

Introduction

Reading musical notation requires the processing of pitch and rhythmic information simultaneously [1]. However, the perceptual characteristics of score reading according to the processing load is unclear. The present study aimed to investigate the perceptual characteristics of score reading according to pitch and rhythm components to manipulate processing load. We used an eye-tracker (EyeLink 1000, SR Research) to examine whether eye responses reflect the differences of the processing load during score reading.

Methods

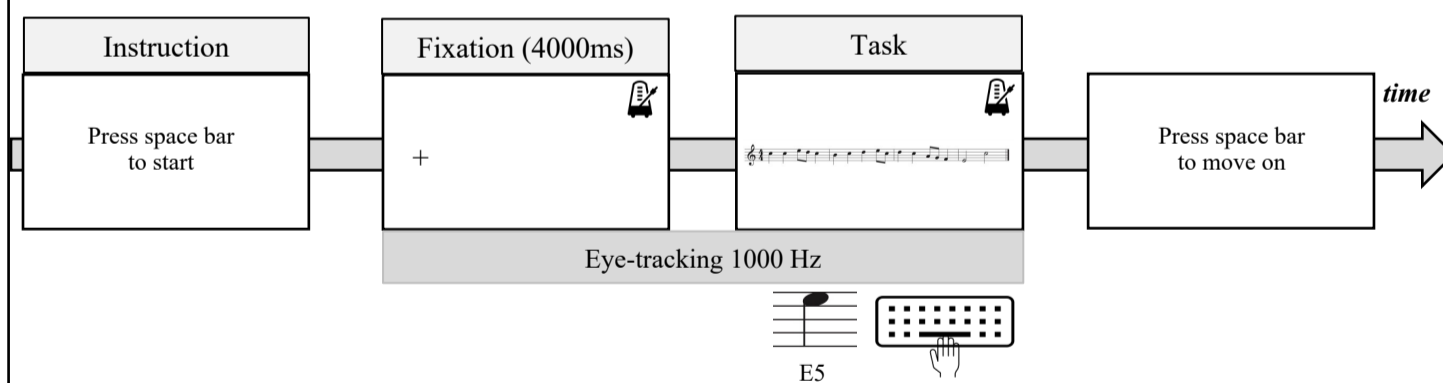
Participants

- 35 participants (19 females, ages: 20-35)
- Musical background questionnaire
- Music ability test

Stimuli

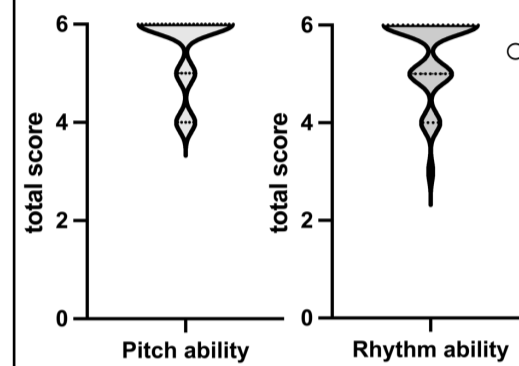
Processing load	pitch	rhythm
low	tonal (no accidentals) simple pitch (SP)	simple (quarter, half note) simple rhythm (SR)
high	atonal (accidentals: # and b) complex pitch (CP)	complex (16th note, triplet, syncopation) complex rhythm (CR)

Procedure



- Auditory cue: metronome was provided at 120 beats per minute (BPM)
- Eye-tracking 1000 Hz (EyeLink 1000, SR Research)
- Participants read musical scores along with the auditory cue over the headphones
- Participants pressed the space bar when they detected E5 in the score
- 3 blocks (total of 96 trials), counterbalanced between participants

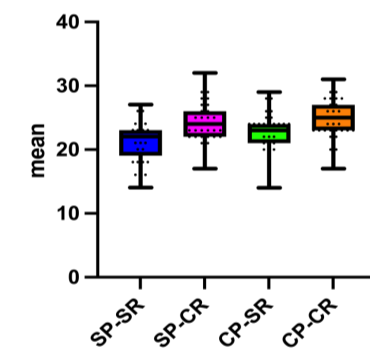
Results of music ability test



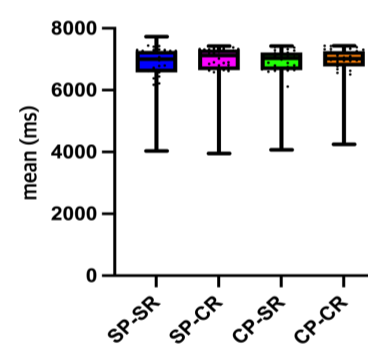
- Participants were able to read pitch (mean = 5.25) and rhythm (mean = 4.54) according to the ABRSM (The Associated Board of the Royal Schools of Music) music ability criteria.

Results of eye responses

Fixation Count



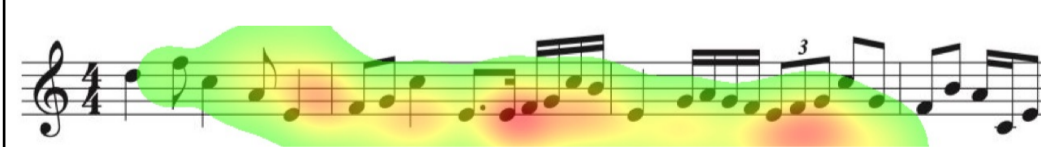
Fixation Duration



- The main effects of pitch [$F = 14.04, p < 0.046$] and rhythm [$F = 17.90, p < 0.000$] were significant.
- No significant interaction between pitch and rhythm was observed.

- None of the main nor interaction effects were statistically significant.

[Sample heatmap from SP-CR]



[Sample heatmap from CP-CR]

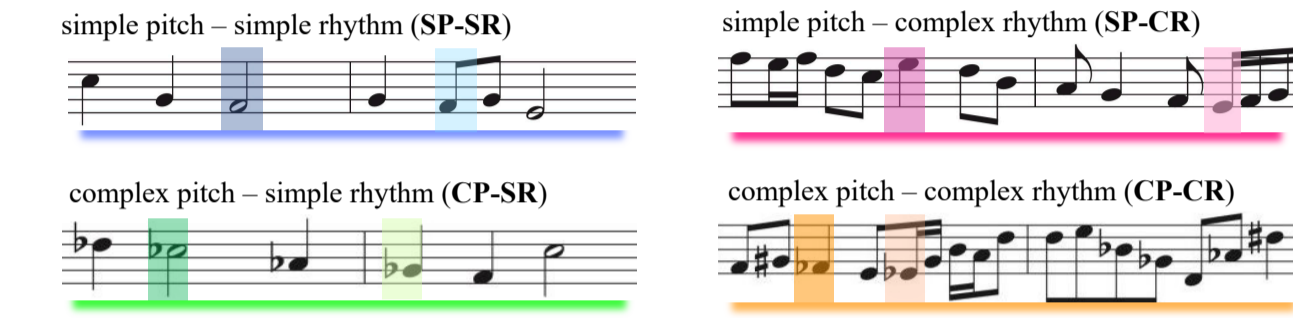


Conclusion

- Pitch and rhythm information processing can be reflected on the eye responses.
- These results suggest that musical notation reading is influenced by the processing load. Higher processing load in rhythm was associated with the greater fixation count and duration, particularly for the areas of the scores where critical information was presented.

Results

AOIs (SR vs. CR)

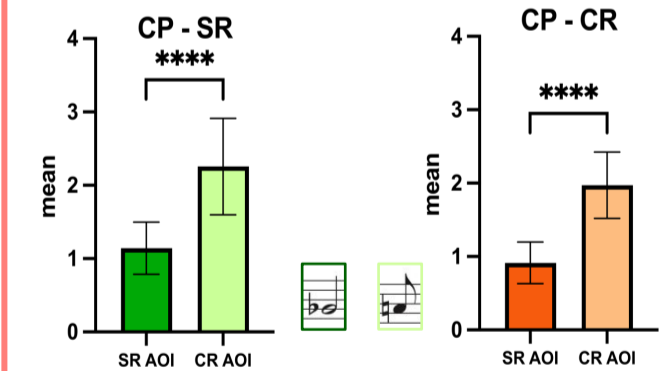
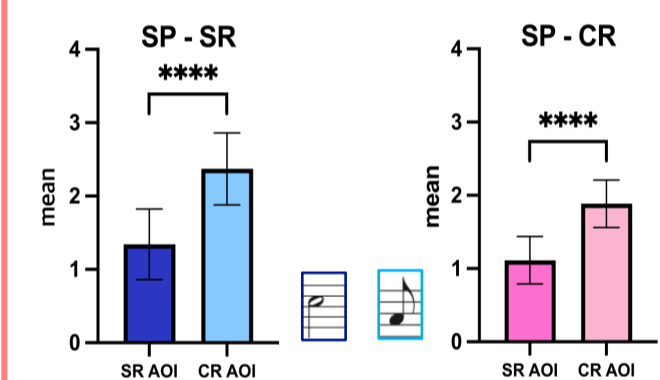


- Selected from either second or third measure of each musical score.
- 0.5 visual degrees of AOI was selected to control the same amount of visual information in each AOI.

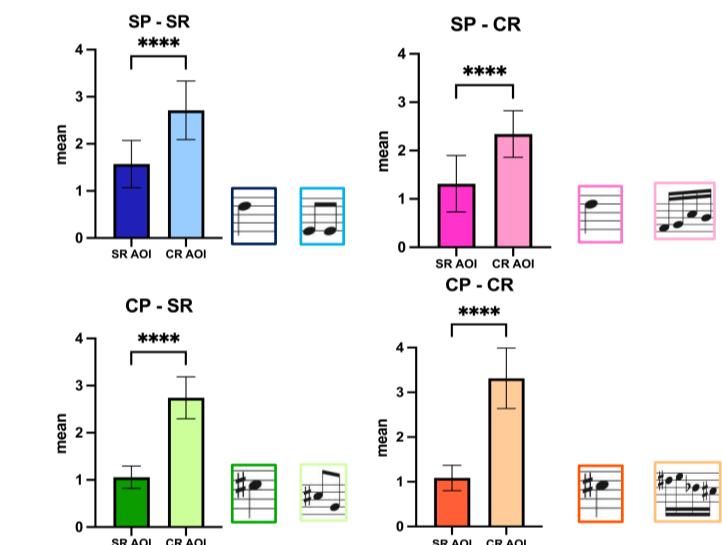
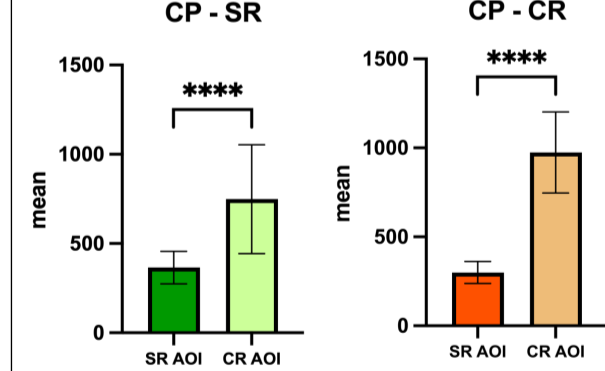
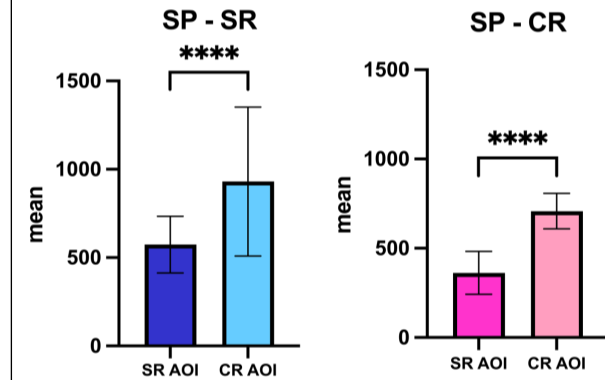
Additional AOIs
(based on the same rhythm duration)

Results of AOIs level eye responses

Fixation Count

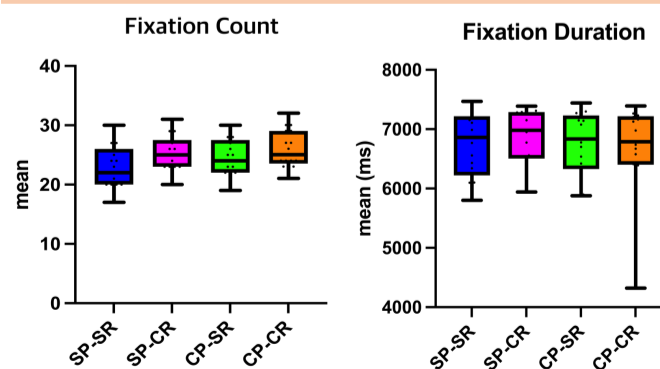


Fixation Duration



- Overall, greater fixation count and duration were observed in high processing load AOIs (those containing complex rhythms) than low processing load AOIs (those containing simple rhythms).
[complex > simple rhythm]

Control experiment: without auditory cue (N= 17)



- To rule out the possible effect of the auditory metronome cue, a control experiment without the auditory cue is in progress.
- A preliminary result from 17 participants suggests that the findings regarding the effect of rhythm can be replicated.
- The main effect of rhythm [$F = 5.772, p < 0.019$] was significant for fixation count. Neither the effect of pitch nor interaction effects were statistically significant for fixation duration.

References

[1] Chang, T. Y., & Gauthier, I. (2021). Domain-specific and domain-general contributions to reading musical notation. *Attention, Perception, & Psychophysics*, 83(7), 2983-2994.
[2] Yang, S. N. (2009). Effects of gaze-contingent text changes on fixation duration in reading. *Vision Research*, 49(23), 2843-2855
[3] Clifton Jr, C., Staub, A., & Rayner, K. (2007). Eye movements in reading words and sentences. *Eye movements*, 341-371.