is written vertically, Mandarin speakers should always be faster to answer time questions after vertical rather than after horizontal primes. This prediction was not borne out in data. Mandarin speakers showed an interaction between target and prime, and not the main effect predicted by writing direction. Therefore, writing direction cannot be responsible for the differences observed in this experiment.

Beyond differences in language, there may be many cultural differences between native English and native Mandarin speakers that may have lead to differences in the response patterns. Although a clear non-language-based explanation that would predict the observed pattern of results is not readily apparent, we can not *a priori* discount the possible effects of cultural differences. Experiment 2 was designed to minimize differences in non-linguistic cultural factors while preserving the interesting difference in language.

In Experiment 2, native English speakers were trained to talk about time using vertical terms. For example, they learned to say that "cars were invented *above* fax machines" and that "Wednesday is *below* Tuesday." The use of vertical terms *above* and *below* in this training was maximally similar to the use of *shàng* and *xià* in Mandarin. *Above* and *below*, like *shàng* and *xià*, were used as absolute terms. Earlier events were always said to be *above*, and later events were always said to be *below*. After the training, participants completed exactly the same experiment as in Experiment 1. If it is indeed language (and not other cultural factors) that led to the differences between English and Mandarin speakers in Experiment 1, then the "Mandarin" linguistic training given to English speakers in Experiment 2 should make their pattern of results look more like that of Mandarin speakers than that of English speakers.

Experiment 2

Method

Participants 32 Stanford University undergraduates, all native English speakers, participated in this study in exchange for course credit.

Materials and Design Participants were told they would learn "a new way to talk about time." They were given a set of 5 example sentences that "used this new system" (e.g. "Monday is *above* Tuesday") and were asked to figure out on their own how the system worked. The new system used *above* and *below* as absolute terms. Events closer to the past were always said to be *above*, and events closer to the future were always said to be *below*. Participants were then tested on a set of 90 questions that used these vertical terms to talk about time (e.g. "Nixon was president *above* Clinton"). These test questions were presented on a computer screen one at a time, and participants responded TRUE or FALSE to each statement by pressing one of two keys on the keyboard. Immediately after the training, participants went on to complete the experiment described in Experiment 1. After the initial training, all materials, instructions, and procedures were identical to those used in Experiment 1.

Results and Discussion

As in Experiment 1, response times exceeding the deadline, incorrect responses, and those following an incorrect response to a priming question were omitted from all analyses. A 2 (prime type) X 2 (target type) repeated measures ANOVA was conducted.

The pattern of results in this experiment was very similar to that obtained for Mandarin speakers in Experiment 1. There was no main effect of prime, $F(1, 31) = 1.29$, $p=.27$. Unlike untrained English speakers, participants trained in the new system for talking about time were not significantly faster to answer time questions after horizontal primes (M = 2235 msecs, SD = 599 msecs) than after vertical primes (M = 2300 msecs, SD = 588 msecs). However, just as was the case with Mandarin speakers, there was a significant interaction between prime-type and target-type, $F(1, 31) = 5.40$, $p < .05$. Just like Mandarin speakers and untrained English speakers, trained participants were faster to answer the relative *before/after* target questions after horizontal primes (M = 2141 msecs) than after vertical primes (M= 2334 msecs). As predicted, the pattern was exactly reversed for the absolute *earlier/later* targets. Like the Mandarin speakers, and unlike the untrained English speakers, trained participants were faster to solve *earlier/later* targets after vertical primes (M= 2266 msecs) than after horizontal primes (M = 2330 msecs). Overall, English speakers who were trained to talk about time using vertical *above/below* terms, showed a pattern of results very similar to that of Mandarin speakers. These results confirm that, even in the absence of other cultural differences, differences in talking can indeed lead to differences in thinking.

Conclusions

In the realm of abstract domains like time, one's native language appears to exert a strong influence on how one thinks about the world. In Experiment 1, Mandarin speakers relied on a "Mandarin" way of thinking about time even when they were thinking about English sentences. Mandarin speakers were more likely to think about time in vertical terms when an absolute reference frame was used, but not when a relative reference frame was used. This pattern of results is predicted by the way Mandarin talks

about time; vertical terms are used in an absolute reference frame, and horizontal terms are used in relative reference frames. English speakers were always more likely to think about time horizontally because horizontal spatial terms predominate in English temporal descriptions. In Experiment 2, native English speakers who had just been trained to talk about time using vertical terms showed a pattern of results very similar to that of Mandarin speakers in Experiment 1. This finding confirms that the effect observed in Experiment 1 is driven by differences in language, and not by other non-linguistic cultural differences. Further, these results show that learning a new way to talk about a familiar domain, can change the way one thinks about that domain. Language can be a powerful tool in shaping abstract thought. When sensory information is scarce or inconclusive (as is the case with the domain of time), languages appear to play an important role in determining how their speakers think.

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