



How Culture Affects Mental Representations of Diagonal Time Lines: effect of the dominant lateral and Vertical MTLs

Yayun Zheng^{1+*}, Yunfan Jing²⁺, Yixin Miao³⁺, Jiayao Liang⁴⁺

¹Department of teacher education, Dali University, Dali, 671003, China

²senior high school, Shanghai Starriver Bilingual School, Shanghai, 201108, China

³sophomore high school, The Cambridge School of Weston, Massachusetts, 02493, The United States

⁴College of Liberal Arts&Sciences, university of illinois Urbana-Champaign, Champaign, 61820, The United states

+These authors contributed equally to this work and should be considered co-first authors.

*Corresponding author.Email: yulia.yayunzheng@gmail.com

Abstract. People depict elapsed time on a horizontal or vertical mental timeline (MTL). Yet how cross-cultural diagonal MTLs are formed remains unknown. Because many studies have shown the relevance of horizontal or vertical MTLs to diagonal MTLs, we hypothesized that diagonal mental timelines in each culture are determined by (and are a combination of) the horizontal and vertical MTLs that are dominant in that culture. Also, we believe that we can test whether diagonal MTLs vary in parallel with the mirror image of horizontal and vertical MTLs using a mirror-reverse task applied by previous researchers. We predicted that subjects' diagonal MTLs should change with the mirror reversal of the target under lateral and vertical triggers. In contrast, subjects should exhibit a top-left/bottom-right MTL (i.e., without the effects of mirror-reading training) regardless of whether they have been trained in standard Mandarin or mirror-reversed Mandarin.

Keywords: Cross-cultural effect; Diagonal MTLs; Mental representation of time; mirror-reverse task

1 Introduction

Over the last two decades, an amount of evidence has suggested that people portray elapsing time on a horizontal or vertical mental timeline (MTL) which might be influenced by the cross-cultural effect [1-7]. According to a recent study, an extra diagonal MTL develops from the bottom left to the top right [8]. Furthermore, W Yang et al. discovered that specific representations of diagonal MTLs differ among cultures [9], and Sun et al. discovered cross-linguistic/cultural differences in the mental representations of diagonal timelines between English and Mandarin speakers: English speakers envision the time unfolding from bottom left to top right, whereas Mandarin speakers

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envison the time unfolding from top left to bottom right[10]. However, it is still unknown how these cross-cultural diagonal MTLs are formed.

In previous studies, plenty of researchers suggested that a person's diagonal mental timeline (MTL) is dependent on their Lateral and Vertical MTLs and cultural linguistic metaphors which explain the vertical dimension of the MTLs [11,12]. Since numerous studies indicated the correlation of lateral or vertical MTLs with diagonal MTLs respectively, we hypothesize that the diagonal mental timeline in each culture is determined by (and is a combination of) the dominant Lateral and Vertical MTLs in that culture.

Numerous pieces of evidence have established the causality of a unidirectional orthography in shaping speakers' mental representations of time. Casasanto and Bottini broaden previous studies by showing that participants' mental timelines would be completely redirected on the spot when they were exposed to the mirror-reversed spelling of speakers' native language [11]. Thus we would do research based on this method to probe into the causality of lateral and vertical MTLs to diagonal MTLs.

The present study will first test whether Mandarin speakers would show MTLs that are commensurate with the previous studies found [12-14]. Participants would be trained to complete space-time congruency tasks that were verified valid [15]. Second, we will determine whether Mental Representations of Diagonal Time Lines are determined by the combination of dominant vertical MTLs and lateral MTLs. Two groups of participants would each complete two tasks to test whether the diagonal MTLs change parallel to the mirror reverse of lateral and vertical MTLs or not.

According to that the diagonal MTL is determined by the combination of the subject's Lateral MTLs and vertical MTLs, the participants, therefore, should change their diagonal MTLs with the mirror reversing of the targets under lateral and vertical primes. By contrast, subjects should show the Top left/bottom right MTL, regardless of whether they have been trained to use standard or mirror-reversed Mandarin (i.e., no effect of mirror-reading training).

2 Method

2.1 Participants

We will recruit 40 healthy participants whose native language is Chinese between 15 and 24 years old: 20 for the normal group, and 20 for the mirror group. This sample size was estimated by G-power 3.1. Participants will be randomly assigned into two groups.

2.2 Prime

A number of Chinese statements will be written in order to express temporal relationships in simple temporal terms. Each prime contains one sentence, and they are classified into four types: horizontal standard orthographic primes, in which each statement is written as HLR, horizontal mirror orthographic primes, in which the same statements as in the horizontal standard orthographic primes are written as HLL, shown in Figure

1. Vertical standard orthographic primes, in which each of the remaining statements is arranged as VTB, and vertical mirror orthographic primes, in which the same utterances as in the horizontal standard orthographic primes are written as VBT, shown in Figure 2.

During the training stage, each participant will perform space-time congruency tasks independently in a quiet room using the same desktop computer.

Wednesday is earlier than Friday. Wednesday is earlier than Friday.

Fig. 1. Example of normal(left) & mirrored(right) lateral question [Owner-draw]

Wednesday is earlier than Friday. Wednesday is earlier than Friday.

Fig. 2. Example of normal(left) & mirrored(right)vertical question [Owner-draw]

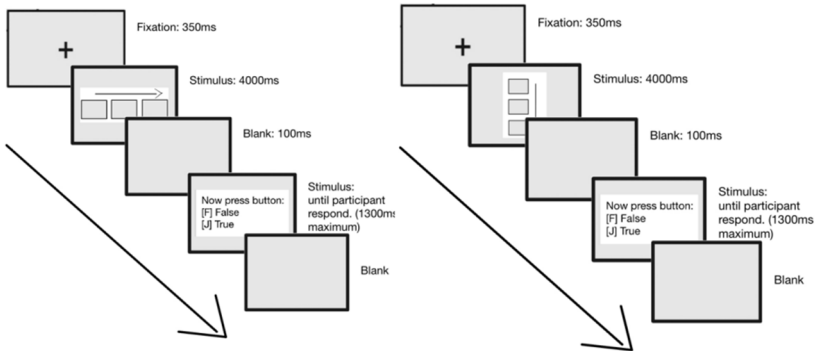


Fig. 3. Flow chart of horizontal(left) & vertical(right) condition [Owner-draw]

In the main experiment, two groups of participants will complete two test blocks with an equal number of trials. Group 1 will complete a standard orthographic test block in horizontal condition as well as a vertical standard orthographic test block. (in each trial, a horizontal or vertical standard orthographic prime precedes a target). Group 2 will complete a horizontal mirror orthographic block (each trial will include a horizontal mirror orthographic prime and a target) and a vertical mirror orthographic block. (with a vertical mirror orthographic prime preceding a target on each trial). The blocks' sequence will be balanced between participants, and the order of trials within each block will be randomized (see Figure 3) .

2.3 Target

The goal comprises a number of triptychs reflecting the idea of time proceeding. Each triptych of image stimuli will depict a separate nature event at three different time intervals. All of these materials will be itemized into two categories: (1) horizontally spatiotemporally compatible targets, with each trio of visual stimuli organized from left to right, as shown by the arrowhead contiguous to the stimulus. (2) vertically spatiotemporally compatible, with each stimulus ordered from top to bottom. The true and false frequencies of the target stimuli will be the same. Participants must decide whether the temporal order indicated in the target is real considering the direction of the arrowheads. (i.e., whether the 3 images are ranking in the correct temporal order, from earliest to latest). For 4000 ms, the target will display in the center of the screen. By hitting one of the two keys listed above, the participant will be asked to assess if the chronological sequence hinted by the target is right based on the direction of the arrow. When the decision is made, a blank screen of 100 ms adumbrates the target, and a new target is presented.

3 Predictions

Individuals' Lateral MTL determines the orientation of their diagonal mental timeline (MTL), which can be affected by exposure to a certain language. Individuals exposed to conventional Mandarin should have a mental timeline that runs from top left to bottom right, whereas those exposed to mirror-reversed Mandarin should have a mental timeline that runs from top right to bottom left. This suggests that the orientation of the diagonal MTL may be influenced by linguistic experience and may differ across people (see Figure 4 on the left). On the contrary, the orientation of an individual's diagonal mental timeline (MTL) is not dictated by their Lateral MTL. Individuals should have a mental timeline that runs from top left to bottom right in this scenario, independent of their language background or exposure to conventional or mirror-reversed Mandarin. This means that mirror-reading training has no influence on the direction of the diagonal MTL if it is not dictated by the lateral MTL (see Figure 4 in the middle and right).

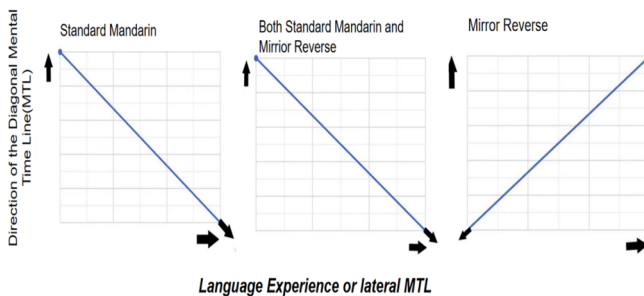


Fig. 4. A mental time line that proceeds from the top left to the bottom right(left)/top right to the bottom left(middle)/ Individuals have the same direction mental timeline regardless of exposure to both standard Mandarin and mirror-reversed Mandarin (right)[Owner-draw]

4 Conclusion

As for our study, we expect to find the result that representations of diagonal timelines differ in trained and untrained participants. As the standard orthographical primes and mirror orthographical primes of sentences in Mandarin are given to the participants, the targeted responses we get are expected to be completely different. It corresponds with our prediction that individuals exposed to standard Mandarin should have MTLs proceeding from the top left to the bottom right, while individuals exposed to mirror Mandarin should have MTLs proceeding from the top right to the bottom left. These all demonstrate that there is a true relationship between the dominant lateral MTLs with respect to people within the specific cultural background and their representation of diagonal timelines. Alternatively, we may find that the diagonal timelines responses revealed by the participants are not affected by whether they are exposed to standard or mirror-reversed Mandarin. That's to say, Mandarin speakers who have MTLs proceeding from the top right to the bottom right under the standard condition will still have the same representation of diagonal timelines when they are exposed to mirroring stimuli. Hence, the predicted results we get in this study would imply no causal relationship between the lateral MTLs and people's diagonal timelines.

Despite all of our experimental designs about MTLs, it is also significant for us to understand how cultural factors show their impact on building MTLs. In Yang and Sun's previous study, it has been proposed that reading direction can be regarded as a leading factor in determining lateral MTLs [16]. As different cultures differ in their reading directions, people within these divergent cultural backgrounds are likely to differ in their MTLs [17]. Based on our study, we can connect this cultural leading cause to our subject—the representation of diagonal timelines. Then, it can be inferred that reading direction inherited from cultural backgrounds plays an important role in altering people's perception of diagonal timelines. Elaboration that includes writing direction in the lateral axis is also possibly related to this topic.

Although the direction of reading and writing had no effect on the level of MTL of Mandarin speakers, the subjects were Taiwanese and did not represent all Mandarin speakers [16]. Researchers have conducted the same experiment with mainland Chinese and Taiwanese and found that writing habits correspond to those of mainland Mandarin speakers [18]. Therefore, we still believe that writing and reading habits caused by cultural factors can affect horizontal MTLs, i.e. writing and reading habits can affect diagonal MTLs.

Furthermore, since our study merely includes mirroring the orthographical primes of sentences in Mandarin, which means in the Left-right axis, we can add a follow-up experiment to fully reveal the effect of the combination of lateral and vertical MTLs. The follow-up experiment involves the same procedure as our main experiment: dividing the participants into a "train" group and a "untrain group", then assigning them sentences and triptychs. Yet the difference is that the follow-up experiment includes exposing the participant to Up-Down or Down-Up writing and testing for flipping of the diagonal MTL on the top/bottom axis. After this experiment, it would be more confident for us to wrap up the data and conclude that diagonal mental timelines are affected by cultural-specific MTLs, both lateral and vertical.

Based on our current experimental design, we believe that our setup is reliable enough to be replicated for a future study focusing on cross-cultural analysis on diagonal timelines. With the application of similar experiment methods involving "train" and "no train" groups, yet adding the set of participants to be multinational, that is, on top of the Mandarin speakers, speakers of another language can be added. This is to attain a cross-cultural comparison, which makes a more complicated yet more thorough-going set of experiments demonstrating the effect of cultural differences on shaping diagonal timelines.

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