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Boroditsky's empirical studies on spatio-temporal association in Mandarin and English: A critical review

Abstract

This paper provides a critical review of Boroditsky and her collaborators' cross-linguistic empirical research on spatio-temporal association in mental conceptualization, to see if it is possible to render the actual relations between language and reality in a systematic manner. It also discusses a small selection of relevant studies conducted by other scholars within this domain. The analysis conducted in this paper sheds light on the shortcomings of the current cross-linguistic research on the relationship between language and thought, and similar problems related to the research on artificial intelligence (AI). Suggestions are given for future empirical study in this area.

Keywords: spatio-temporal association, mental conceptualization, empirical studies, language and thought

1. Introduction

While the strong version of linguistic determinism (Whorf, 1956) has been controversial since it first appeared, the question of "does language shape thought?" has never ceased to raise the attention of a number of linguists. For example, Kousta, Vinsen and Vigliocco (2008) investigate the semantic effects of grammatical gender on English-Italian bilinguals' perception of gender; Pyers and Senghas (2009) draw on evidence from learners of an emerging sign language in Nicaragua to show that language promotes false-belief understanding; Tajima and Duffield (2012) demonstrate that different sentence structures in Japanese and Chinese predispose their speakers to different attentional patterns.

Among all the subcategories of research in language and thought, one direction that is of particular interest to many psycholinguists and cognitive linguists has been the influence of spatial expressions in a language on the temporal perception of people using that language. The topic of spatial construal of time is actually not a novel one in studies of the relationship between language and thought. In 1954, Piaget explored the connection between spatial and temporal reasoning in child development; however, it is Clark (1973) who was the first to bring the issue of temporal concepts to the semantic grounding in language development. He proposes that children acquire expressions of space and time by learning how to apply these expressions to their prior knowledge about these concepts. Following Clark and pushing his study further, a great many scholars of linguistics, psychology and cognitive sciences have worked on the spatial-temporal association of language and thought. For instance, Gentner (2001) proposes and tests three possibilities to establish the conceptual role of space-time mappings: *system-mapping*, *cognitive archaeology*, and *structural parallelism*, finding that people's representation of time is actually structured in part by online structural analogies with the more concrete experiential domain of space. Vallesi, Binns and Shallice (2008) investigate how the abstract concept of time is represented in our cognitive systems, and suggest that one way in which the amount of elapsed time is cognitively represented is through the use of a spatial coordinate reference frame, from left to right. And via investigating grammatically-prescribed prepositions, Kranjec et al. (2010: 114, 111-116) demonstrate that the semantics of particular locative prepositions do constrain how we think about paired temporal concepts. Much evidence has pointed to the conclusion that people's perceptions of the abstract domain of time are derived from a more experience-based conceptualization of space: people tend to talk about time by employing spatial expressions.

The above-mentioned studies are all based on monolingual data, and the existing research mostly takes English as the focus of study while leaving a great number of other languages unconsidered. This kind of language-specific studies has a grave effect on the exploration of the general relationship between language and thought, as they can only demonstrate the influence of a language on thinking in that particular language – the results of which cannot be safely generalized (Borodistky, 2001; Kranjec, 2006). As Weist et al. (1999) have noted, languages have diverse temporal and spatial coding systems which definitely cannot be inferred from any single language. Even the temporal metaphors vary across languages. Members of different language communities develop

distinctive conceptual repertoires (Casasanto & Boroditsky, 2008: 579–593). As a result, in recent years, the importance of cross-linguistic studies on spatio-temporal association has been increasingly recognized by scholars working in this field (Casasanto & Boroditsky, 2008; Miles et al., 2011; Radden, 2004; Shinohara, 1999). Boroditsky could be considered the most influential yet controversial scholar who has published extensively – together with her collaborators – on the spatio-temporal association in order to demonstrate that language shapes thought.

The aim of this paper is to critically review Boroditsky and her colleagues' cross-linguistic empirical studies on spatio-temporal association in mental conceptualization. The paper will also discuss a few relevant studies conducted by other scholars. As people's perception of time is culturally specific (Radden, 2004; Lai & Boroditsky, 2013) and languages are developed in – and thus attached to – their corresponding cultures, Chen (2007) points out that cross-linguistic studies require competent knowledge on the part of the researcher about the languages under investigation. Accordingly, the authors of this paper, as mainland Chinese, acknowledge their sufficient understanding of the Chinese culture, and as English teachers at university, they have had long exposure to the cultures of English-speaking countries. Mandarin and English are their two most frequently used languages; considering this, the present paper will mainly review four empirical studies conducted by Boroditsky and her collaborators on the spatial construal of temporal perception in Mandarin and English, as these four studies share similar objectives and adopt comparable research methodology. In fact, each one of these studies is developed from the prior one(s), and could be taken as an extension or continuous refining of the previous studies.

A critical analysis of these four empirical investigations and other relevant studies demonstrates the general tendency of empirical research conducted to understand the relationship between language and thought. It will hopefully shed light on the shortcomings of existing cross-linguistic research in this domain, and similar problems related to the research on artificial intelligence (AI), as well as multiple theories of translation/interpretation. All seem to constitute a natural consequence of the fact that different languages as well as different metalanguages are used across diverse speech communities.

2. First Attempt (2001): language shapes thought

Boroditsky's "Does language shape thought? Mandarin and English speakers' conceptions of time" (Boroditsky, 2001) is among the first attempts to examine the relationship between language and thought in relation to spatio-temporal associations in a cross-linguistic context and is the first to specifically address Mandarin and English as testing languages. This work, although criticized by some scholars (Chen, 2007; January & Kako, 2007) and later even by Boroditsky herself (2010), is quite an influential study, as it laid the groundwork for empirical studies on cross-linguistic investigation of spatial and temporal mapping, partly due to this controversy.

In this study, three experiments are conducted concerning the spatio-temporal relationship in Mandarin and English to demonstrate that it is language and not other cultural factors that shapes people's habitual thoughts. A presupposition of this research is the different ways Mandarin and English refer to time: while Mandarin speakers tend to talk about time vertically, native English users are more likely to adopt horizontal temporal expressions. Based on this premise, Boroditsky finds that this difference between the two languages has a strong influence on the ways their speakers think about time.

The participants of the first experiment are 26 native English speakers and 20 native Mandarin speakers at Stanford University. The participants answer questions about time after being exposed to spatial scenarios that are either horizontal or vertical, accompanied by a sentence description. The testing language is English and the participants are tested with English instructions. Questions are presented on a computer screen one at a time and participants' response times are measured and recorded by the computer. It is found that English speakers and Mandarin speakers tend to think differently about time. Native English speakers answer time questions faster after horizontal scenarios than after vertical scenarios, and they are also found to react faster to temporal questions phrased in horizontal terms than in vertical terms. At the same time, native Mandarin speakers' response times to temporal questions after horizontal scenarios and after vertical scenarios are almost the same. However, when considering the vertically-phrased temporal questions, the native Mandarin speakers are found to react faster after vertical scenarios than after horizontal scenarios. This is contradictory to the native English speakers' results. In conclusion, Boroditsky proposes that people's experiences with a language can shape the way they think.

Adopting a similar design and procedure, the second experiment examines the performance of 25 Mandarin-English bilinguals to further test how learning a new language influences people's thinking patterns. It is found that the propensity to think about time vertically is related to the length of experience with Mandarin but not to the length of English experience. In the last experiment, 70 Stanford University undergraduates who are native English speakers are exposed to a set of 90 vertically phrased temporal questions to get used to this new way of talking about time, after which they are asked to go through the procedures in Experiment 1. The results show that these participants tend to act more like native Mandarin speakers in comparison with untrained English speakers. As such, the author argues that learning a new way to talk about a familiar domain can change the way people think about that domain and that it is language alone that led to the differences between English and Mandarin speakers' perceptions of time. Taking the findings of the three experiments together, Boroditsky then concludes that language indeed shapes people's habitual thoughts.

As mentioned above, Boroditsky's first attempt to demonstrate the relationship between language and thought through cross-linguistic empirical studies in Mandarin and English has received some criticism from other scholars. For instance, Chen, a Chinese scholar, replicated Boroditsky's research in Taiwan (Chen, 2007). He found that the presupposition in Boroditsky (2001) that Mandarin speakers tend to talk about time vertically is untenable, as Mandarin speakers actually tend to adopt horizontal spatial metaphors of time more frequently than vertical spatial metaphors. And when focusing on "month" as the time unit, Chen found that Mandarin speakers show both trends of vertical and horizontal bias in equal distribution, which was contradictory to Boroditsky's findings. In conclusion, Chen claims that Boroditsky's study fails to prove that Mandarin and English speakers differ in their spatial conceptualizations of time – and this provides no evidence for linguistic relativity.

Chen's findings are further supported by January and Kako (2007) who conducted six replications of Boroditsky's research, all of which provide contradictory evidence to Boroditsky's original study. Additionally, upon reviewing the third experiment in Boroditsky's paper, January and Kako found it untenable that 90 exposures to a new spatio-temporal metaphor can change native English speakers' perception of time. Thus, Boroditsky's (2001) results cannot be considered as evidence in support of the Linguistic Relativity Hypothesis. Finally, the authors point out that while westerners may indeed typically order

events in time horizontally from left to right when forced to do so (Tversky, Kugelmass, & Winter, 1991), this does not necessarily reveal that their internal conceptualization of time is horizontally organized, and cultural convention may not be the single factor that drives this effect.

The two studies are highlighted here in part because of their insightfulness as critical empirical replications of Boroditsky's initial research, and also because of their influence on Boroditsky's further attempts to examine the spatial conceptualization of time in Mandarin and English. Their doubts and critical remarks are clarified and rebutted in Boroditsky's later studies, which will be discussed in the following sections.

Besides the deficiencies pointed out by Chen (2007) and January and Kako (2007), there are other issues that need to be discussed critically in Boroditsky's initial attempt. First, the participants in the three experiments should have been selected more carefully. All the subjects in the three experiments were English speakers – even the native Mandarin participants in Experiments 1 and 2 had had at least 10 years of exposure to English. There is fair reason to believe that the native Mandarin speakers' modes of thinking were influenced by the English language they had acquired, at least to some extent – if it is really the case that language can shape thought. Thus, these "native" Mandarin participants could not be taken as pure Mandarin speakers. To be more exact, they could only be considered Mandarin speakers who had been influenced by the English language/thinking patterns or as Mandarin–English bilinguals. This indicates that Borodisky's research findings based on the so-called "native" Chinese speakers are not valid.

Second, the testing place should have been seen as a factor that might have influenced the results. The circumstantial elements also might have had some effect on people's thinking modes. Staying in an English speaking context where all the communication was carried out in English, the participants might have inevitably thought according to the patterns characteristic of English (Lai & Boroditsky, 2013). This may partly explain why Chen (2007) failed to replicate Boroditsky's findings in Taiwan.

A third issue arises, in that all the three experiments were conducted in English with English instructions, and English was the testing language for describing the spatial scenarios and addressing the target questions. This was kept constant, even when testing the "native" Mandarin speakers' spatial

perception of time. In this case, it is not unreasonable to contend that the Mandarin speakers' temporal conceptions might have been affected by this exposure to the English language, if the effect demonstrated in Experiment 3 is true (that even a short-term exposure to a different special-temporal organisation can change people's perception of time). Moreover, people do not always speak their minds: answering temporal questions or learning a new way of speaking does not necessarily mean that the same process has actually occurred in people's minds. As January and Kako (2007) have noted, people are sometimes forced to speak in a certain way. To talk about time in horizontal/vertical terms in the experiments does not necessarily reveal that people's internal conceptualizations of time are horizontally/vertically structured. Boroditsky's study only gives evidence for the fact that the Mandarin and English languages adopt different spatial-temporal representations, thus leading to different ways of talking about time – but not thinking about time. All of these arguments imply that Boroditsky's initial research did not lend support for her conclusion that language shapes thought.

A lot of space has been devoted in this section to the discussion of Boroditsky's first paper, because that work laid the foundation for her further investigations on the relationship between language and thought in relation to spatio-temporal associations. The defects and shortcomings of this study (mentioned above) are later considered and improved in Boroditsky's and her collaborators' more recent works. The following three studies could be seen as continuations and refinements of Boroditsky's initial attempt.

3. Second Attempt (2010): Mandarin and English speakers think about time differently

Boroditsky's second attempt at investigating spatio-temporal mapping in Mandarin and English can be seen as a modification of her first study. It rebuts the criticism voiced by other scholars that Boroditsky (2001) had only demonstrated that Mandarin and English speakers talk about time differently" but do not necessarily "have different lines of time conceptualization". The article "Do English and Mandarin speakers think about time differently?", published in 2010, was designed to specifically address the proposal that English and Mandarin speakers not only talk about but also think about time in different ways (Boroditsky, Fuhrman, & McCormick, 2010).

In this research, Boroditsky and her colleagues seemed more cautious when claiming that "Mandarin speakers tend to talk about time vertically while English speakers' temporal expressions are horizontally structured" (2001: 22); as a result of more careful investigation, they rephrase it as "both English and Mandarin adopt horizontal spatial terms to talk about time…. Mandarin speakers also systematically and frequently use vertical metaphors. While in English, although vertical spatial terms can also be used to talk about time, these uses are rare" (2010: 123). Thus the original assumption of this research is refined to the statement that "vertical metaphors for time are more frequent in Mandarin than they are in English." This study could be taken as a reply to Chen's (2007) findings that Mandarin speakers actually adopt horizontal expressions to talk about time more frequently than vertical terms, and it moves one step further by emphasizing that the research domain is a comparison between English and Mandarin, and not Mandarin itself, thus laying a stronger and more reliable foundation for the study.

In this study, Boroditsky and her colleagues also point to some deficiencies in Chen's (2007) and January and Kako's (2007) replications of the original study. While Chen's investigation was based on 73 Mandarin speakers and only 14 English speakers, the participants in January and Kako's (2007) experiment are all native English speakers, which largely reduces the validity of their findings.

Boroditsky et al. acknowledge some shortcomings of the 2001 study; for example, the three-dimensional spatio-temporal association was reduced to two-dimensional mapping: with the front/back axis and left/right axis conflated into the horizontal dimension – although this problem seems to be still left unsolved in this study. They also admitted that the direction of time perception – which is an important aspect in the spatial conceptualization of time – was disregarded in the original research and that they had tried to compensate for this flaw.

Altogether, 181 participants in America took part in the 2010 study: 118 native English speakers and 63 Mandarin-English bilinguals. As we can see, this choice of subjects demonstrates the same problem as Chen's (2007) study: too few Mandarin speakers compared to the large number of native English speakers. However, in this new study, Boroditsky et al. take the participants' language proficiency into account, which is an improvement in comparison to the initial study. All 118 native English speakers had no prior exposure to Mandarin. This

was to ensure that their thinking patterns had not been influenced by another language. The 63 bilinguals are reported to be highly proficient in Mandarin. However, similar to Boroditsky (2001), this experiment did not include any Mandarin monolinguals, so the comparison between Mandarin and English also seems untenable.

In the study, the participants were first asked to look at two pictures – one after another – in the same location on a computer screen, and then decide whether the second photo represented an earlier or later time by pressing one of two adjacent keys (either vertically or horizontally arranged) that were covered with black and white stickers which meant either 'earlier' or 'later' (with the left/upper key meaning "earlier" as the canonical situation and right/lower key "earlier" as the non-canonical situation). Thus, language was totally eliminated during the whole testing procedure.

Boroditsky et al. made a big step forward by employing nonlinguistic stimuli and responses. This responded well to January and Kako's (2007) claim that talking about time using spatial words did not entail that time was spatially conceptualized in people's minds. Nonlinguistic evidence helped elucidate the relationship between space and time in the human mind. However, both the English speakers and the bilinguals received English instructions before the test, which might suggest that this test is really English-oriented. In addition, the experiment was conducted in an English speaking environment, which might have had some influence on the Mandarin-English bilinguals' perception of time during their tests. The results of this study are presented in Figure 1 (next page).

The figure revealed that both English and Mandarin speakers demonstrated a canonicity effect on the horizontal axis, which indicates that speakers of both languages conceptualize time horizontally from left to right. However, when considering the vertical condition, only Mandarin speakers (in this experiment, the bilinguals) reacted faster when the "earlier" response key was on top than when it was in a lower position. The vertical canonicity did not have any effect on native English speakers – they even responded faster when the "earlier" key was at the bottom (which indicates a slight bottom-up direction in their time perception). Therefore, the authors concluded that while native English speakers tend to think about time horizontally from left to right, native Mandarin speakers are equally good at both horizontal (from left to right) and vertical (from top to bottom) conceptualization of time. This was interpreted as evidence that Mandarin and English speakers think about time differently.
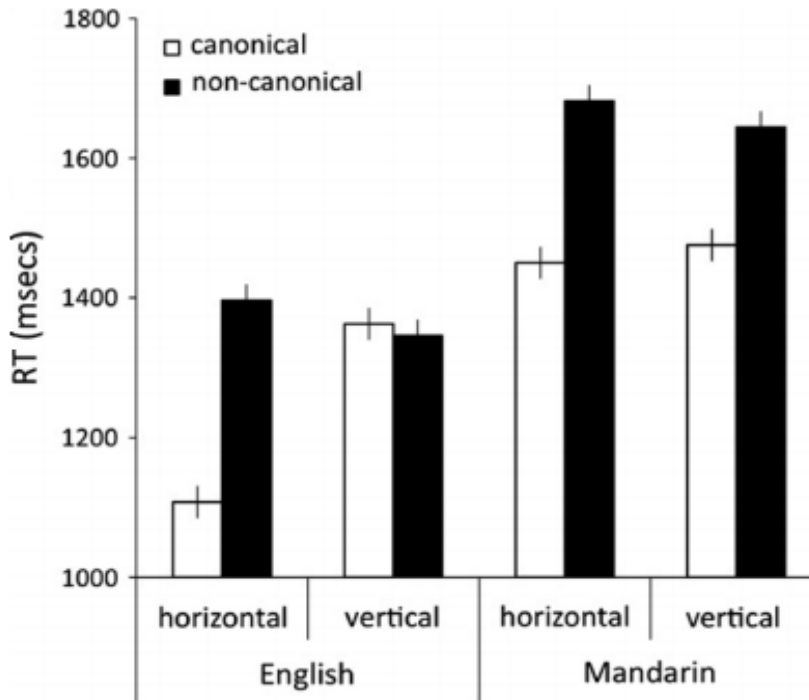
Figure 1. Native English and native Mandarin speakers' response times (adapted from Boroditsky et al., 2010: 125)

However, we also notice that the Responding Times (RT) for English speakers and Mandarin speakers were different, with the English speakers responding far faster in both the horizontal and the vertical tests. This is a question worth considering, yet left unexplained by the researchers – the authors did not present their interpretation of this finding. It might have been the case that the testing environment was biased in favor of the native English speakers, as this experiment was conducted with English instructions and in an English speaking context.

Considering the above limitations of Boroditsky et al.'s 2010 study, much more work still needed to be done in order to verify the proposition that Mandarin and English speakers indeed conceptualize time differently due to different spatial-temporal expressions in their respective native languages.

4. Third Attempt (2011): both linguistic and cultural forces shape time perception

Fuhrman, McCormick, Chen, Jiang, Shu, Mao & Boroditsky's paper entitled "How linguistic and cultural forces shape conceptions of time: English and Mandarin time in 3D" (2011) continues to investigate how English and Mandarin speakers conceptualize time. As the title suggests, a major development of this study compared with the previous ones is that the researchers stepped out of the circle of language per se, and took cultural elements into consideration when examining the factors influencing people's perception of time. This assumption contradicted Boroditsky's (2001) claim that it is language itself – and not other cultural factors – that shapes people's temporal conceptualizations. And as we can already see in the title, the authors of this study included both native English speakers and native Chinese speakers, who had sufficient knowledge of their respective native languages and cultural backgrounds. This lays a firm foundation for a cross-linguistic study, since, as Chen (2007) points out, adequate knowledge about the target languages and cultures is necessary to reach any objective and credible conclusions in cross-linguistic research.

The experiments in this study took place in both America (for the English tests) and China (for the Mandarin tests), the native countries of the testing languages, thus minimizing the effects of language context on people's thoughts. Therefore, this study has an advantage over the previous investigations by being carried out in a truly cross-linguistic context. Moreover, the participants of this research were more carefully selected. The first experiment included 59 Stanford students who were native English speakers and whose English proficiency was claimed to be 5 based on a 1-5 scale, and none of them had had any exposure to Mandarin. The Mandarin speakers were also claimed proficient in Mandarin (5 out of 5) and none of them reported a proficiency level in English of above 4 out of 5. The English and Mandarin levels of EM bilinguals were also taken into consideration in Experiment 2. This self-rated language proficiency provided additional information on whether the participants could be taken as "pure" native speakers of a language or if they were influenced by another language that might have exerted influence on their perceptions, thus adding weight to the objectivity and credibility of the experiments.

As the second attempt, this study also used non-linguistic stimuli, but unlike the previous investigation, the instructions were presented in the participants' native languages, thus reducing the short-term influence

of non-native languages on native speakers' perception of time. Additionally, this research expanded from the two-dimensional (horizontal-vertical) space examined in the two previous studies to include a three-dimensional (transverse-vertical-sagittal) space, an improvement already mentioned in the second study, but not applied until this investigation. The results of the first experiment are presented in Table 1 below.

	English	Mandarin
Left is earlier	* 936*	1675
Right is earlier	1045	1793
Near is earlier	1015	1745
Far is earlier	983	1666
Top is earlier	974	* 1609*
Bottom is earlier	993	1853

Table 1. English and Mandarin speakers' average response times (ms) in the 3D (adapted from Fuhrman et al., 2011: 1312)

This table shows the average response times of the English and Mandarin speakers along the three dimensions (both canonical and non-canonical). It shows that native English speakers gave the fastest responses when "left" represented "earlier", and the Mandarin speakers when "top" stood for "earlier". This demonstrates that Mandarin speakers tended to think about time vertically (with the direction from top to bottom) rather than transversely. This finding is actually in contrast with the results of Boroditsky et al.'s (2010) second study, presented in Figure 1, which indicated that Mandarin speakers had a tendency to think about time horizontally more than vertically, just as the English speakers did. Moreover, Table 1 reveals that English speakers also showed a slight tendency to think about time vertically, as they responded a bit faster when "top" represented "earlier" than when "bottom" represented "earlier". This was also contradictory to Boroditsky et al.'s results. We can reasonably attribute these contradictions to the different language proficiencies of the participants and the different experiment environments in the two investigations. Moreover, just as in the previous study, the English speakers in the present study also reacted much faster than the Mandarin speakers. The explanation for this observation offered by researchers this time was that the English speakers were more familiar with participating in psychological experiments.

The second experiment in this study was designed to explore the factors influencing people's internal conceptualizations of time. The findings are presented in the Figures 2 and 3.
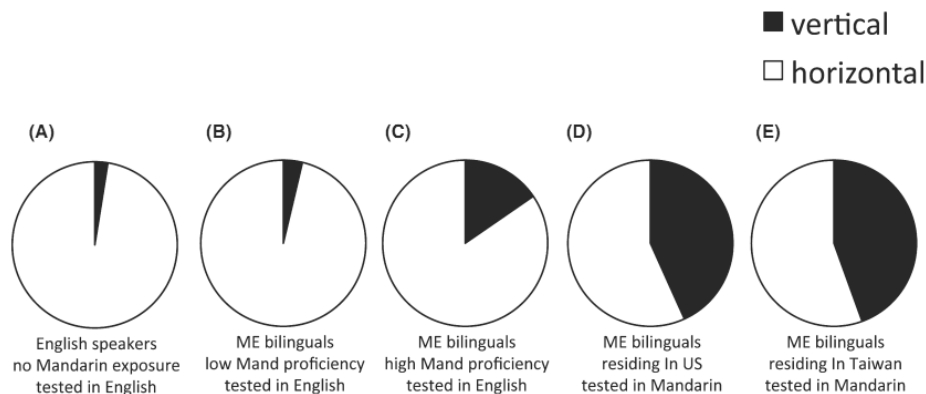

Figure 2. Different participant groups' tendencies in time perception. part1 (adapted from Fuhrman et al., 2011: 1319)
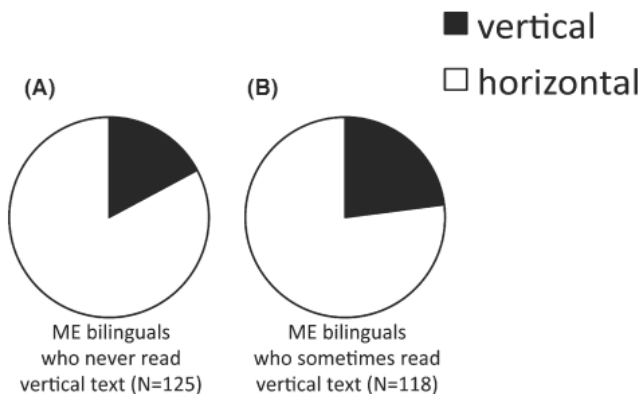

Figure 3. Different participant groups' tendency for time perception. part 2 (adapted from Fuhrman et al., 2011: 1319)

As shown in Figures 2 and 3, this study further proposes that English and Mandarin speakers' perceptions of time are influenced by five factors: proficiencies in Mandarin and in English, the language of the test, the country of the test and experience with a vertical text – instead of by language alone, as claimed in Boroditsky's (2001) first study.

Based on the findings presented in Figure 2, the authors further claimed that short-term language exposure plays a significant role in people's perceptions of time. However, the question which remained unanswered is whether

this difference really occurred due to the different testing languages. When taking a closer look at the participants in these groups, we find that this claim cannot be justified. In their paper, the authors report that the bilingual participants in groups D and E were native Mandarin speakers and thus were tested in Mandarin. And for group C, the authors do not mention whether the participants were native Mandarin speakers or not – and it seems unlikely, according to the arrangement of this experiment (otherwise the comparison between the first three groups would be untenable). Thus, it is quite reasonable to assume that the different levels of vertical tendency of different groups may not have been the result of short-term influence from the testing languages; instead they were more likely to result from the participants' long exposure to the language they were tested in. As well, the number of bilingual participants tested in English (170) was much larger than the group of native Mandarin bilingual participants who were tested in Mandarin (47). Given this questionable identity of the participants in group C and the biased distribution of participants among different groups, it is clear that this study fails to demonstrate the immediate influence of language on people's temporal conceptions.

Furthermore, although the participants in this research differ in their Mandarin proficiency levels from non – to highly proficient, their English language levels are from good to quite good (with the group lowest level equal to 3.53 on a five-point scale). It is hard to justify that the highly competent Mandarin speakers' inner conceptualization of time has not been influenced by their good to very good English proficiencies.

Thus far, we can see that although the third attempt improved the research methodology relative to the previous papers – in particular in the selection of participants, and although it expanded the scope of the previous studies, it is still insufficient to be taken as an evidence for different spatio-temporal mapping patterns in Mandarin and English. Further empirical studies remain to be carried out.

5. Fourth Attempt (2013): immediate and chronic influence of spatio-temporal metaphors on time perception

This is one of the latest studies investigating the space-time relationship in English and Mandarin and is a continuation of Boroditsky and her colleagues' previous attempt (2010) to demonstrate that both immediate and chronic

factors exert influence on people's perception of time. Two experiments are conducted in this study to investigate the influence of spatio-temporal metaphors in a language on its speakers' conceptualization of time (Lai & Boroditsky, 2013).

The subjects of this investigation were even more carefully selected than in the three previous studies. They included both Mandarin and English monolinguals as well as bilinguals. In order to minimize possible adverse effects of any other languages on the subjects, the group of Mandarin monolinguals was comprised only of those whose English level was around 1 (on a five-point scale), and who did not know Cantonese. Likewise, all the English monolinguals had had no prior exposure to Chinese. The English monolinguals and the ME bilinguals were tested in America and the Mandarin monolinguals were tested in Taiwan.

The first study was divided into two questions. For the first question, the native English group and the ME-bilingual group were both tested in English, and the native Mandarin group was tested in Mandarin. The results from the two groups tested in English showed that unlike the English monolinguals who took an ego-moving perspective in temporal conceptualization, the ME bilinguals demonstrated a tendency to adopt a time-moving perspective, which was in line with the Mandarin monolinguals. Next, the same groups were tested on another question. This time, both the Mandarin monolinguals and ME bilinguals were tested in Mandarin, while the native English group was tested in English. A comparison between the first two groups revealed that the ME bilingual group conceptualized time from an ego-moving perspective which was similar to the English monolinguals' perception of time. In this study, the possibility of short-term influence of the testing language (by only comparing the groups tested in the same language) and testing location (as the bilinguals were only tested in America) was also considered and controlled.

The results from this study demonstrate clearly that bilinguals import temporal conceptual structures both from L1 (Chinese) to their perception of temporal metaphors in L2 (English), as in the first question, and from L2 to L1, as in the second question. This is an extension and fine-tuning of the more general conclusion that the spatio-temporal metaphors in a language shape their speakers' internal conceptualizations of time, which is a constant topic in Boroditsky and her colleagues' previous research.

However, as Lai and Boroditsky point out themselves, in this study the same bilingual group was tested on two different questions. It would be interesting to test this group on one and the same question in both Mandarin and English to see whether on-the-spot linguistic exposure could affect their perceptions of time. But again, in such a study, the bilinguals' native languages and the testing locations all need to be taken into consideration to ensure that the differences in the participants' temporal perceptions are indeed caused by the testing languages and not by their long-term exposure to a language or the general language environment of the test.

The second experiment of this study was specifically designed to test whether short-term exposure to different spatio-temporal metaphors can affect people's conceptualization of time. In this experiment, the ME bilinguals were tested both in America and Taiwan in Mandarin. The subjects were asked (front-back or up-down) temporal questions, and had to point to the space around them to locate these time points (3-D: up-down, left-right, front-back). The results showed that the subjects arranged time vertically when prompted with up-down metaphors and sagittally when prompted with front-back metaphors in Mandarin. The authors claimed that Mandarin speakers were more likely to conceptualize time along the front-back axis when understanding front-back metaphors and more likely to construct up-down representations of time when understanding up-down metaphors. Based on this finding, the authors further concluded that different spatio-temporal metaphors have in-the-moment influences on people's conceptualizations of time.

These results, however, can hardly be taken as evidence for immediate influence of spatio-temporal metaphors on time perception. Firstly, the results of this experiment seem to be self-evident: there would be no reason for language users to conceptualize time vertically when processing horizontal spatio-temporal metaphors. It is both a waste of energy and an abnormal way of thinking and communicating according to the Cooperative Principle (Grice, 1975) and Relevance Theory (Sperber & Wilson, 1986) in conversational analysis. In other words, the findings of this study are universally applicable: the same might be true in other languages and cultures. The results of this study could only be taken as evidence for the fact that spatio-temporal metaphors are still psychologically alive in Mandarin and exist in line with people's perceptions of time and space, but provide no evidence for the linguistic relativity hypothesis.

Besides, a closer look at the sample questions reveals that the subjects' responses might have been premised by the questions, and did not necessarily entail the participants' thinking in that way. For example,

> *"假设这里是这个礼拜，你认为前一个礼拜在哪里？ 后一个礼拜在哪里？"
>
> * "suppose <u>this here</u> is <u>this classifier-ge week</u>, you think <u>front one classifier-ge week</u> locate where? <u>Back one classifier week</u> locate where?"
>
> * *translation:* "suppose here is this week, where do you think is last week? where do you think is next week? (adapted from the original study)

As thus, the concepts of "front" and "back" were used explicitly in the prompting questions, thus, it was easy for the subjects to adopt these concepts while responding to the questions. This does not necessarily mean that the subjects thought about time in that manner. Furthermore, it is worth noticing that to express "last week" and "next week", in addition to "前一个礼拜 (front one classifier-ge week)" and "后一个礼拜 (back one classifier week)", in Mandarin, people also say "上一个礼拜 (upper one classifier-ge week)" and "下一个礼拜 (lower one classifier-ge week)". Therefore, it might be possible that the responses in this experiment did not truly reflect people's inner perception of time, but were simply conditioned responses to what they had heard and remembered a few seconds before.

Thirdly, even if the results are indeed reflections of bilinguals' perceptions of time, is this perception really caused by the immediate influence of the questions posed by the experimenters? This is another question which needs to be explored. As the authors claim, the prompting questions used in this study were "conventional metaphoric expressions in Mandarin, not novel constructions", which means that the study adopted a conventional way of expressing spatio-temporal metaphors in Mandarin. As the participants were highly proficient in Mandarin (4.48 and 5 on a five-point scale), and those who were tested in Taiwan were native Mandarin speakers, it is reasonable to assume that all these subjects had indeed been affected by the Mandarin way of processing spatio-temporal metaphors for a long time, and to a great extent. The questions delivered to them were in line with their habitual ways of talking about time, thus, the effect of the questions on the participants' perception of time should rather be interpreted as a long-term influence than an on-the-spot influence during this experiment.

The authors noticed that subjects who were tested in America were more likely to use the left-right axis than those in Taiwan and less likely to use the front-back axis. They interpret this finding as the result of different testing locations. The testing locations of course, might be an influencing factor, but another factor is still missing here – the participants' English proficiency. As we can see from the original study, both groups had high proficiency in Mandarin, though the bilinguals in America had a mean English proficiency of 4.01 and the bilinguals in Taiwan only 2.71. As it has been proven that proficiency levels of a language may influence people's perception of time in another language (Fuhrman et al., 2011), due weight should be given to the different English levels of the participants when investigating and interpreting the participants' different patterns of temporal perception.

6. Conclusions and implications for further research

The discussion presented in this paper illustrates the continuing improvement of Boroditsky's and her colleagues' attempts at examining the temporal-spatial association in Mandarin and English to support the linguistic relativity hypothesis. The process also reflects the kinds of problems that many researchers face when doing cross-linguistic and cross-cultural research in language and cognition. Boroditsky and her colleagues made significant progress from the initial attempts to test that language shapes thought in general, and then restricted it to the more specific conclusion about Mandarin and English; later these continued attempts were extended to include both language and culture as the influencing factors on Mandarin and English speakers' different modes of temporal perception; more recently, the linguistic influence on people's conceptualization of time was examined from both immediate and long term perspectives. As the research goes forward, the author(s) tend(s) to be more cautious in the selection of participants, testing materials and the design of testing procedures. These also reflect the general tendency in the study of the relationship between language and thought with respect to spatio-temporal mappings.

However, there are still certain flaws in the existing literature, as exemplified in the last two attempts by Boroditsky and her colleagues: although the English and Mandarin proficiency levels of the participants were considered and restricted, the selection was still based on the subjects' self-reported levels

of English and Mandarin. The participants' language proficiency was not tested in an objective way. It is sometimes difficult to distinguish one level from another subjectively, even in one monolingual user, not to mention the situation where there are so many bilingual participants (in one study, around 200). The subjects' self-perception of their language levels, like their temporal perceptions, might have been affected by other internal or external factors, such as their personalities – some people just tend to be more cautious or modest while making estimations.

In the meantime, the claim that language has an immediate effect on temporal perception still needs further examination. Existing experiments are either designed to test different groups of participants on the same token (as in the second experiment of the third attempt, described above) or the same group tested on different tokens (as in the first experiment of the fourth attempt, above). The experiment specially designed to test in-the-moment effect of spatio-temporal metaphors on people's perceptions of time (the second experiment in the fourth study) falls into the loop of "people tend to think in A when talking about A". Actually, this loop is untenable unless alternative explanatory pathways (e.g., there could be a possibility for people to "think in B when talking about A") can be ruled out. There is still no sufficient evidence that immediate situational linguistic factors shape people's perceptions of time.

The existing research has demonstrated firmly that Mandarin and English speakers have different temporal conceptualization models and the reasons why this occurs: it is due to different spatio-temporal expressions in the two languages and other cultural factors, such as writing and reading directions. One domain which still needs further exploration is concerned with how the different time-perception models in the two languages occur. As already exemplified, English and Mandarin have different temporal perceptions because of their different spatio-temporal metaphors, but the ways in which English/ Mandarin metaphors are mapped onto their respective speakers' perceptions of time is still an unexplored area. Cross-linguistic studies have found time and again that some, but not all spatial lexemes can be used in the temporal language (Shinohara, 1999), and different languages have different conflations of temporal cognition and spatial expression (Radden, 2004), which calls for further exploration is the situation in Mandarin and English.

Cross-linguistic studies which focus on the spatial and temporal systems in children have found that temporal and spatial systems emerge simultaneously

and have independent statuses in children's minds, thus rejecting the claim that temporal distinctions are derived from spatial differences (Weist, Atanassova, Wysocka & Pawlak, 1999). And in a more recent study on a Turkish sign language, Arik (2012) notices mismatches between the participants' temporal expressions and the deictic use of the front-back axis, suggesting that temporal and spatial language may not be derived from each other but might only share some properties at the lexical level. Thus, more empirical studies with carefully considered methodology need to be conducted in order to provide support for the Sapir-Whorf linguistic relativity hypothesis, through the spatio-temporal mapping of language and cognition.

References

ARIK, Eengin (2012): Space, time, and iconicity in Turkish sign language (TID). *Trames,* 16(4), 345-358.

BORODITSKY, Lera (2001): Does language shape thought? Mandarin and English speakers' conceptions of time. *Cognitive Psychology,* 43(1), 1-22.

BORODITSKY, Lera, FUHRMAN, Orly, MCCORMICK, Kelly (2010): Do English and Mandarin speakers think about time differently? *Cognition,* 118(1), 123-129.

CASASANTO, Daniel, BORODITSKY, Lera (2008): Time in the mind: Using space to think about time. *Cognition*, 106, 579-593.

CHEN, Jenn Yeu (2007): Do Chinese and English speakers think about time differently? Failure of replicating Boroditsky (2001). *Cognition,* 104(2), 427-436.

CLARK, Herbert H. (1973): Space, time, semantics, and the child. In: Timothy E. MOORE (ed.): *Cognitive development and the acquisition of language.* New York: Academic Press, 27-63.

FUHRMAN, Orly, MCCORMICK, Kelly, CHEN, Eva, JIANG, Heidi, SHU, Dingfang, MAO, Shuaimei, BORODITSKY, Lera (2011): How linguistic and cultural forces shape conceptions of time: English and Mandarin time in 3D. *Cognitive Science*, 35, 1305-1328.

GENTNER, Dendre (2001): Spatial metaphors in temporal reasoning. In: M. GATTIS (ed.): *Spatial schemas in abstract thought*. Cambridge, MA: MIT Press, 203-222.

Grice, H. P. (1975): Logic and Conversation. In: Peter COLE, JERRY L. MORGAN (eds.): *Syntax and Semantics (Vol.3) Speech Acts*. New York: Academic Press, 41-58

JANUARY, David, KAKO, Edward. (2007): Re-evaluating evidence for linguistic relativity: Reply to Boroditsky (2001). *Cognition,* 104(2), 417-426.

KOUSTA, Stravroula-Thaleia, VINSON, David P., VIGLIOCCO, Gabriella. (2008): Investigating linguistic relativity through bilingualism: The case of grammatical gender. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 34(4), 843-858.

KRANJEC, Alexander (2006): Extending spatial frames of reference to temporal concepts. Paper Presented at the Twenty-Eighth Annual Conference of the Cognitive Science Society, Vancouver 2006.

KRANJEC, Alexander, CARDILLO, Eileen. R., SCHMIDT, Gwenda L., CHATTERJEE, Anjan. (2010) Prescribed spatial prepositions influence how we think about time. *Cognition*, 114, 111-116.

LAI, Vicky Tzuyin, BORODITSKY, Lera (2013): The immediate and chronic influence of spatio-temporal metaphors on the mental representations of time in English, Mandarin, and Mandarin-English speakers. *Frontiers in Psychology,* 4, 142-164.

MILES, Lynden, TAN, Lucy, NOBLE, Grant, LUMSDEN, Joanne, MACRAE, C. Neil (2011): Can a mind have two time lines? Exploring space–time mapping in Mandarin and English speakers. *Psychonomic Bulletin & Review*, 18(3), 598 – 604.

PIAGET, Jean (1954): Language and thought from a genetic perspective. *Acta Psychologica*, 10, 51-60.

PYERS, Jennie E., SENGHAS, Ann (2009): Language promotes false-belief understanding: Evidence from learners of a new sign language. *Psychological Science, 20*(7), 805-812.

RADDEN, Günter (2004): The metaphor TIME AS SPACE across Languages. In: Nicole BAUMGARTEN, Claudia BÖTTGER, Markus MOTZ, Julia PROBST (eds.): *Übersetzen, Interkulturelle Kommunikation, Spracherwerb und Sprach-vermittlung – das Leben mit mehreren Sprachen. Festschrift für Juliane House zum 60. Geburtstag. Zeitschrift für Interkulturellen Fremdsprachenunterricht* , 8(2/3), 1-14.

SHINOHARA, Kazuko (1999): Conceptual mappings from spatial motion to time: Analysis of English and Japanese. In: Christopher L. NEHANIV (ed.): *Computation for Metaphors, Analogy, and Agents.* Berlin/Heidelberg: Springer, 230-241.

SPERBER, Dan, WILSON, Deirdre (1986): *Relevance: Communication and Cognition*. Cambridge, MA: Harvard University Press.

TAJIMA, Yayoi, DUFFIELD, Nigel (2012): Linguistic versus cultural relativity: On Japanese-Chinese differences in picture description and recall. *Cognitive Linguistics*, 23(4), 675-709.

TVERSKY, Barbara, KUGELMASS, Sol, WINTER, Atalia (1991): Cross-cultural and developmental trends in graphic productions. *Cognitive Psychology*, 23, 515-557.

VALLESI, Antonio, BINNS, Malcolm A., SHALLICE, Tim (2008): An effect of spatial-temporal association of response codes: understanding the cognitive representations of time. *Cognition,* 107(2), 501-527.

WEIST, Richard M., ATANASSOVA, Marja, WYSOCKA, Hanna, PAWLAK, Aleksandra (1999): Spatial and temporal systems in child language and thought: A cross-linguistic study. *First Language*, 19(57), 267-308.

WHORF, Benjamin Lee (1956): *Language, thought and reality: Selected writings of Benjamin Lee Whorf.* (John B. CARROLL, Stephen C. LEVINSON, Penny LEE (eds.)). Cambridge, MA: MIT Press.