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Auditory pitch modulates the localization of audiotactile stimuli during active touch

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Introduction

Most studies focus on the role of temporal and spatial parameters in multisensory interaction. However, it is known that cross-modal correspondences can also impact multisensory processing [1]. Between them, we can find the association between frequency and spatial location. Specifically, it has been reported that, in the auditory source location, humans consistently map high pitch to high positions in space [2]. Some authors explored the associations between this cross-modal correspondence and touch using high and low-frequency tones and vibratory stimulus, reporting an implicit association between the relative elevation of a tactile stimulus and the frequency of a sound in passive touch condition [3,4]. Surprisingly, this cross-modal correspondence in active touch is a neglected topic. Considering that active exploration can impact multisensory interactions, **we wanted to explore whether pitch can modulate the localization of a tactile stimulus in active touch conditions.**

Method

Participants:

21 participants (8 men; age mean 29.56)

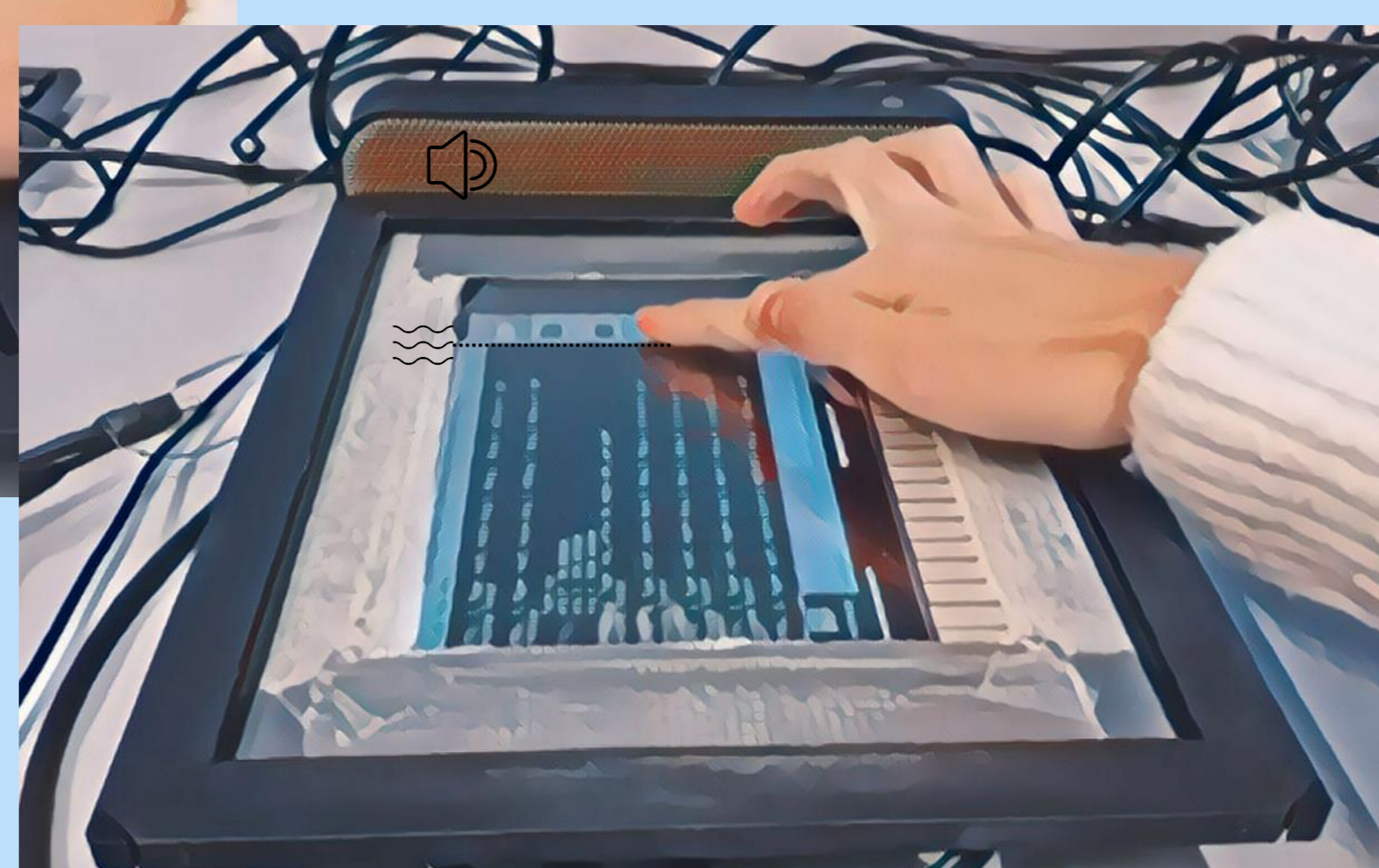
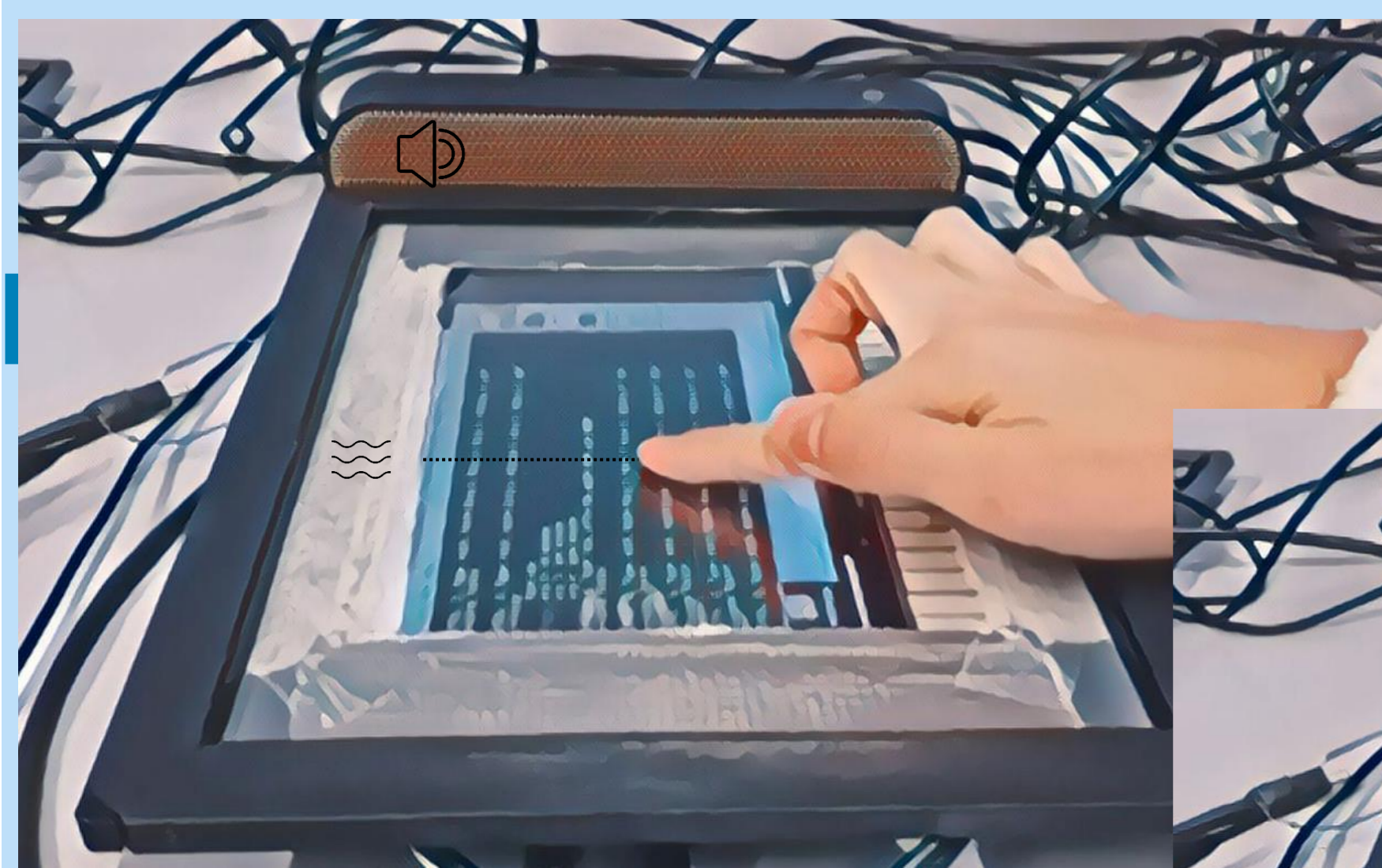
Conditions:

Neutral: pinknoise
High Pitch: 6KHz
Low Pitch: 800 Hz

Tactile stimulus: sinusoidal signal with a spatial period of 5000 m and an amplitude of 100%. Height: 2 mm; Width 10 cm.

Stimulation:

Auditory stimulus: pink noise, a 6KHz, and an 800Hz tone



1. STAIRCASE 2. METHOD OF ADJUSTMENT 3. MARGINALIZED PSI-METHOD

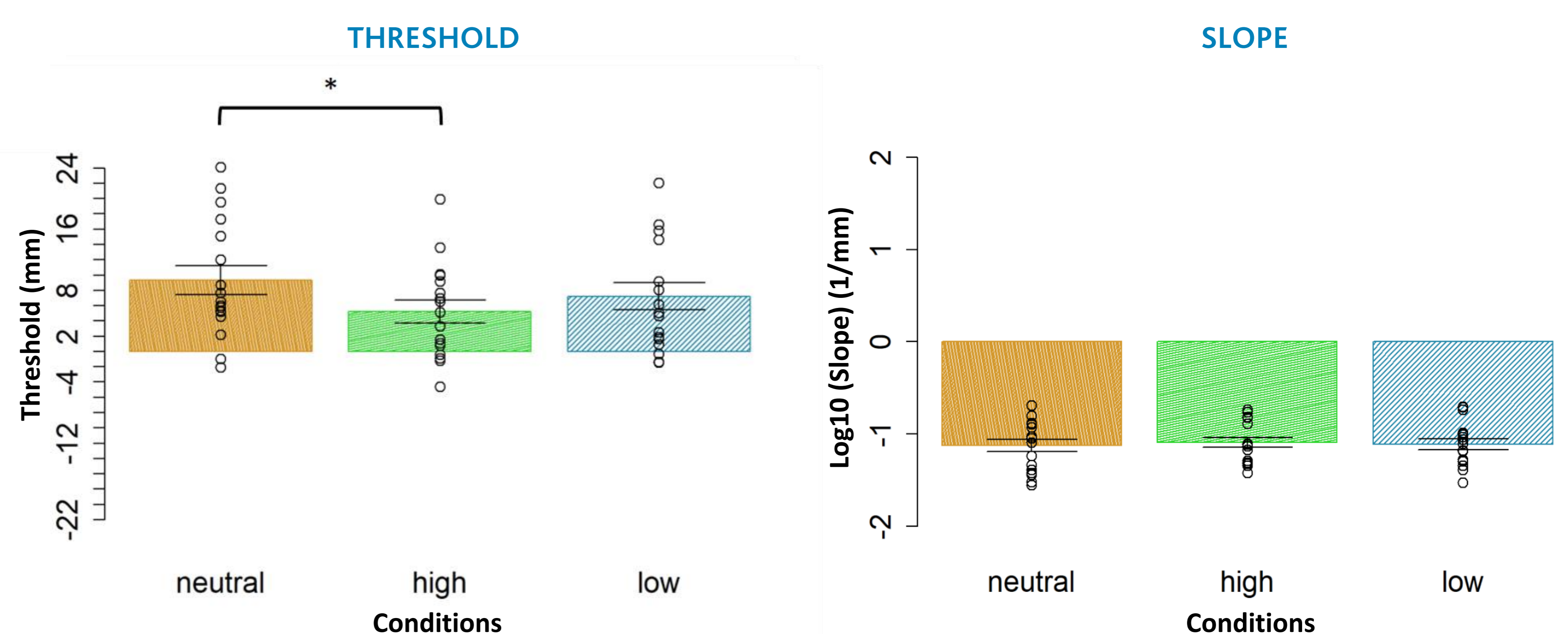
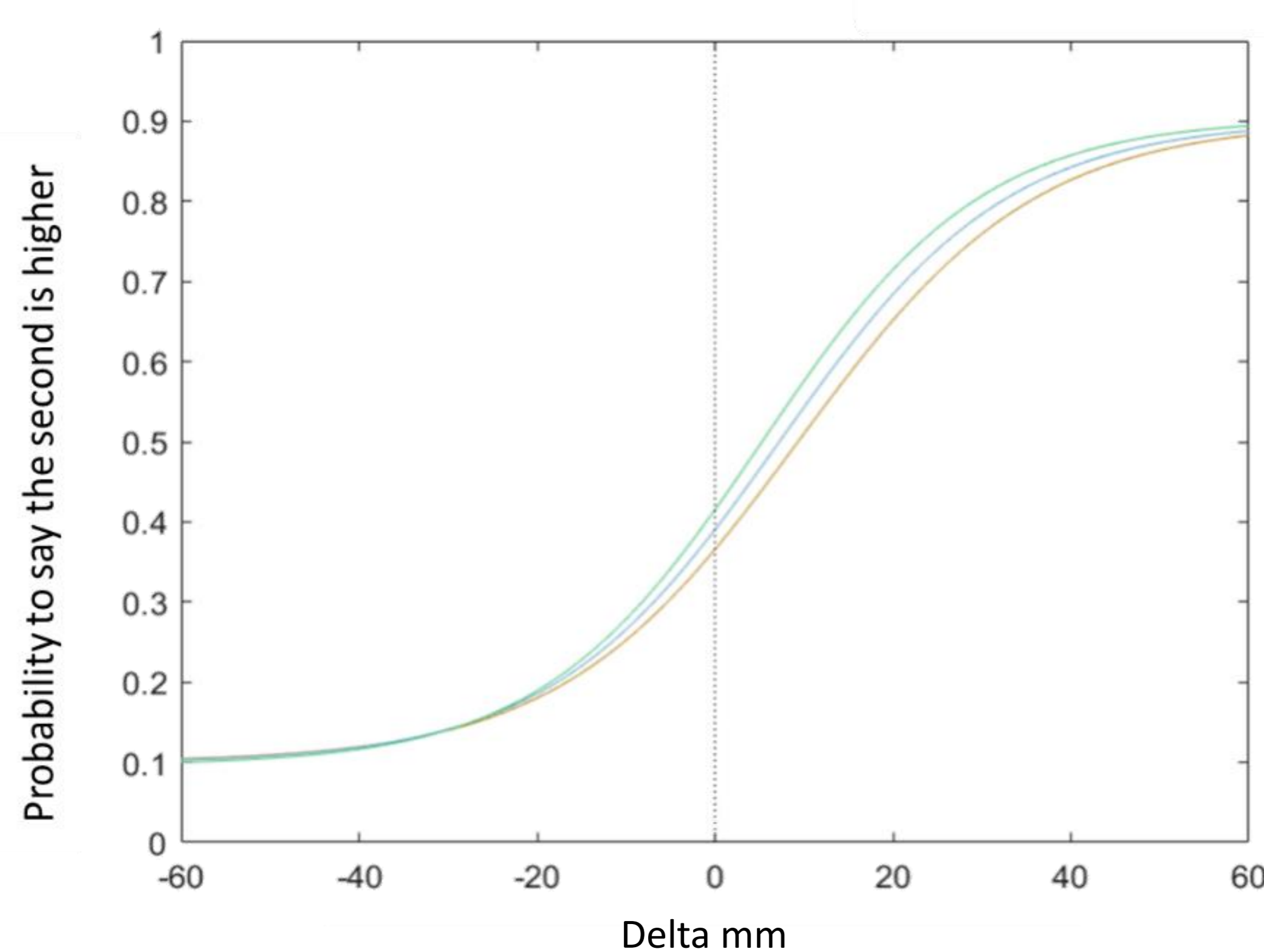
Task:

2AFC – Participants had to slide their index finger twice against a horizontal haptic display and judge the vertical position of a target audio-tactile stimulus (second slide) relative to a reference audio-tactile stimulus (first slide).

Standard position: $Y - \Delta/2$
Comparison position: $Y + \Delta/2$

Results

Data fitted to Cumulative Gaussians
Threshold and slope of the psychometric curve as dependent variable



Significant difference in the threshold between High pitch and Neutral conditions (p adjusted (adj)=.021)

Conclusions

- Significance difference in threshold between high pitch condition and the neutral one
- No differences in slope between conditions

Relationship between auditory pitch and perceived location of the audiotactile stimulus, with the high pitched sound biasing perception of the tactile stimuli towards higher locations on the screen. This modulation is translated into a shifted threshold towards lower values, while the slope does not significantly vary between conditions.

This research extend previous findings by reporting the effects of frequency on touch during active explorations. In addition, our research supports that this association is independent of the device's orientation (as in our case, the device is in the horizontal plane) [4].

References

1. Chiou, R., & Rich, A. N. (2012). Cross-modality correspondence between pitch and spatial location modulates attentional orienting. *Perception*, 41(3), 339–353. <https://doi.org/10.1068/p7161>
2. Parise, C. V., Knorre, K., & Ernst, M. O. (2014). Natural auditory scene statistics shapes human spatial hearing. *Proceedings of the National Academy of Sciences of the United States of America*, 111(16), 6104–6108. <https://doi.org/10.1073/pnas.1322705111>
3. Occelli, V., Spence, C., & Zampini, M. (2009). Compatibility effects between sound frequency and tactile elevation. *NeuroReport*, 20(8), 793–797. <https://doi.org/10.1097/WNR.0b013e32832b8069>
4. Deroy, O., Fasiello, I., Hayward, V., & Auvray, M. (2016). Differentiated audio-tactile correspondences in sighted and blind individuals. *Journal of Experimental Psychology: Human Perception and Performance*, 42(8), 1204–1214. <https://doi.org/10.1037/xhp0000152>

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