



Differential Modulation Effects of Music Expertise on English and Chinese Sentence Reading

Weiyan Liao, Sara Tze Kwan Li & Janet H. Hsiao
Department of Psychology, University of Hong Kong



Introduction

- Music expertise is shown to modulate cognitive abilities such as executive functions (Degé, Kubicek & Schwarzer, 2011), memory (Taylor & Dewhurst, 2017), and attention (Rodrigues et al., 2013).
- In addition, music expertise is shown to modulate perceptual processes involved in English reading but not in Chinese reading due to the similarities in the perceptual processes involved (Li & Hsiao, 2018; Li, Chung, & Hsiao, 2019).
- Music expertise is also shown to modulate syntactic and semantic processes in language reading (Fitzroy & Sanders, 2013; Dittinger et al., 2017).
- In order to examine which aspects of music expertise could account for the observed modulation effects, we used the Goldsmiths Musical Sophistication Index (Gold - MSI; Müllensiefen, Gingras, Musil, & Stewart, 2014) to measure participants' musical experience and sophistication.
- We hypothesized that music expertise modulates English sentence reading in both perceptual and linguistic regularity processing, whereas in Chinese sentence reading, the modulation may be limited to linguistic regularity processing, and that musicians' higher sensitivity to linguistic irregularities than non-musicians during reading may be particularly related to more engagement in expression analysis, which could be reflected in the MSI emotions subscale.

Methods

Participants: 86 Chinese (L1)-English (L2) bilinguals (43 musicians) aged 18 to 34.

Materials:

- Gold-MSI was used to measure participants' musicality in different aspects. There are five sub-scales of Gold-MSI: active engagement, perceptual abilities, musical training, emotions, singing abilities.
- English and Chinese reading: 3 conditions (original sentence vs. semantically incorrect sentence vs. random word list), with 24 trials each condition.
- Participants answered a comprehension question after reading an original sentence, or a word recognition question after reading a semantically incorrect sentence/random word list.
- Music and Tibetan reading: 2 conditions (original sentence vs. random word list), with 24 trials each condition.
- Participants answered a word/musical segment recognition questions after reading each original sentence/phrase or random word/segment list.
- For the musical phrase reading task, a musical phrase auditory matching task was carried out after the musical segment recognition task.

Design

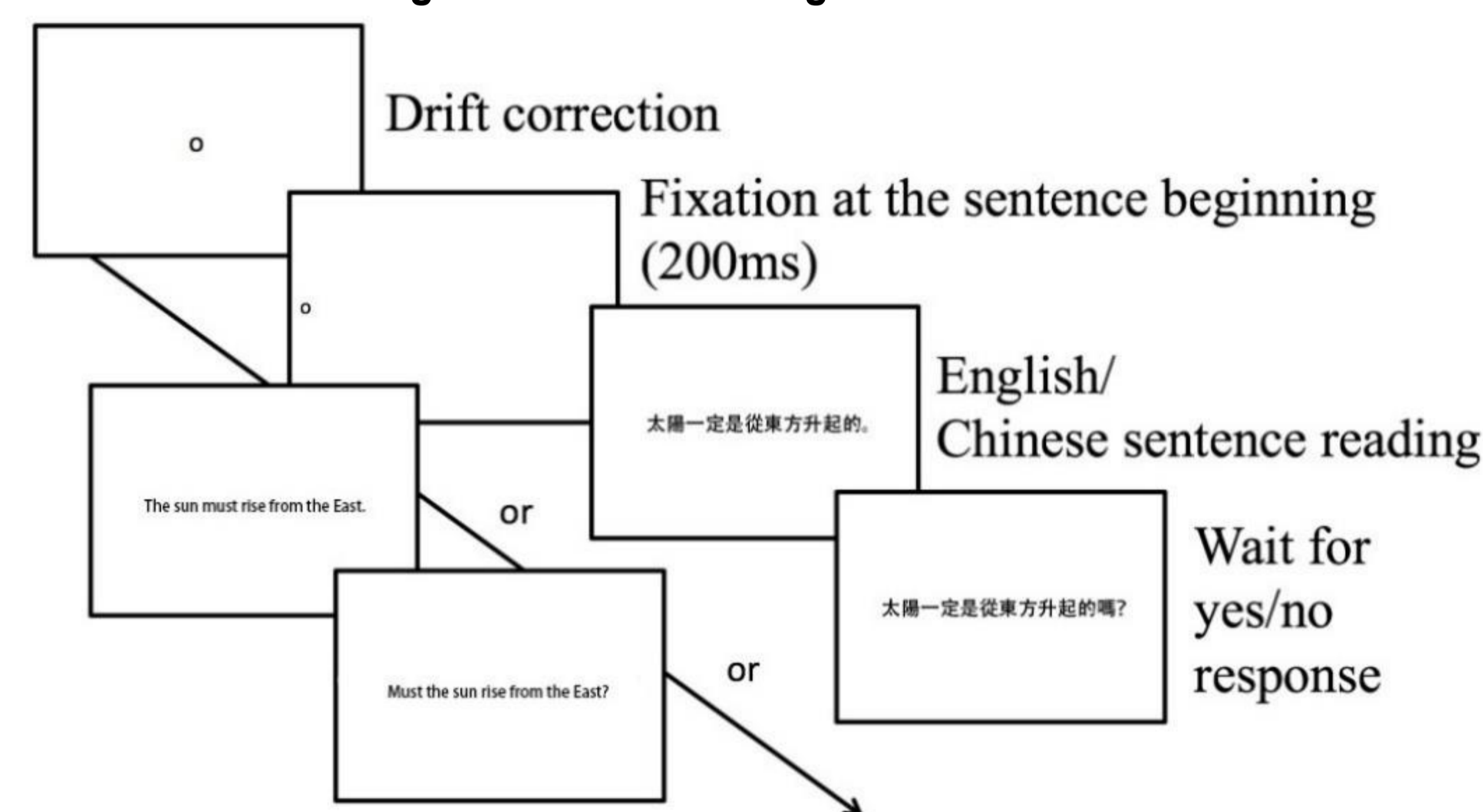
- Independent variables: musician group (musician vs. non-musician); sentence type (original vs. semantically incorrect vs. random word list).
- Dependent variables: reading performance (sentence reading time) and eye movement pattern (Dispersed-Sequential Scale).

EMHMM

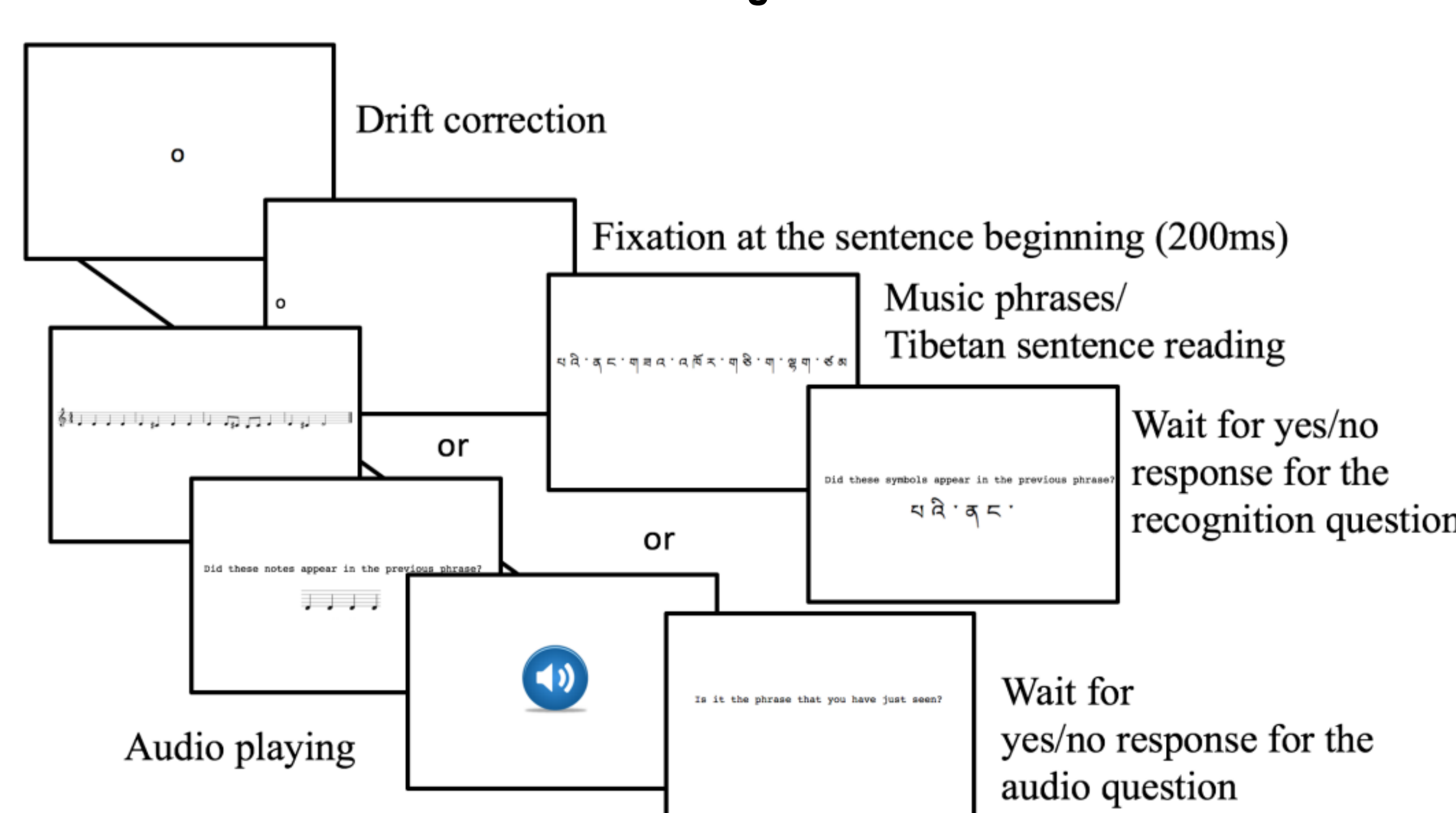
- Each participant's eye movement in was modeled with one HMM.
- The two representative HMMs were generated using 3 ROIs to help discover a general eye movement pattern across all sentences.

Procedure

Procedure of the English/Chinese reading task

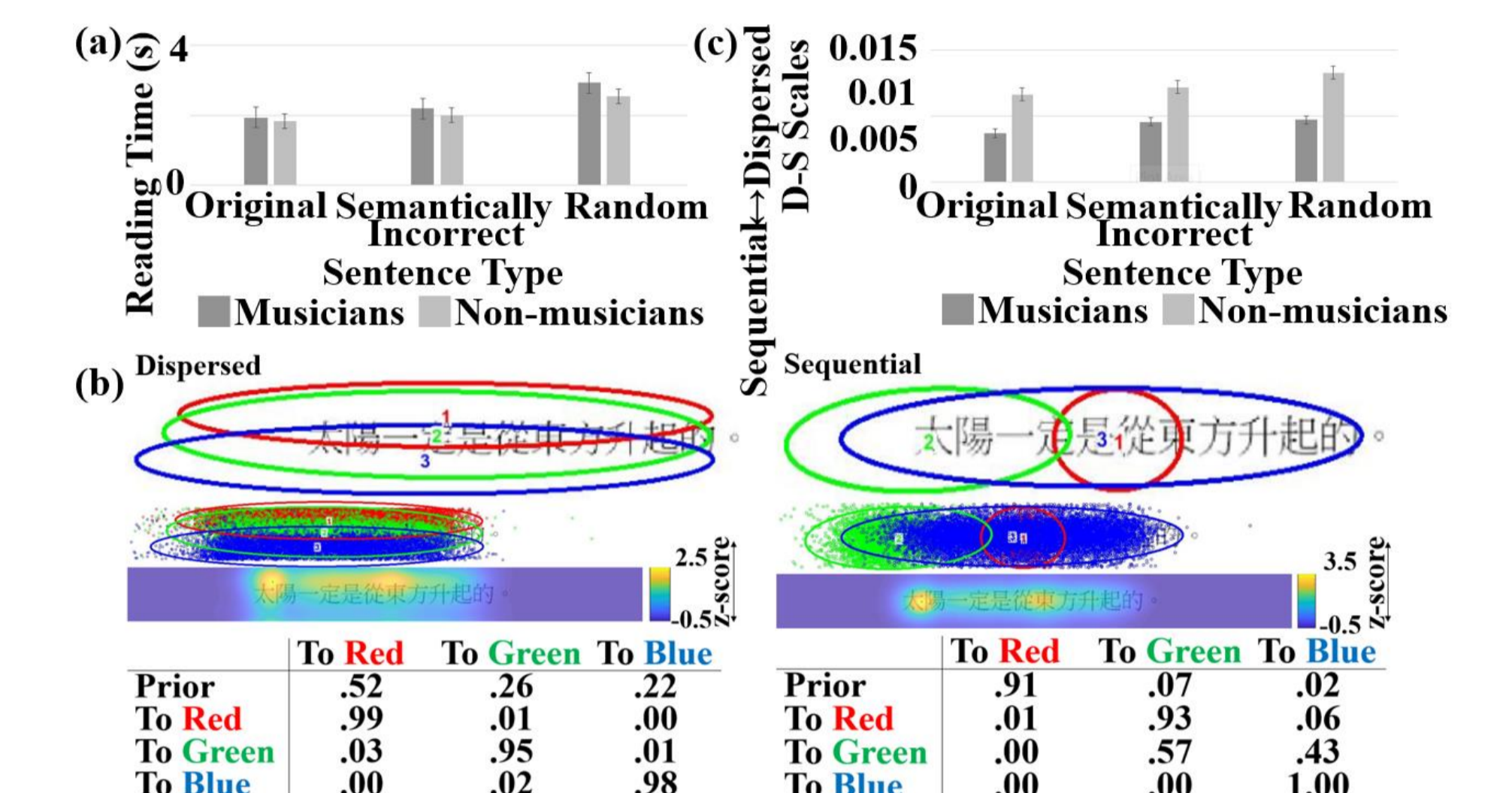
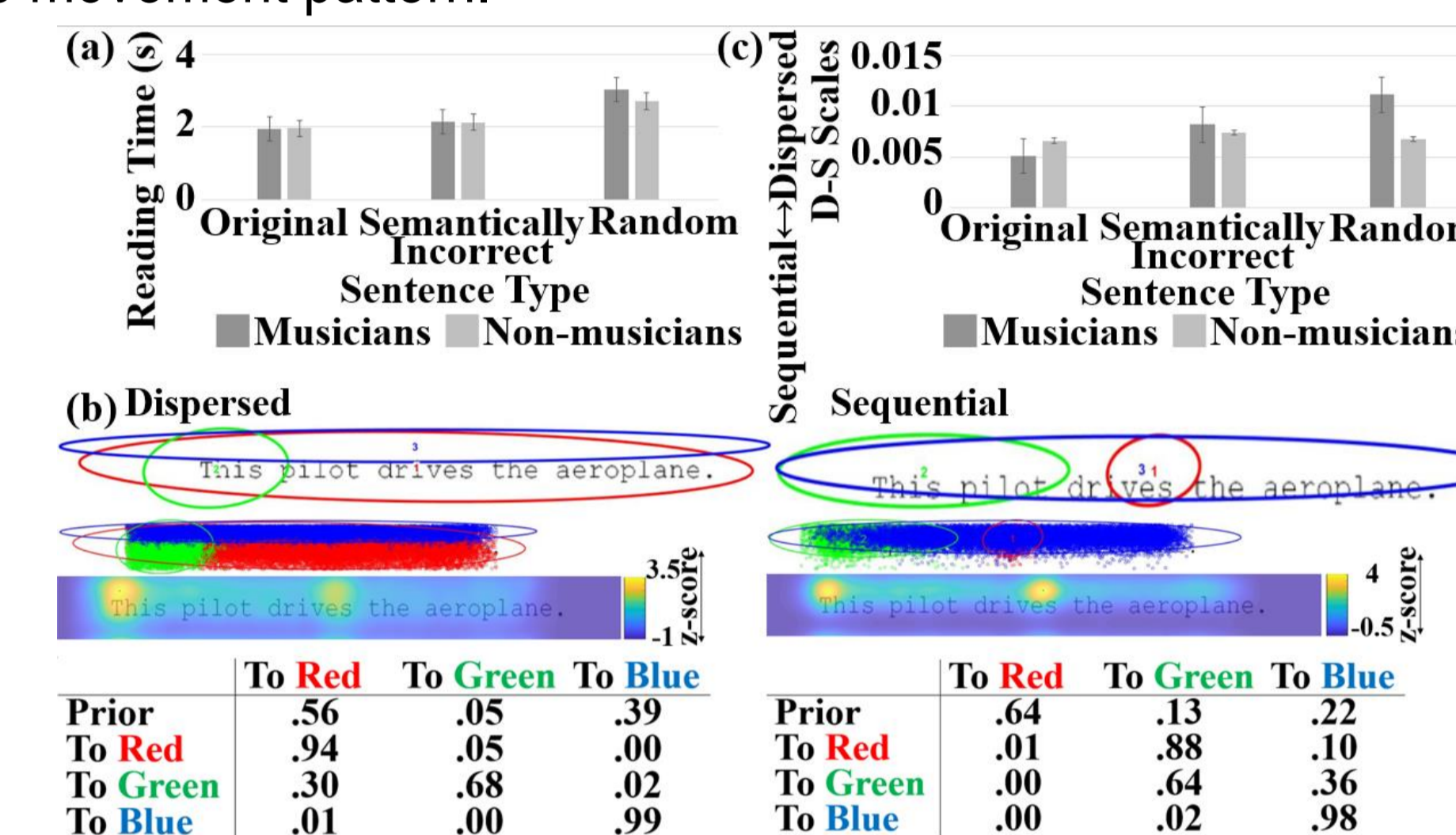


Procedure of the music/Tibetan reading task

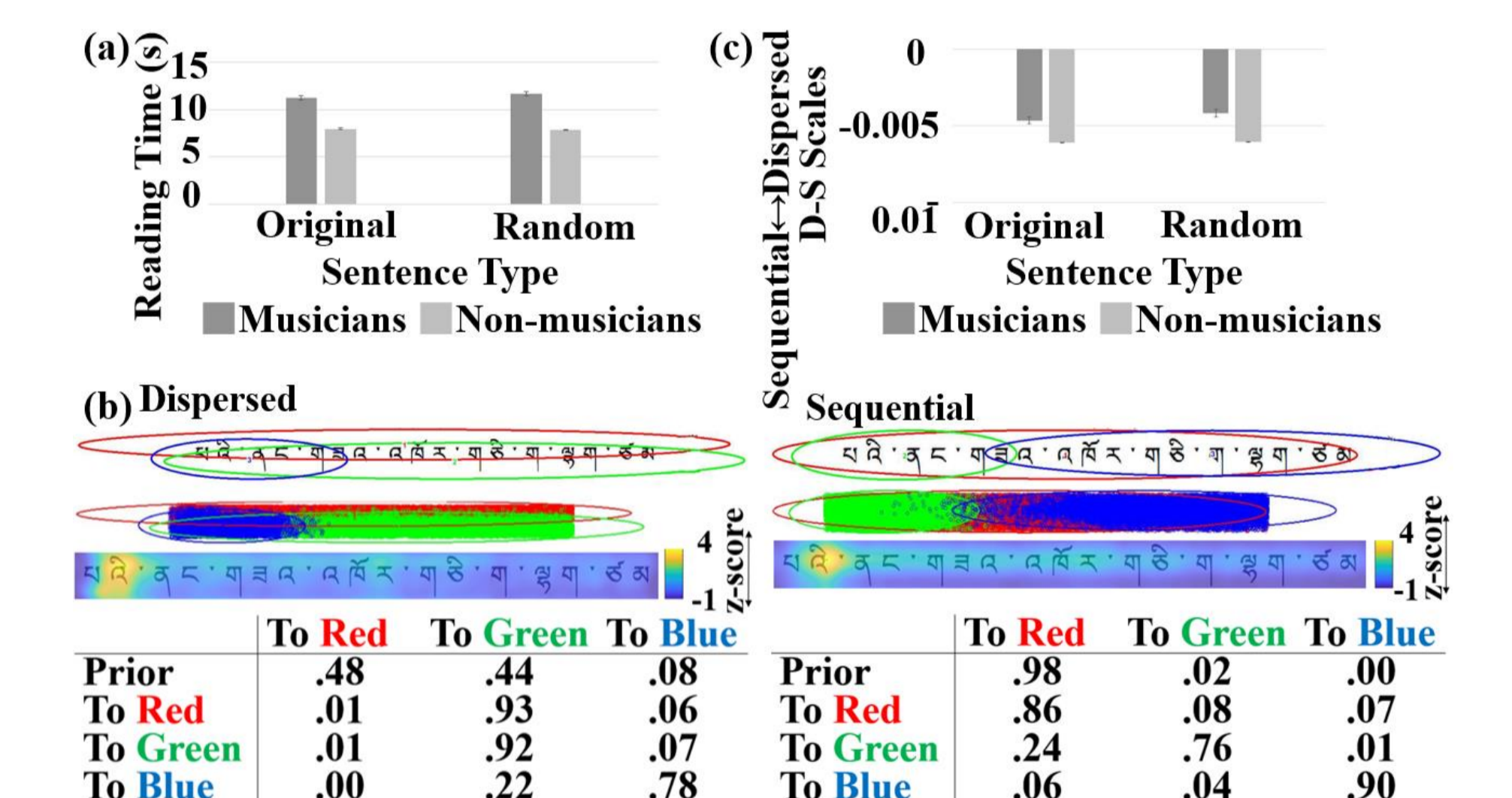
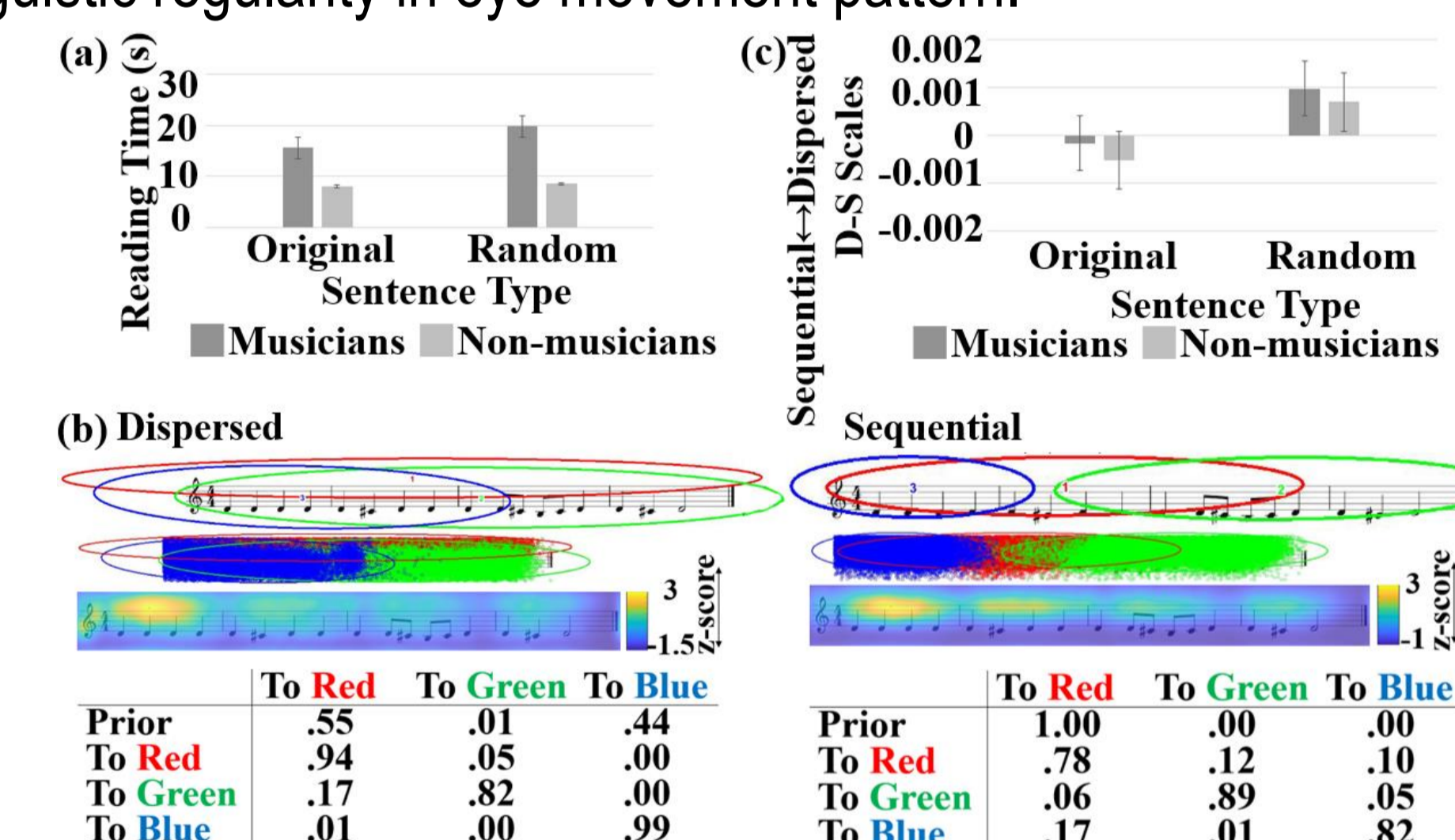


Results

- In English reading, the difference of reading time between random word lists and semantically incorrect sentences, and the difference between random word lists and original sentences were larger in musicians than non-musicians. MSI index on emotions predicted normalized sensitivity to linguistic regularity in reading time.
- In eye movement patterns, musicians showed a more sequential pattern when reading original sentences than random word lists. MSI index on singing abilities predicted normalized sensitivity to linguistic regularity in eye movement pattern.
- In Chinese reading, the difference of reading time between random word lists and original sentences were larger in musicians than non-musicians. MSI index on emotions predicted normalized sensitivity to linguistic regularity in reading time.
- However, musicians did not differ from non-musicians in eye movement patterns, and none of the MSI indices predicted normalized sensitivity to linguistic regularity in eye movement pattern.



- In music reading, musicians spent more time reading random segments than original phrases, whereas non-musicians did not show this difference. MSI on musical training predicted normalized sensitivity to linguistic regularity in reading time.
- However, musicians did not differ from non-musicians in eye movement patterns, and none of the MSI indices predicted normalized sensitivity to linguistic regularity in eye movement pattern.



Conclusion & Discussion

- These results suggested that music expertise can modulate language processing at different cognitive processing levels, and it can have differential modulation effects on different languages, depending on the similarities in the processes involved.
- Higher sensitivity to linguistic regularity reflected in reading time in both English and Chinese reading could be predicted by higher MSI on emotions, suggesting that the higher sensitivity reflected in reading time in musicians may be related to more engagement in expression analysis.
- Higher sensitivity to linguistic regularity reflected in eye movement pattern in English reading was predicted by higher MSI on singing abilities, suggesting that the higher sensitivity reflected in eye movements may be related to executive functions, which has shown to associate with eye movement behaviors (e.g. Vakili, Mass, & Schiff, 2019).

References

- Degé, F., Kubicek, C., & Schwarzer, G. (2011). Music lessons and intelligence: A relation mediated by executive functions. *Music Percept.: An Interdisciplinary Journal*, 29(2), 195-201.

- Dittinger, E., Chobert, J., Ziegler, J. C., & Besson, M. (2017). Fast brain plasticity during word learning in musically-trained children. *Front. Hum. Neurosci.*, 11, 233.

- Fitzroy, A.B., & Sanders, L.D. (2013). Musical expertise modulates early processing of syntactic violations in language. *Front. Psychol.*, 3, 603.

- Li, T. K., Chung, S., & Hsiao, J. H. (2019). Music-reading expertise modulates the visual span for English letters but not Chinese characters. *J. Vision*, 19(4):10.

- Li, T. K., & Hsiao, J. H. (2018). Music Reading Expertise Modulates Hemispheric Lateralization in English Word Processing but not in Chinese Character Processing. *Cognition*, 176, 159-173.

- Müllensiefen, D., Gingras, B., Musil, J., & Stewart L. (2014). The musicality of non-musicians: An index for assessing musical sophistication in the general population. *PLoS ONE*, 9(2): e89642.

- Rodrigues, A.C., Loureiro, M.A., & Caramelli, P. (2013). Long-term musical training may improve different forms of visual attention ability. *Brain Cognition*, 82(3), 229-235.

- Taylor, A.C., & Dewhurst, S.A. (2017). Investigating the influence of music training on verbal memory. *Psychol. Music*, 45(6), 814-860.

- Vakili, E., Mass, M., & Schiff, R. (2019) Eye movement performance on the Stroop Test in adults with ADHD. *J. Atten. Disord.*, 23(10), 1160-1169.