

Final Paper

Manxin Lan
LING 4477

1 Introduction

The question of whether language affects thought has a long history of debate in the field of linguistics. The space-time mapping in languages is used to answer this question in many research (e. g. Boroditsky, 2001; Gu et al., 2019). These studies show that spatial representation of time in languages by encouraging “structural alignment between the two domains and may cause relational structure to be imported from space to time” (Boroditsky, 2001). In this research, we dig deeper into spatiotemporal metaphors in Mandarin to see if different space-time mapping in different time units would lead to different temporal cognition. Mandarin has two types of spatiotemporal metaphors: horizontal (*qián* “front” and *hòu* “back”) and vertical (*shàng* “up” and *xià* “down”). We hypothesized that native speakers prefer different spatial metaphors when talking about different units of time (for instance, people prefer horizontal metaphors over vertical metaphors when talking about hour). The goal of the research is to examine whether the preference of spatial metaphors affects the temporal cognition of certain time units, which would shed light to the question of whether language affects temporal cognition

2 Experiment 1

The first experiment is a norming study for Experiment 2. The goal of this experiment is to confirm the preferences of metaphors in different time units. The results of this experiment would be used to help to analyze the data in experiment 2.

2.1 Methods

2.1.1 Design and Materials

The participants are asked to choose between two sentences that shares the same meaning and structure in each trial, and the only difference between the two sentences is that one uses a horizontal metaphor, and the other uses a vertical metaphor. The participants are asked to choose the one that is more acceptable. There are 32 experimental trials and 32 unrelated filler trials. There are 4 sentences for each of the 8 time units (second, minute, hour, day, week, month, year, and century). The instructions and stimuli are all in Mandarin. Below are examples from the stimuli:

Second: 考试铃声响起的{下, 后}一秒, 她开始做题。

The second after ({down, back}) the exam bell rang, she started to do the questions.

Minute: 她{上, 后}一分钟就已经离开房间了。

She had left the room a minute ago {up, back}.

Hour: 他知道{下, 后}个小时该做什么工作。

He knows what work to do in the next {down, back} hour.

Day: 我买了{下, 后}一天回北京的机票。

I bought a ticket to go back to Beijing the next {down, back} day.

Week: {上, 前}一周他就已经痊愈了。

He recovered last {up, front} week.

Month: 我{上, 前}一个月还没有理发。

I haven't had a haircut in the last {up, front} month.

Year: 我还没决定好{下, 后}一年在哪里住。

I haven't decided where to live next {down, back} year yet.

Century: 上海是从{上, 前}个世纪开始发展的。

Shanghai began to develop in the last {up, front} century.

2.1.3 Participants

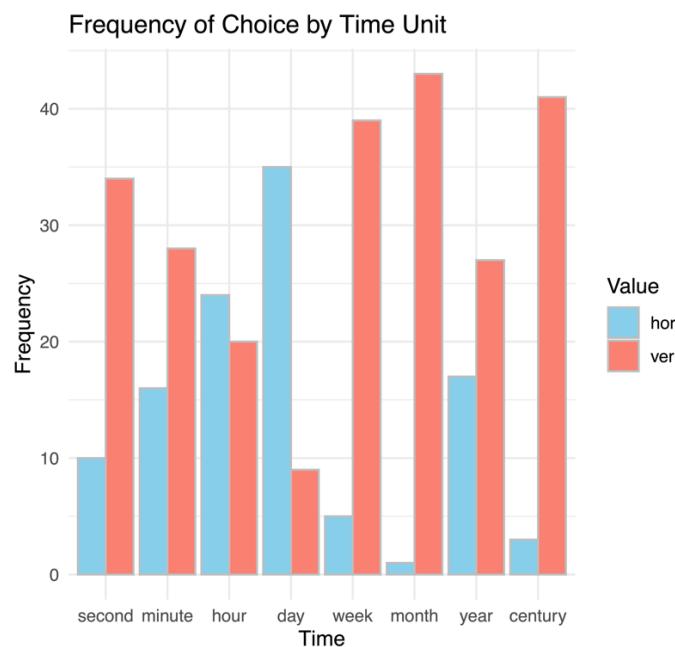
We gathered 11 participants who are all Mandarin native speakers. They all have certain amount of exposure in English, but they all completed all education before and including high school in Mandarin.

2.2 Predictions

We predict people would prefer horizontal metaphors for second, minute, hour, and day sentence whose time units are shorter, and that people would prefer vertical metaphors for week, month, year and century sentences, whose time units are longer.

2.3 Results

We fit the data in a mixed effect linear model in which the proportion of horizontal response as the dependent variable and time units as a categorical independent variable. We set subject id and item number as random effect variables and 8 time units as fixed effect variables. The model compares each time unit with the grand mean. Our data shows that hour and day both have positive estimates and the effects are significant ($p = .064$ and $p = .00056$). Week, month and year shows negative estimate and are significant ($p = .09594$, $p = .01730$, and $p = .04862$). Second, minute, and year does not show statistically significant effect.



2.4 Discussion

The positive estimates of hour and day shows that they fit with our hypothesis (the dependent variable codes horizontal as 1 and vertical as 0). This means that the preference for hour and day sentences is horizontal metaphor. The negative estimate of week, month and year indicates that they fit with the predictions, which means that people prefer vertical metaphors for week, month and year sentences.

Second, minute, and year does not show a clear preference in the data, so we would not analyze these time units in the second experiment.

People overall prefer vertical metaphors (as the grand mean is 0.315), but day sentences show a strong preference for horizontal metaphors, which might be related to the lexicalized expression *qián tiān* (“front day,” the day before yesterday) and *hòu tiān* (“back day,” the day after tomorrow).

3 Experiment 2

The goal of this priming experiment is to see if temporal perception aligns with the space-time mapping we found in Experiment 1.

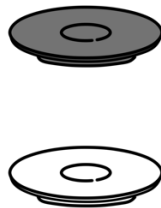
3.1 Methods

3.1.1 Design and Materials

In each experimental trial, the participants see two prime pictures and answer one question for each prime picture, and then they are asked to answer a time related question. The two prime pictures in each trial are pictures of two similar objects arranged in either horizontal or vertical way. The two primes in a trial have the same direction arrangement. The participants would be asked a true/false question on the position of the objects. Below are two examples of prime picture and question:



T/F: 白鸟在黑鸟前面。 The white bird is ahead of the black duck.



T/F: 黑盘子在白盘子下面。 The black plate is below the white plate.

After answering two prime questions, the participants are asked to answer a time-related question. Here are examples of time questions for 8 time units:

Second: 冲过终点线的一秒晚于起跑的一秒。

The second of crossing the finish line is one second later than starting.

Minute: 交卷的一分钟早于答题的一分钟。

The one minute to hand in the paper is earlier than the one minute to answer the question.

Hour: 做饭的一小时早于吃饭的一小时。

The hour for cooking is earlier than the hour for eating.

Day: 圣诞节比中秋节晚。

Christmas is later than Mid-Autumn Festival.

Week: 期末周比期中周晚。

Finals week is later than midterm week.

Month: 夏天的月份比春天的月份晚。

The summer months are later than the spring months.

Year: 二战开始的一年早于新中国成立的一年。

The year World War II started was earlier than the year PRC was founded.

Century: 人工智能的世纪晚于蒸汽机的世纪。

The century of artificial intelligence is later than the century of the steam engine.

There are 32 experimental trails and 64 filler trails that also include two non-horizontal/vertical pictures and an unrelated question. The instruction and questions are all in Mandarin. We measure the reaction time for the target question (time question) in the experimental trials

The reason why we did not use temporal terms like March or Monday in target questions as in Boroditsky, 2001 is that the expressions of months and days includes numbers in Mandarin. We were concerned that the participants would be comparing numbers but not time in the experiment.

3.1.3 Participants

We gathered 24 participants who are all Mandarin native speakers. They all have certain amount of exposure in English, but they all completed all education before and including high school in Mandarin.

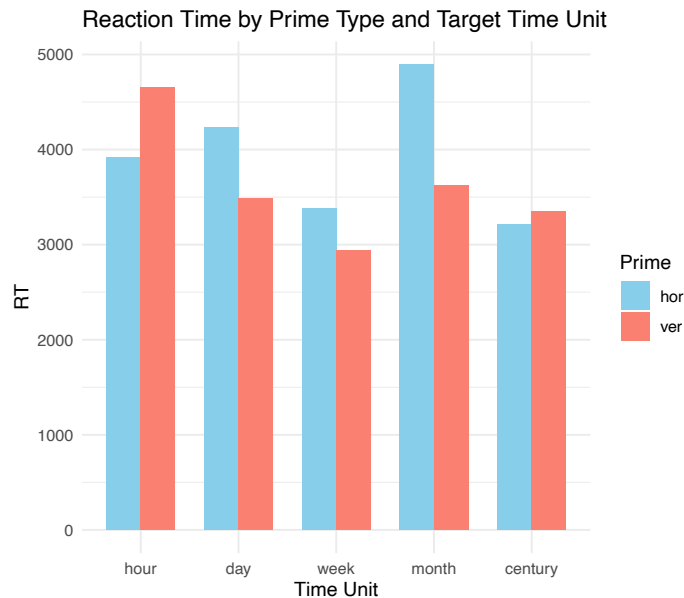
3.2 Predictions

Our hypothesis is that the temporal cognition aligns with the space-time mapping in the first experiment. Thus, we would expect lower reaction time for hour and day questions after horizontal prime than vertical prime, and lower reaction time for week, month, and century questions after vertical primes than horizontal primes.

3.3 Results

Since the results from Experiment shows that second, minute, and year does not have a significant preference on metaphors, we only analyze hour, day, week, month, and century in

Experiment 2. To compare the relative reaction time in horizontal and vertical prime conditions in short time units (hour and day) and longer time units (week, month, and year), we did a paired t-test on the difference in reaction times (horizontal – vertical) in shorter and longer time units. The data shows moderate significant evidence that the mean difference between short time units and long time units is negative.



3.4 Discussion

The results confirm our hypothesis that the reaction time difference between horizontal and vertical prime in short time units should be smaller because the reaction time is shorter after horizontal prime and vice versa for long time units. People benefit from horizontal primes for short time unit questions, and they benefit from vertical primes for long time unit questions, which indicates that the

The results of the two experiments provide evidence for the alignment between space-time mapping in language and temporal cognition.

4 Conclusion

Mandarin has two directions in spatiotemporal metaphors: horizontal and vertical. Native speakers' preference on metaphors differs when expressing different units of time. Experiment 1 shows that people prefer horizontal metaphors for hour and day, and prefer vertical metaphors for week, month and century. The preference in language aligns with temporal cognition of different units of time that we find in Experiment 2. The results from the Experiment 2 shows that the relative reaction time of answering short time unit questions after horizontal prime is shorter than it is after vertical prime, and that the relative reaction time of answering long time unit questions after vertical prime is shorter than it is after horizontal prime. The alignment shows that the preference in language does affect how people perceive different units of time. This provides evidence for the claim that language could affect cognition.

5 References

- Boroditsky, L. (2001). Does language shape thought?: Mandarin and English speakers' conceptions of time. *Cognitive psychology*, 43(1), 1-22.
- Gu, Y., Zheng, Y., & Swerts, M. (2019). Having a different pointing of view about the future: The effect of signs on co-speech gestures about time in Mandarin–CSL bimodal bilinguals. *Bilingualism: Language and Cognition*, 22(4), 836-847.

Acknowledgement

I express my sincere gratitude to Professor Helena Aparicio for her invaluable guidance and mentorship. Special thanks to Emily Sun for her outstanding work in creating stimuli pictures. Both have significantly enriched the quality of this paper.