

Shape congruence modulates visuo-haptic interactions during binocular rivalry

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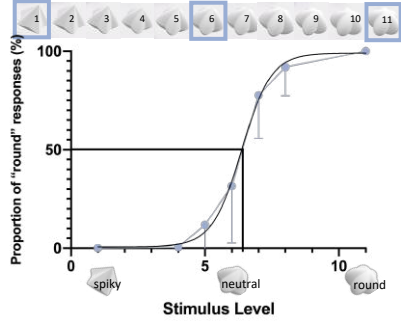


Introduction

Resolving perceptual ambiguity is an important task for the perceptual system (1). Some strategies the perceptual systems use is to integrate information from multiple modalities (2,3) and utilize the coupling between perception and action (4,5). Here, we seek to investigate the influence of visuo-haptic interactions on disambiguating ambiguous stimuli during binocular rivalry.

Methods

Stimuli

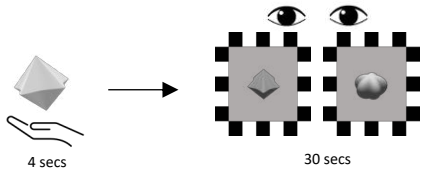


Experimental setup



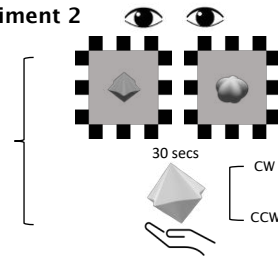
- (Haptic) 11 objects parametrically modulated in curvature(6) were 3D printed. To find the perceptually neutral shape, 7 participants performed a 2AFC task where they explored the haptic stimulus and chose whether the shape was closer to a round or spiky shape. Results indicated the 6th shape in the stimulus set as the neutral shape. The spiky, neutral, and round shapes were chosen as haptic shape stimuli.
- (Visual) Spiky and round shapes from each pole were 3D rendered on a fixed axis.

Experiment 1



- 20 participants (7 male, ages 21-28)
- Participants explored one of spiky/neutral/round/no haptic object.
- Afterward, they reported their visual dominance during binocular rivalry for approximately 30 secs.

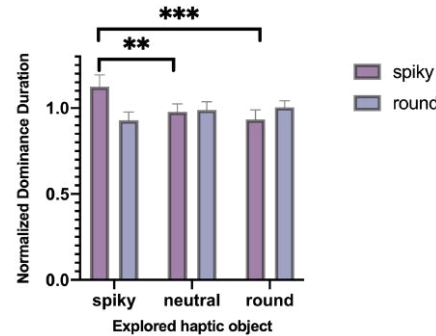
Experiment 2



- 16 participants (8 male, ages 19-29)
- Participants explored one of spiky/neutral/round/no haptic object in a fixed direction (CW/CCW), which was congruent with the rotation direction of either visual rival target.
- The object was presented simultaneously with the onset of binocular rivalry.

Results

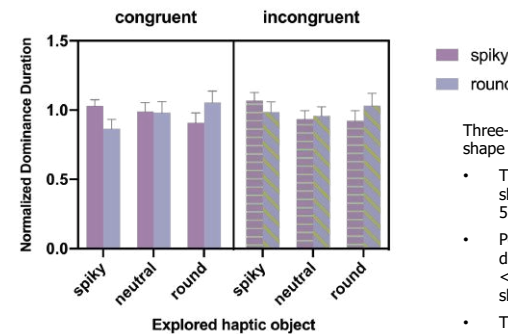
Experiment 1



Normalized dominance durations were calculated by dividing mean dominance durations for each condition with the visual-only mean dominance duration.

- Two-way rm ANOVA revealed a significant interaction between explored haptic shapes and dominant visual shapes ($F(2, 38) = 6.995, p < .005$).
- Post-hoc paired t-tests only showed significant difference in dominance of spiky shapes (spiky-round: $t(19) = 3.883, p < .005$, spiky-neutral: $t(19) = 3.170, p = .005$).

Experiment 2



Three-way rm ANOVA again revealed a significant visuo-haptic shape congruence effect on binocular rivalry.

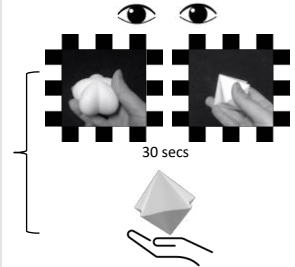
- There was a significant interaction between explored haptic shapes and dominant visual shapes ($F(1.152, 17.285) = 5.461, p < .05$).
- Post-hoc paired t-tests showed significant difference in dominance of both round (round-spiky: $t(15) = 2.145, p < .05$, neutral-spiky: $t(15) = 2.210, p < .05$) and spiky shapes (spiky-round: $t(15) = 2.213, p < .05$).
- There was no significant main effect or interaction for rotation direction congruence.

Conclusion

Perception of visual shapes was influenced by the explored haptic object in binocular rivalry. While this shape congruence effect was mostly led by the spiky shape when the haptic object was given as a prime, it was observed for both round and spiky shape when visual and haptic stimuli were presented simultaneously. This hints that shape congruence effects are not entirely mediated by conceptual or semantic associations between the two modalities. Prior studies indicate the influence of participants' voluntary actions on visual perception, which is not unrelated to the current haptic exploration situation. We seek to look further into the influence of perception-action coupling on perceptual selection by enhancing the reality of the experimental setting.

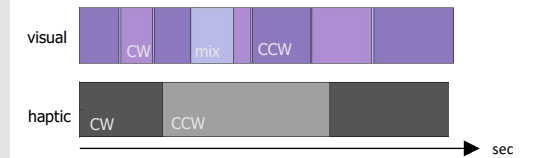
Future Direction

Task



- To enhance the coupling between visual and haptic modalities, we used more naturalistic videos as visual targets.
- Participants freely explored haptic stimuli for the duration of binocular rivalry.
- Explored haptic objects were identical to previous experiments.

Preliminary observations



- Shown above is an observation from a participant of the successive visual dominance during binocular rivalry and haptic object rotation direction durations within a trial.
- It is suggested that haptic object rotation behavior displays similarities with that of visual rival targets.

References

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