

# Complexity in music perception - is it reflected in listeners' pupil dilation?

Edris Hakimzada edrish@kth.se Helena T. Linder Miñambres ht1m@kth.se  
 Izabelle Lundqvist izalun@kth.se Yuxuan Zhang yuxuanzh@kth.se  
 KTH Royal Institute of Technology, Sweden

## Abstract

This study aimed to investigate if listeners' pupillary dilation reflects the complexity of music perception. A carefully controlled experiment on music perception was performed using an integrated eye tracker (Tobii pro nano). The findings suggested that the music that was more complex elicited a larger pupil dilation, which was also the case for the music that was more liked and disliked by the participants.

## Background

- ▶ A brief and involuntary reaction that occurs when the pupil dilates as a result of some action that involves cognitive load, such as auditory perception-related activities, is referred to as a Task-Evoked Pupillary Response [1, 2].
- ▶ In regards to music stimuli, pupil dilation has been shown to be sensitive to familiarity and timbre (especially to the human voice's timbre) [3].
- ▶ Other musical attributes such as balance, contour, symmetry, and complexity have been studied behaviorally as well as computationally [4] but, is there a psychophysiological sensitivity to these parameters?

## Method

- ▶ The PsychoPy Python package was used to design a controlled experiment in which participants were presented 50 music excerpts.
- ▶ The musical stimuli used were the complexity subset of the MUST set developed by Clemente et al. [4]. The participants were also asked to rate their liking of each excerpt on a scale from 1 to 7.
- ▶ 8 participants were seated in front of a computer screen in a dimly lit room, as seen in figure 1, to allow greater pupil dilation.



Figure 1: Experimental setup.

## Results & Discussion

**Figure 2** suggests that the pupil dilation was more significant as the complexity of the music excerpts increased. There is an obvious difference between the high and low complexity excerpts.

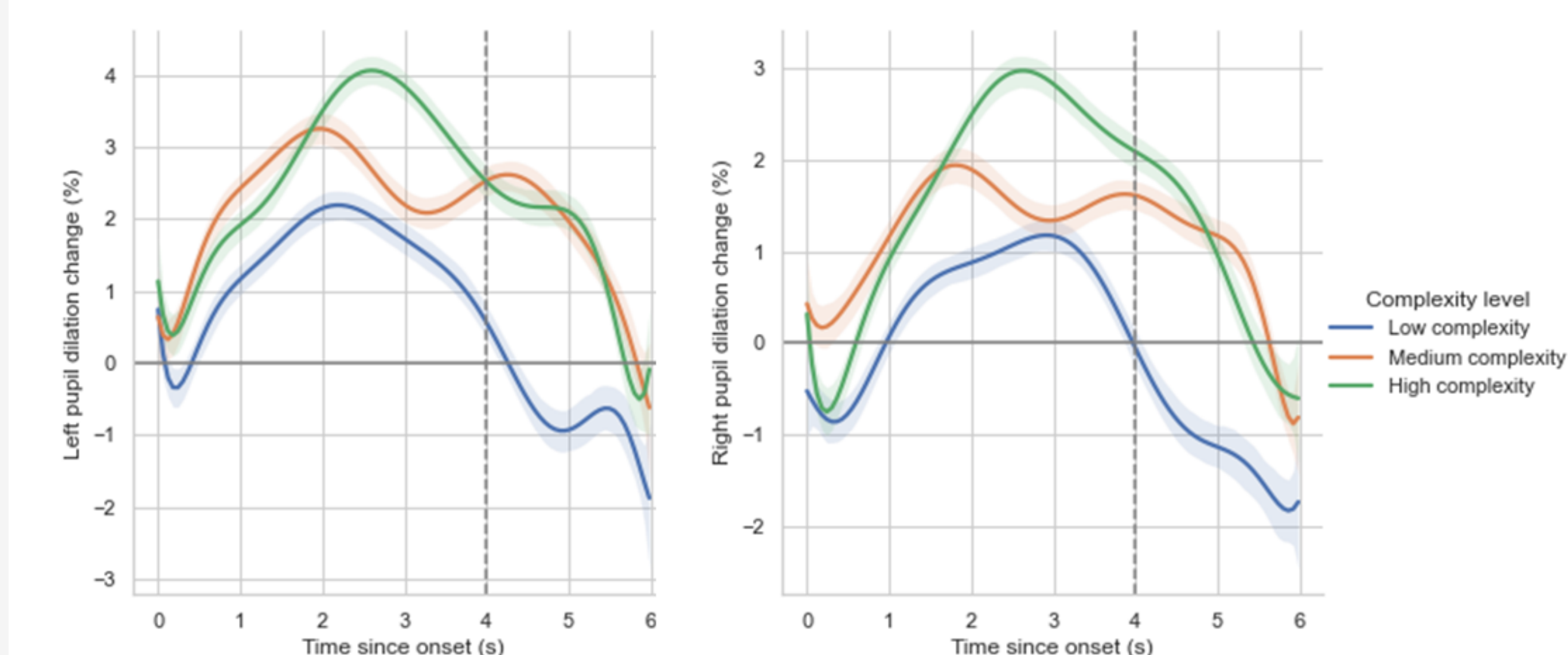


Figure 2: Polynomial regression of the pupil dilation changes from the baseline value as a function of music complexity level and time.

## Results & Discussion

**Figure 3** shows that low-complexity music had lower liking scores. However, there does not seem to be a relationship between liking scores and complexity for the higher end of the complexity spectrum.

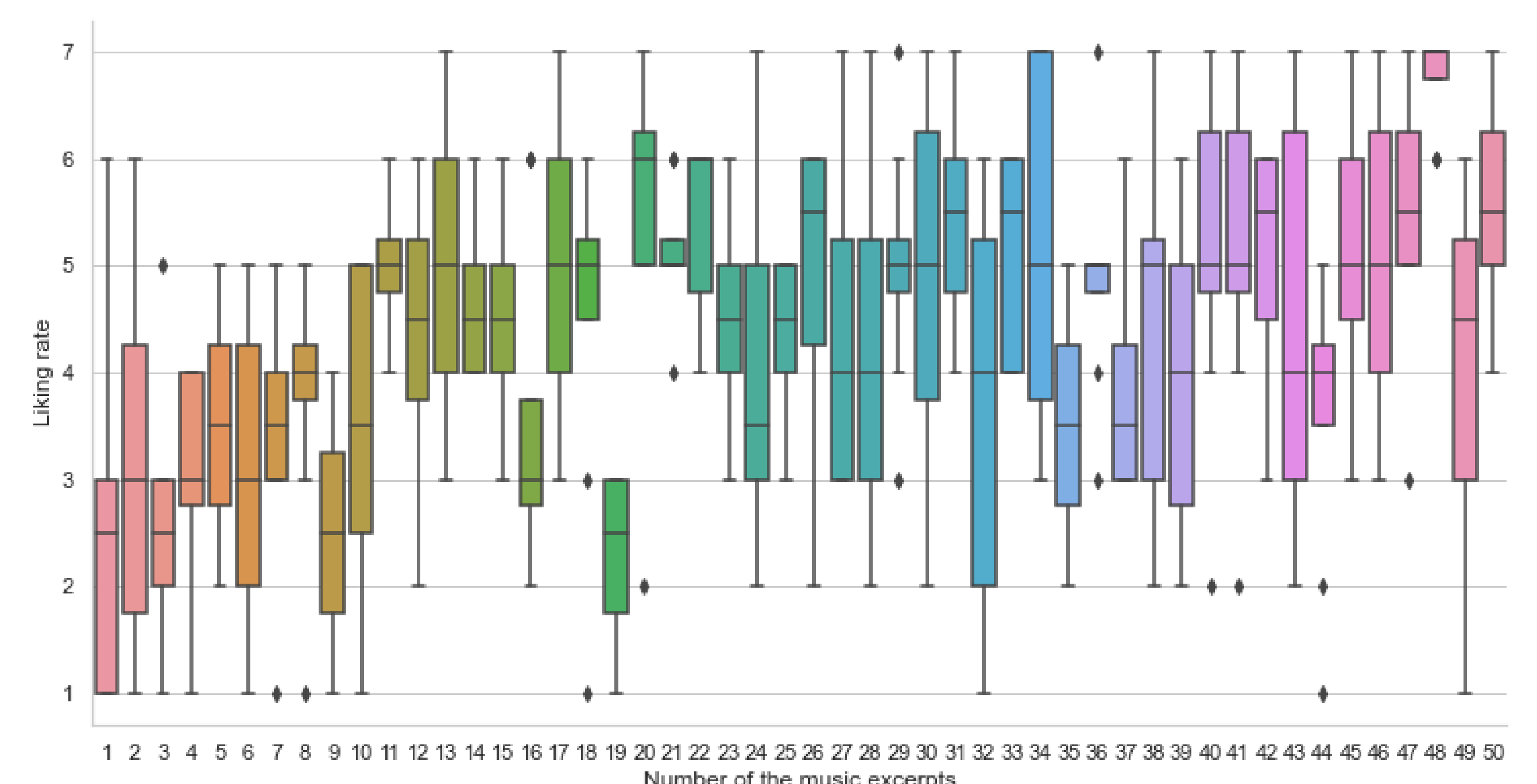


Figure 3: Relationship between the liking rate and the complexity level of music excerpts.

As shown in **Figure 4**, the music that participants both liked and disliked elicited more pupil dilation, which was partly consistent with previous experiments [5]. However, as Gringas et al. explained, these relationships may depend on individual differences [5]. The sample size of this experiment was small and the duration of the music stimuli was short, therefore the results are only suggestive.

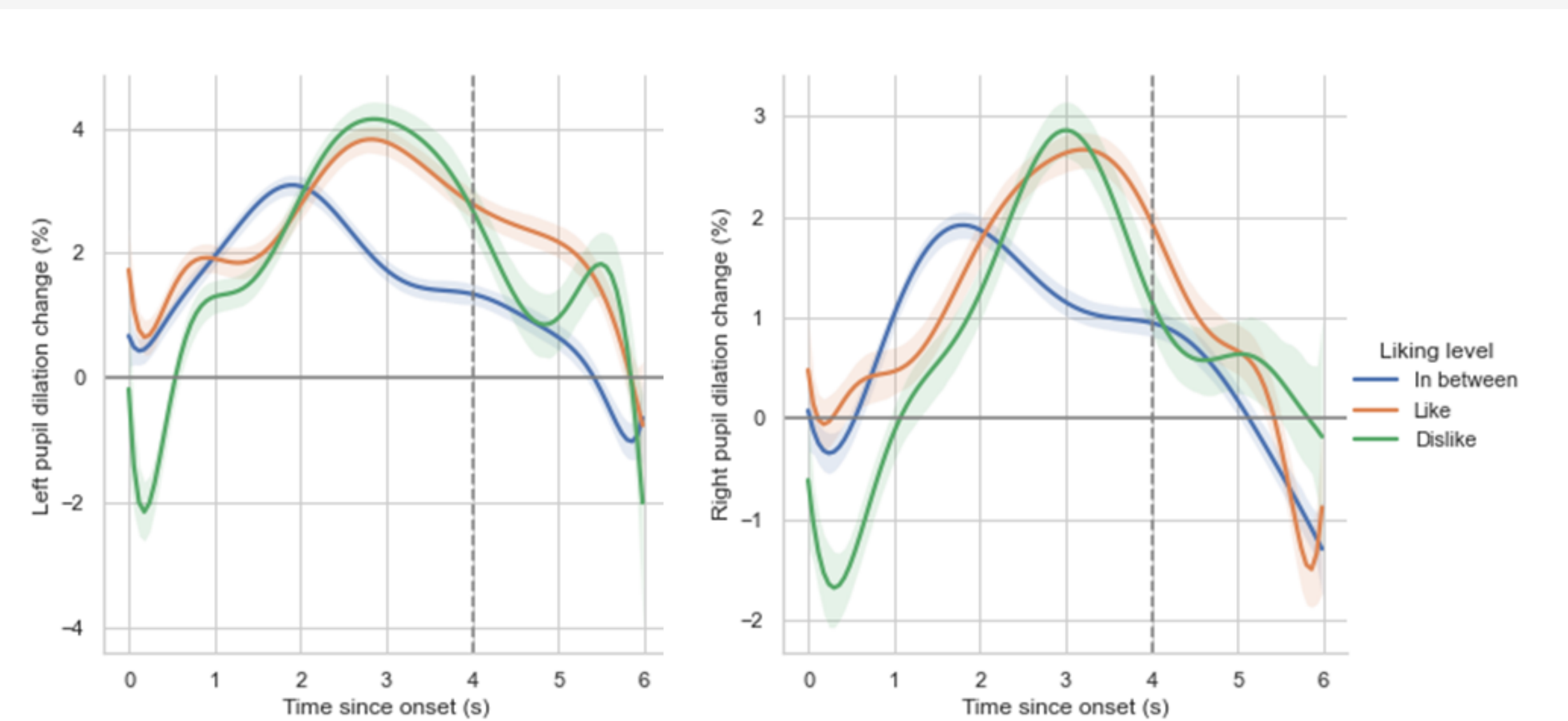


Figure 4: Polynomial regression of the pupil dilation changes from the baseline as a function of liking rate and time.

## Conclusion

This study drew a preliminary conclusion that pupil dilation might be induced by the more complex music. Moreover, the music that was more liked but also disliked by the participants also seemed to elicit larger pupil dilation, which partially reflects the results from previous studies. More research is needed to find the relationship between pupil dilation and people's liking of the music based on individual differences.

## References

- [1] Jackson Beatty. "Task-evoked pupillary responses, processing load, and the structure of processing resources." In: *Psychological bulletin* 91.2 (1982), p. 276.
- [2] Jackson Beatty, Brennis Lucero-Wagoner, et al. "The pupillary system". In: *Handbook of psychophysiology* 2.142-162 (2000).
- [3] Michael W Weiss et al. "Pupils dilate for vocal or familiar music." In: *Journal of Experimental Psychology: Human Perception and Performance* 42.8 (2016), p. 1061.
- [4] Ana Clemente et al. "A Set of 200 musical stimuli varying in balance, contour, symmetry, and complexity: Behavioral and computational assessments". In: *Behavior Research Methods* 52.4 (2020), pp. 1491–1509.
- [5] Bruno Gringras et al. "The eye is listening: Music-induced arousal and individual differences predict pupillary responses". In: *Frontiers in human neuroscience* (2015), p. 619.