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## Spatiotemporal detection threshold of audio-tactile delays under conditions of active touch with and without a visual clue

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## Introduction

While a body of research has investigated audio-tactile interactions at both the behavioral and neural level, much of this work has explored responses to passive, vibrotactile signals<sup>1,2</sup>, and investigations in an active haptic modality are much more limited. The aim of this experiment was to assess the sensitivity of individuals to detect spatiotemporal delays between tactile and auditory stimuli under conditions of active, dynamic touch, with or without a visual clue.

## Materials and Methods

### Procedure

**13 participants:**

- 50x2x2 trials/participants

**Conditions:**

- 2 visual: Black screen (no visual clue) vs Line (visual clue) (2.5x100mm)
- 2 sliding directions (L→R and R→L)

**Spatiotemporal delays range:** 0, 25, 50, 75, 100, 150, 200, 250, 300, 350, 400, 500, 600, 700 ms (converted to 0-60 mm for model refit).

Two-alternative forced-choice (**2AFC**) task

**Adaptive PSI( $\Psi$ ) Method:** for optimal stimulus placement.

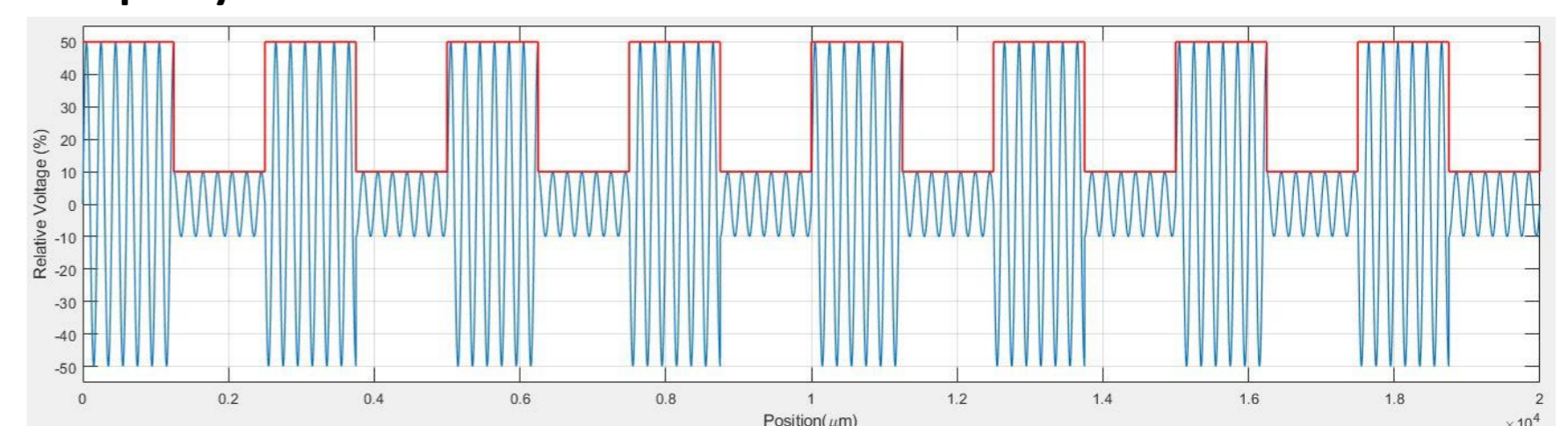
**Hierarchical model** fitted to the individual raw data.

### Apparatus and stimuli

The tactile display was an **Haptic surface** based on **ultrasonic vibration (E-VITA)**<sup>3</sup>. The device is composed of a 5" screen and a Banana Pi with Linux OS.

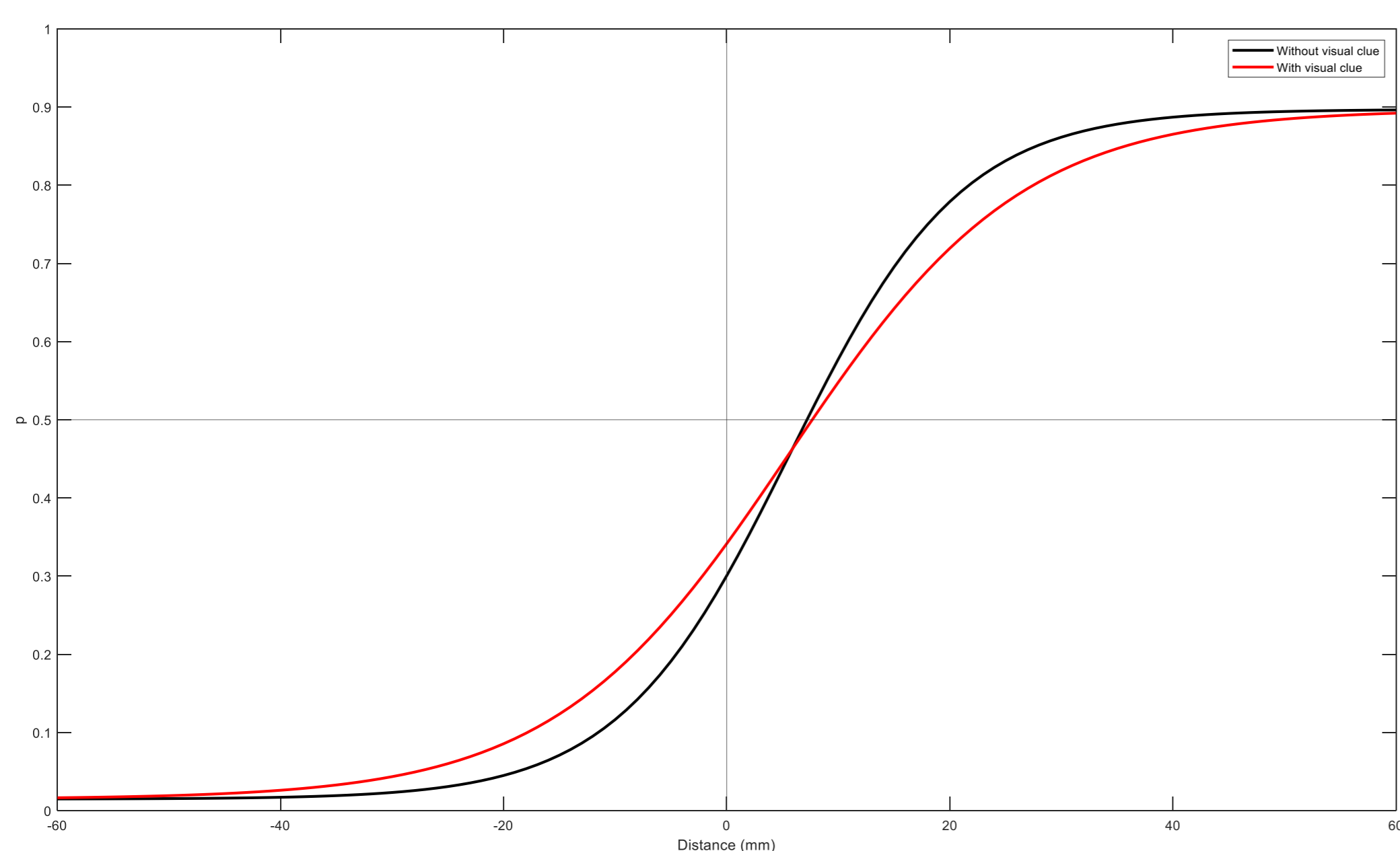
Tactile Stimuli (1 tactile zone area (2.5x100mm, presented in the center of the haptic plate)) were used to trigger audio stimulation, ensuring effective audio-Tactile stimuli synchronization (< 3  $\mu$ s).

Visual stimuli were presented via the embedded E-vita LCD display.

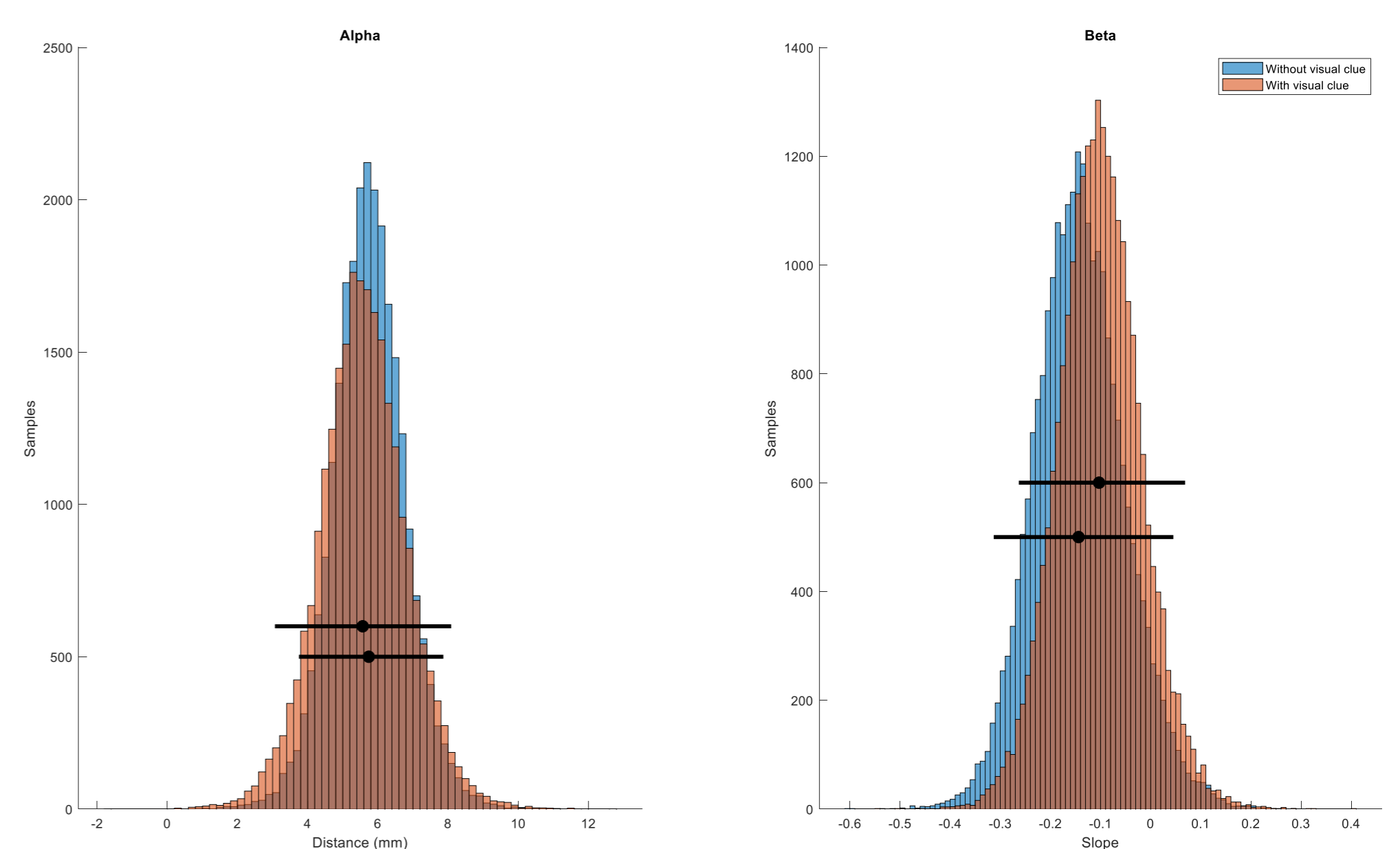


**Haptic Signal:** Square wave, 5000  $\mu$ m, 50% V, ratio: 50%

## Results



Median psychometric function constructed from the model posterior predictive distribution (10000 simulations) based on data for the two conditions (black curve: no visual clue; red curve: visual clue).



Posterior distribution for population mean threshold (alpha, left panel) and log(slope) (beta, right panel) for the two visual conditions.

## Conclusions

In conclusion, we show that sensitivity to spatio-temporal audio-tactile delays can be investigated using a novel paradigm based on an adaptive psychophysics procedure in active touch. Slope and threshold parameters did not significantly differ across the two visual conditions, suggesting that the presence of a visual clue indicating the location of the tactile stimulus does not aid performance.

## References

- (1) Philippi, T. G., van Erp, J. B. F., and Werkhoven, P. J. (2008). Multisensory temporal numerosity judgment. *Brain Research*, 1242:116–125.
- (2) Timora, J. and Budd, T. (2018). Steady-State EEG and Psychophysical Measures of Multisensory Integration to Cross-Modally Synchronous and Asynchronous Acoustic and Vibrotactile Amplitude Modulation Rate. *Multisensory Research*, 31(5):391–418.
- (3) Reki , Y., Vezzoli, E., Grisoni, L., and Giraud, F. (2017). Localized Haptic Texture: A Rendering Technique based on Taxels for High Density Tactile Feedback. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, CHI '17*, pages 5006–5015, New York, NY, USA. Association for Computing Machinery.

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