2021-06

The influence of partial occlusion on shape recognition

KANG, JUNGHEE

PERCEPTION

The influence of partial occlusion on shape recognition

Gunnar Schmidtmann

UNIVERSITY OF PLYMOUTH

AVA Christmas Meeting 2020

Background

"...information is concentrated along contours at those points on a contour at which its direction changes most rapidly..."

"Common objects may be represented with great economy, and fairly striking fidelity, by copying the points at which their contours change direction maximally, and then connecting these points appropriately with a straightedge."

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Attneave, F. (1954). Some informational aspects of visual perception. *Psychological review*, *61*(3), 183–193.

Previous work

SCIENTIFIC REPORTS

OPEN

Shape recognition: convexities, concavities and things in between

Gunnar Schmidtmann, Ben J. Jennings & Frederick A. A. Kingdom

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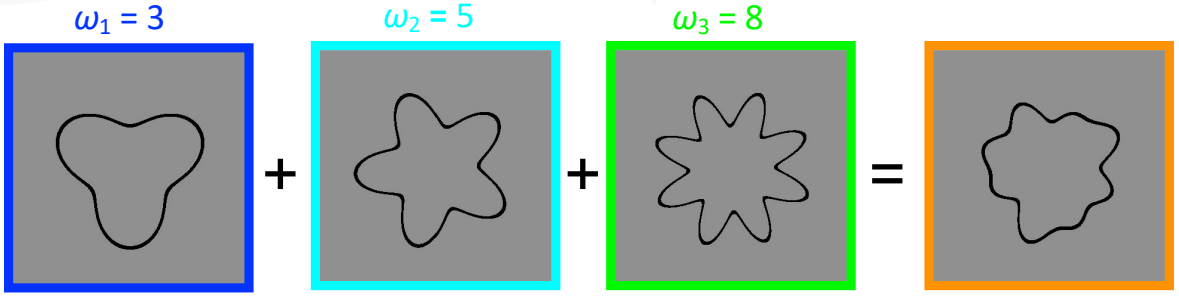
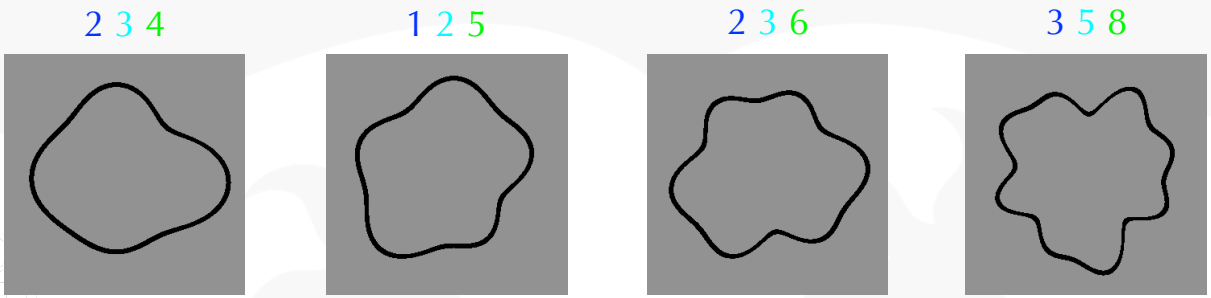
Stimuli

compound radial frequency patterns

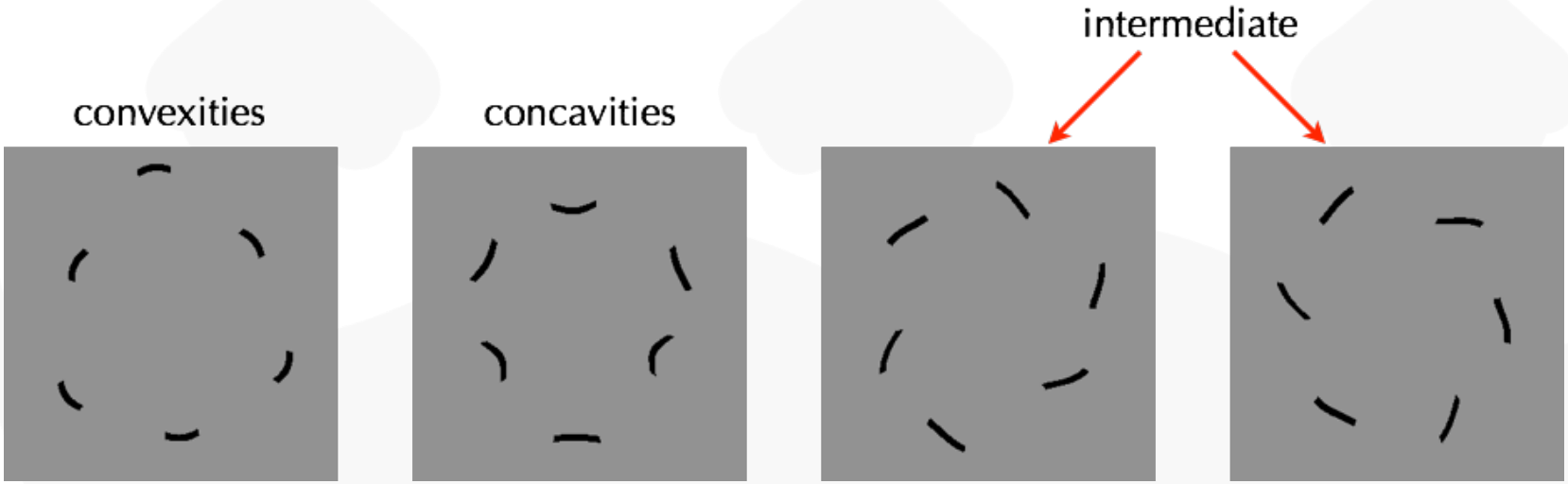


$$RF_{compound} = r_{mean}(1 + A_1 \sin(\omega_1 \theta + \varphi_1) + A_2 \sin(\omega_2 \theta + \varphi_2) + A_3 \sin(\omega_3 \theta + \varphi_3))$$

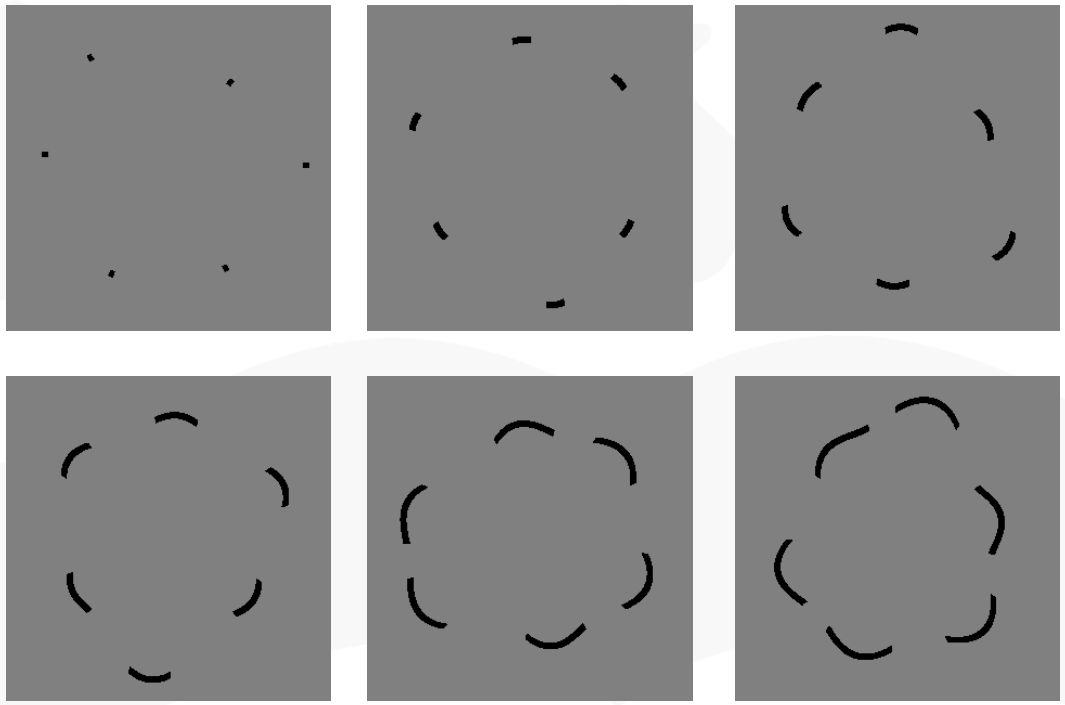
- r_{mean}: mean radius of underlying circle (=100 Pixel)
- A: modulation amplitude (=0.1)
- ω_1: radial frequency
- θ: polar angle
- φ_1: phase / orientation (random)



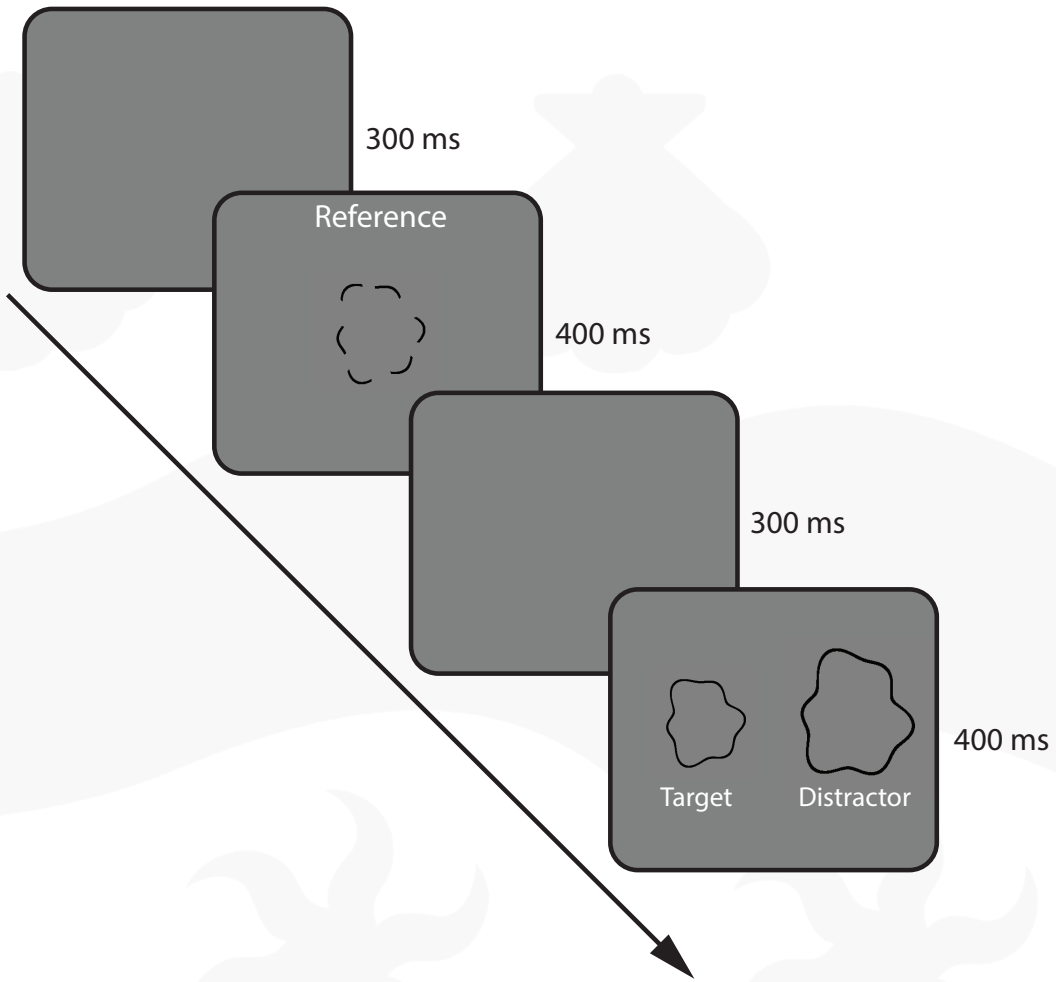
Stimuli



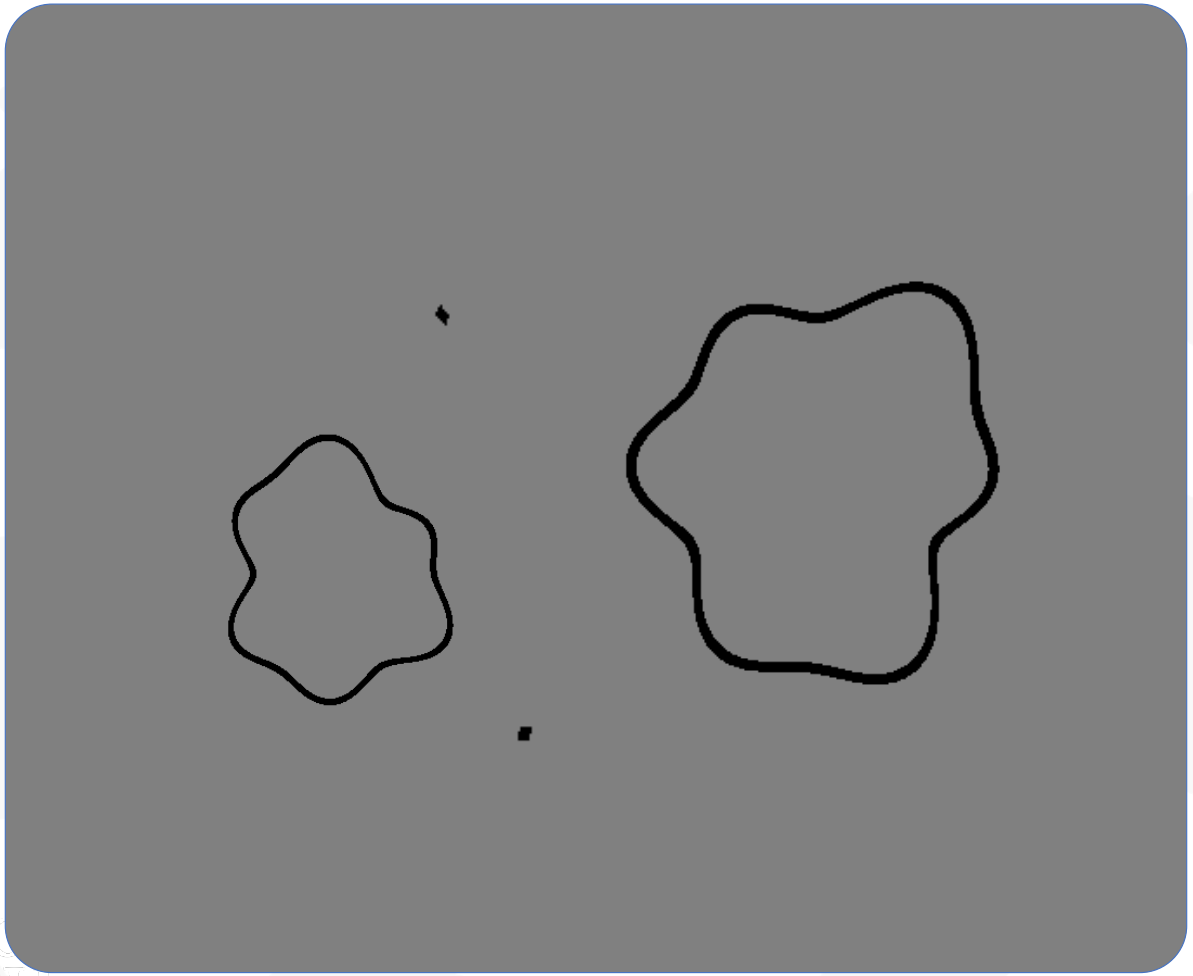
Stimuli



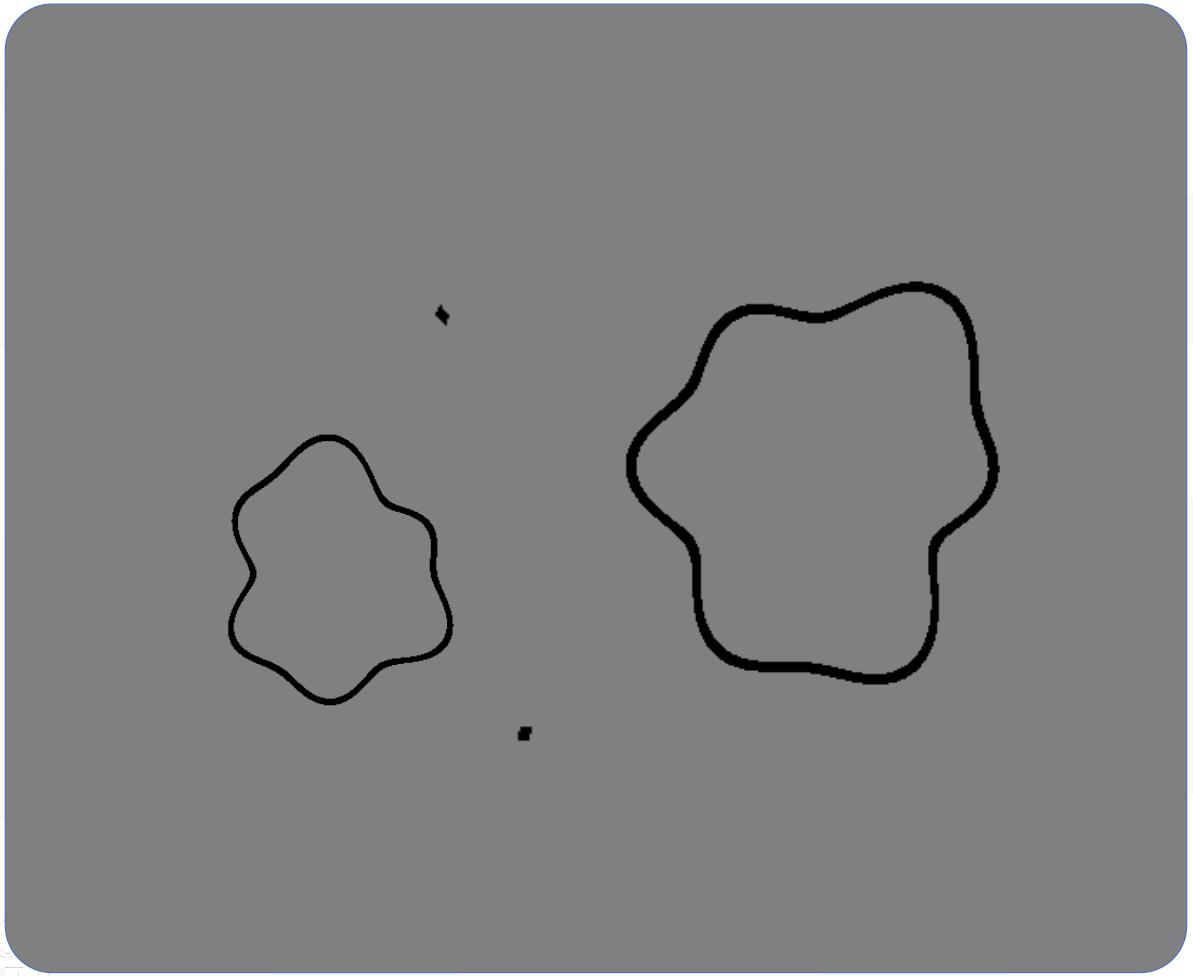
Paradigm



Demo

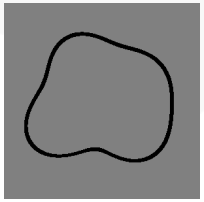


Demo



Results

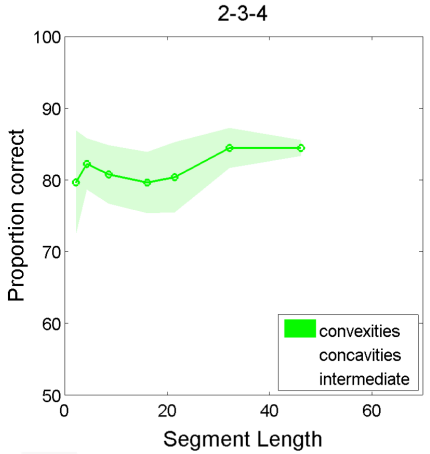
2-3-4

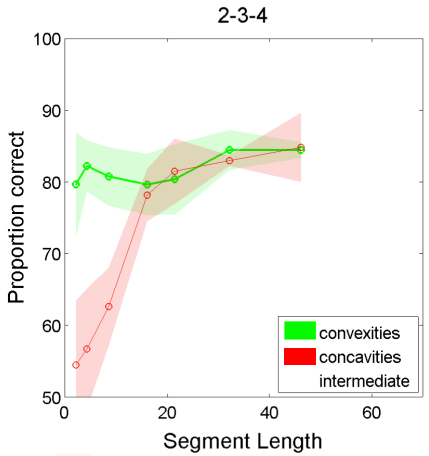


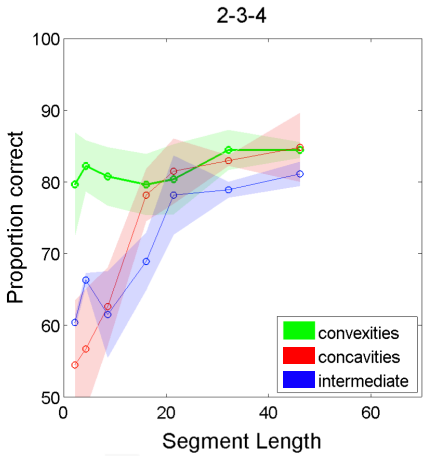
convexities

concavities

intermediate







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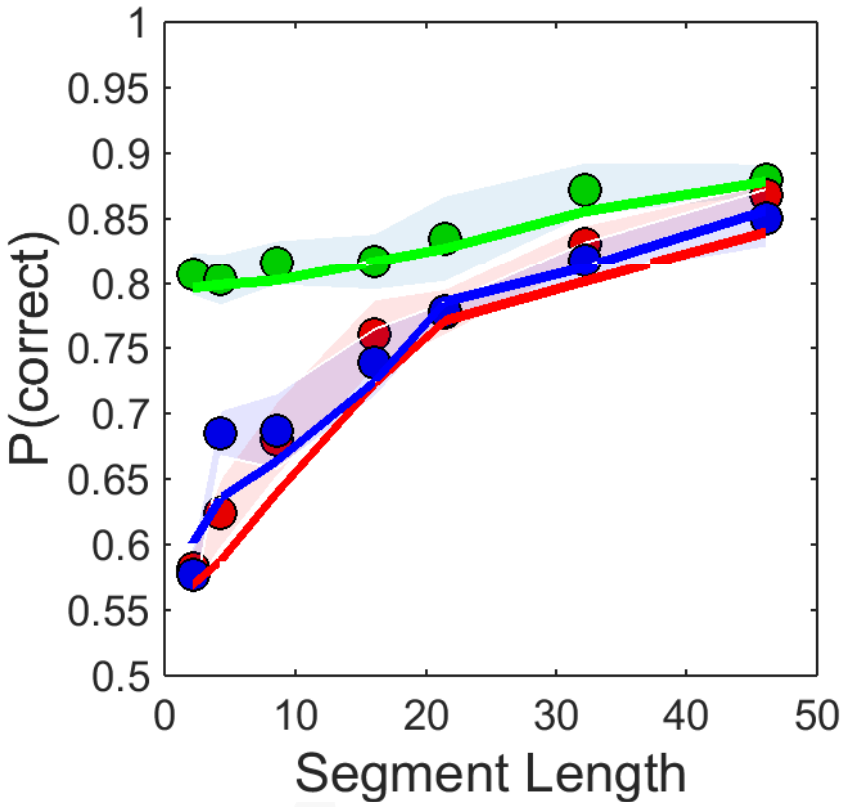
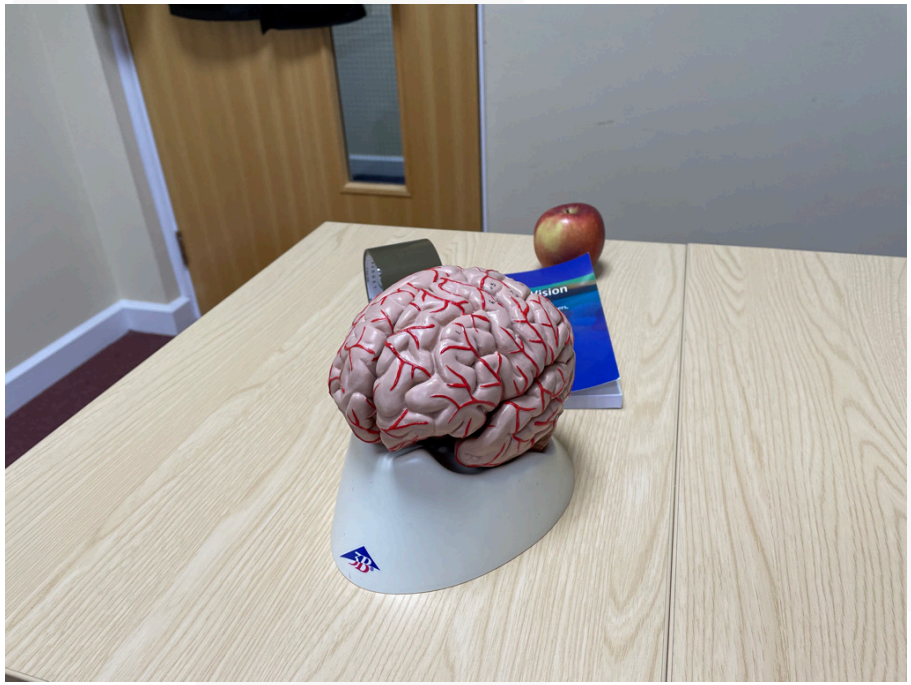
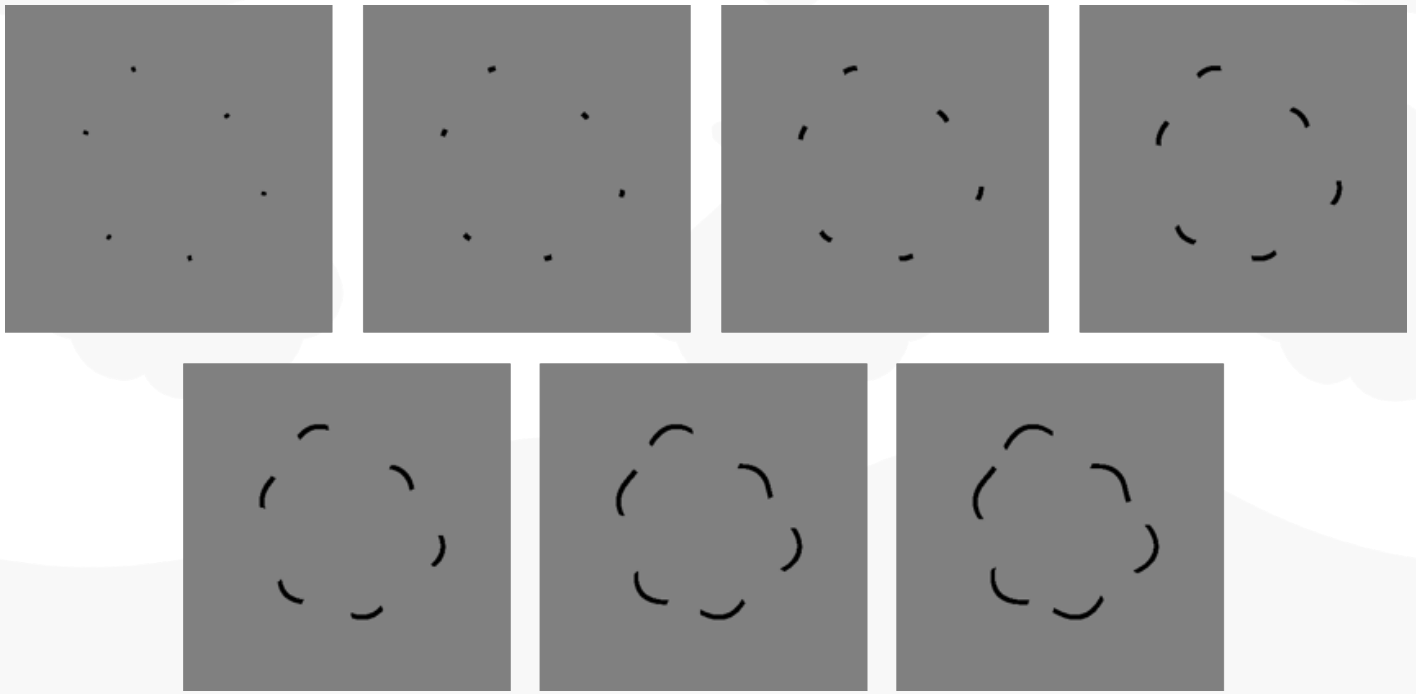
Model Results

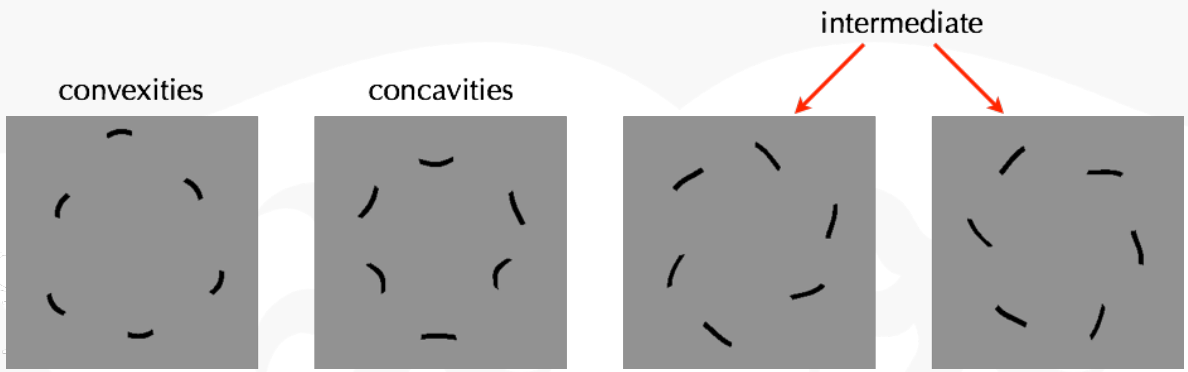


New Experiment - Partial Occlusion



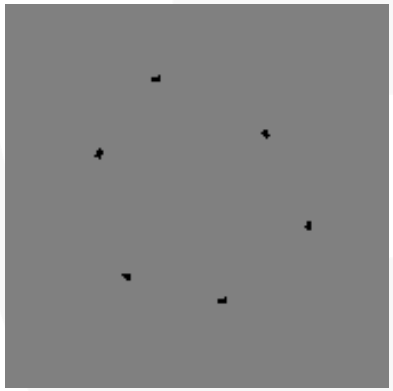
Stimuli



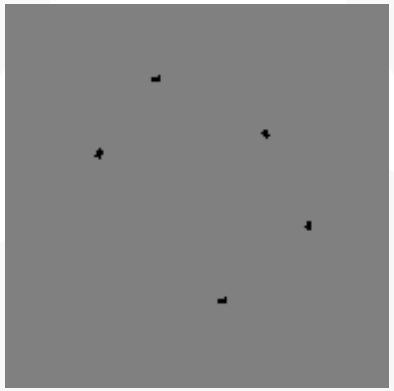


Partial Occlusion

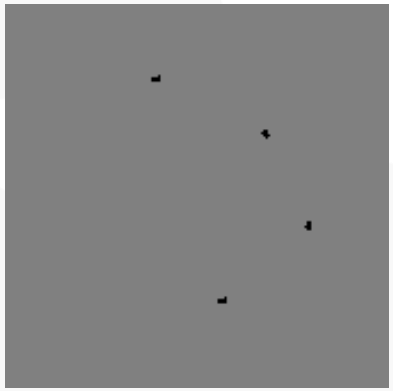
No occlusion



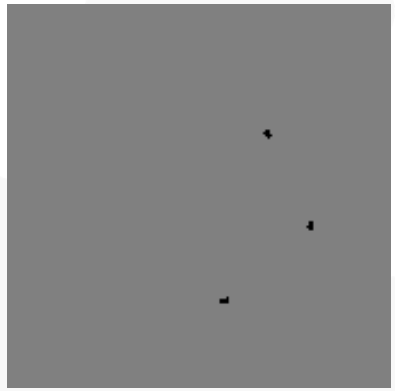
16.7% occlusion



33% occlusion

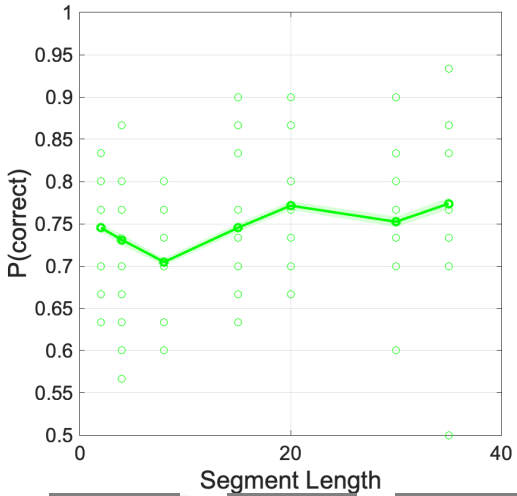


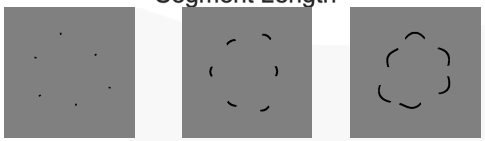
50% occlusion



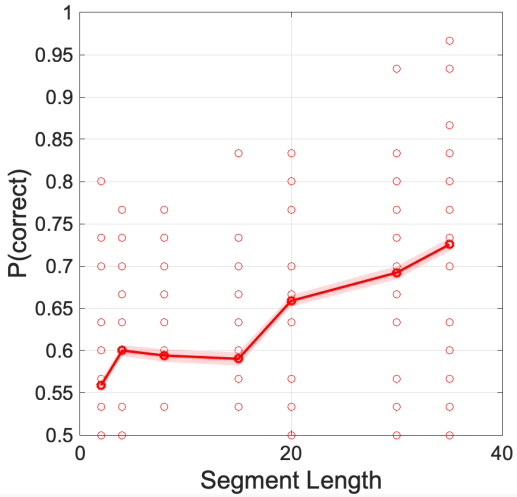
Results – no occlusion

convexities

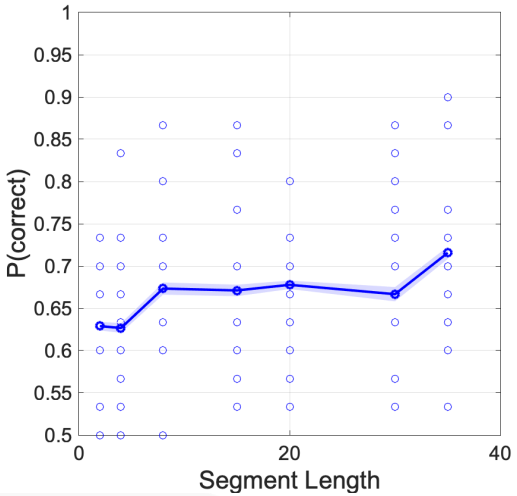


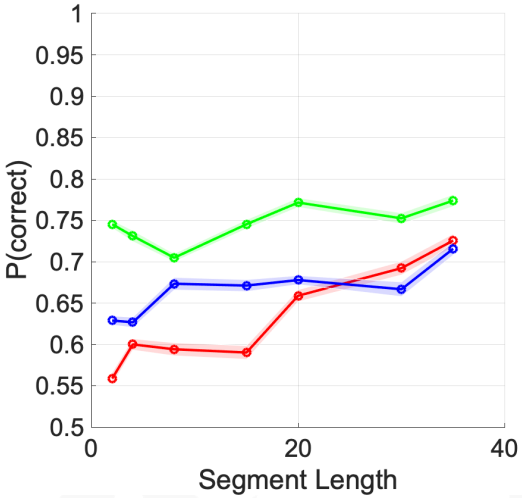


concavities



intermediate





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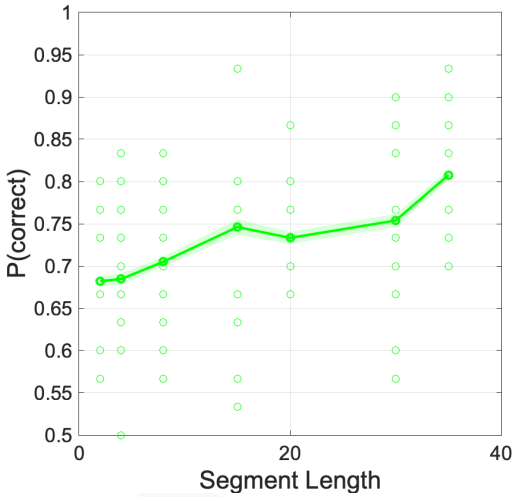
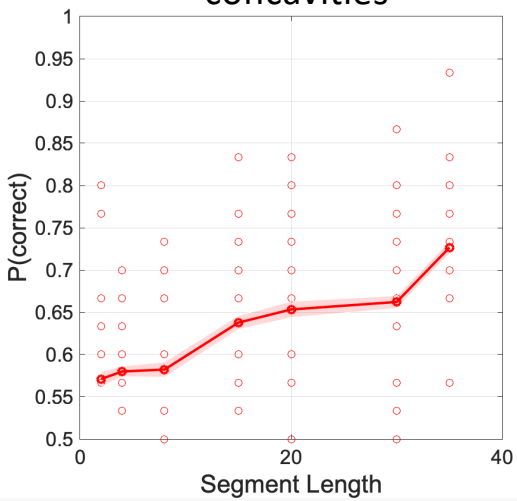
Results – 16.7% occlusion

convexities



concavities



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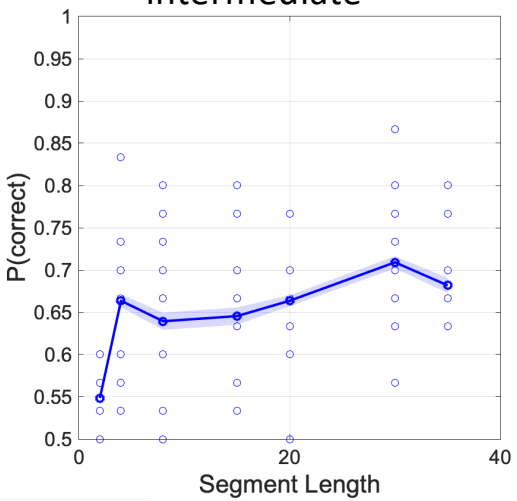

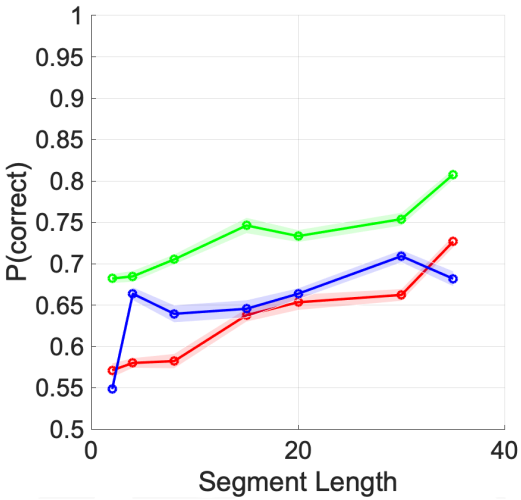

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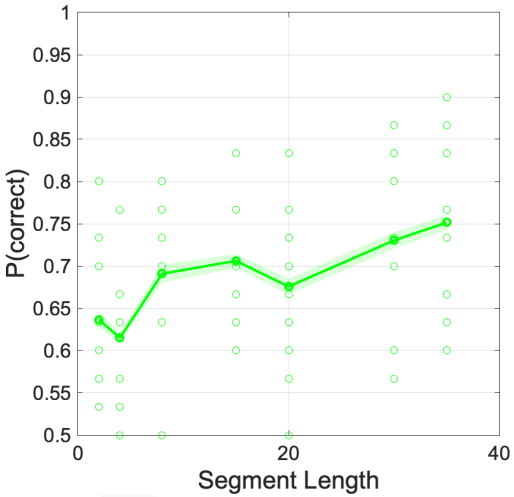
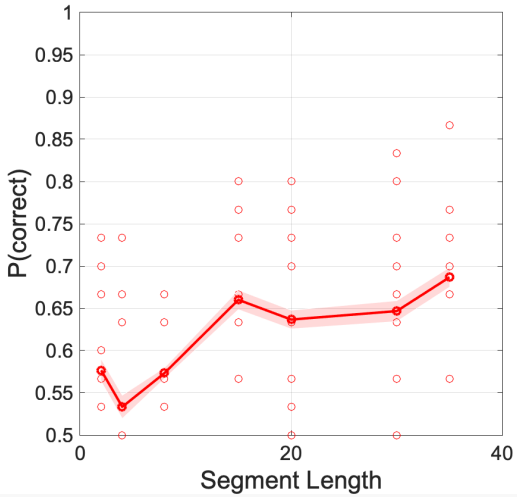
Results – 33% occlusion

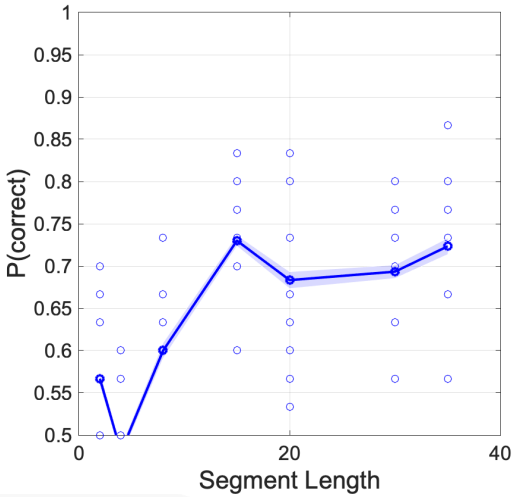
convexities

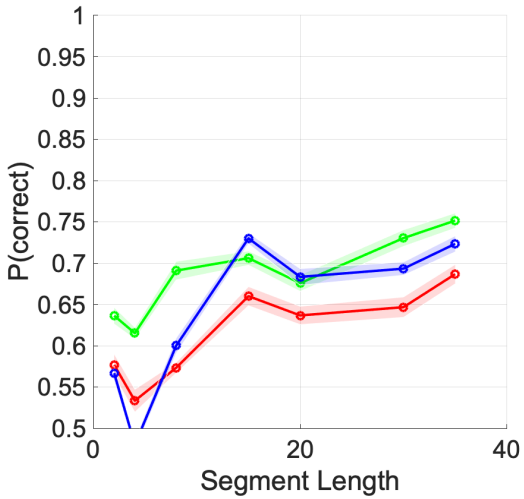


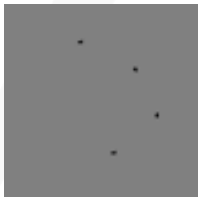
concavities



intermediate







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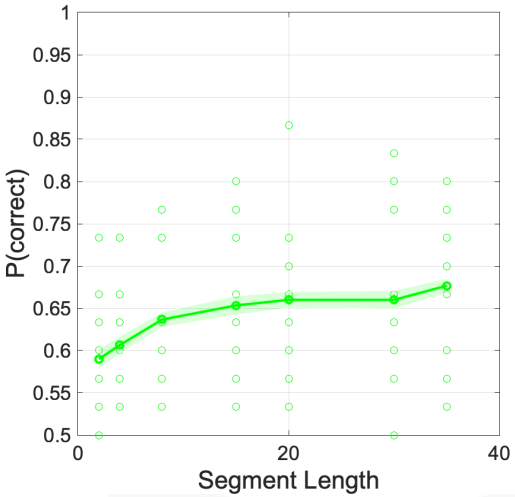
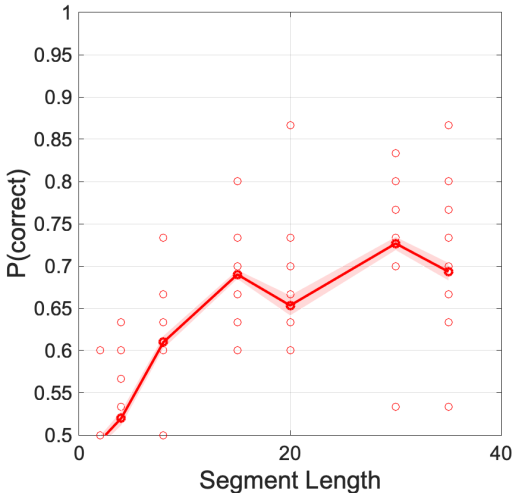
Results – 50% occlusion

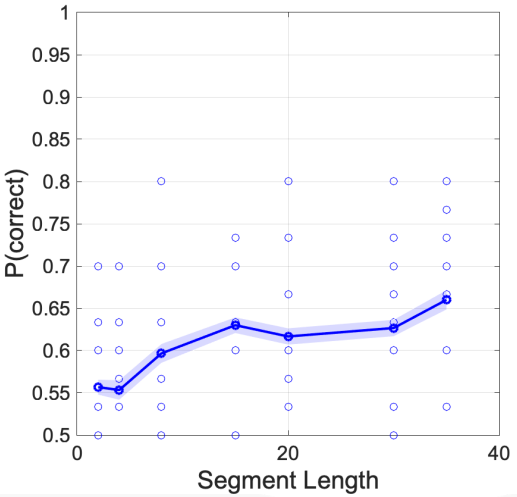
convexities

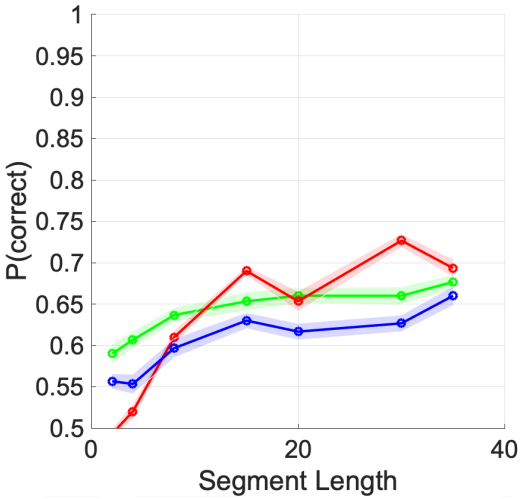


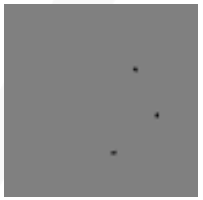
concavities



intermediate







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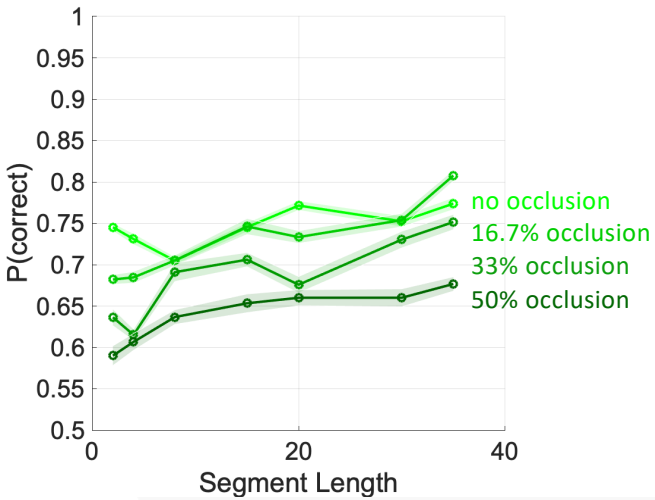
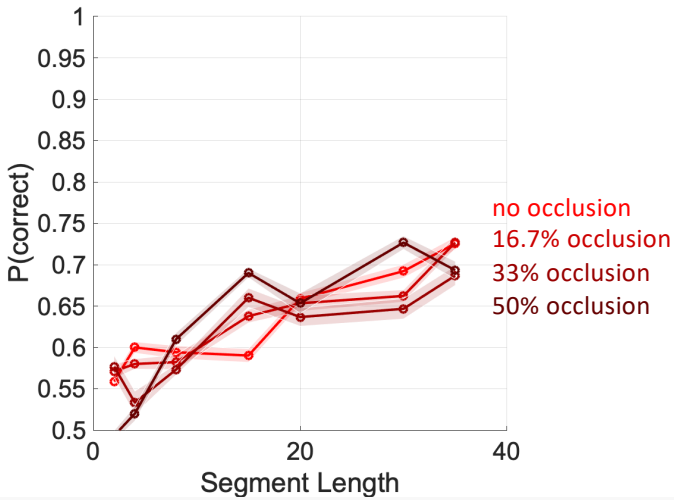
Results – combined

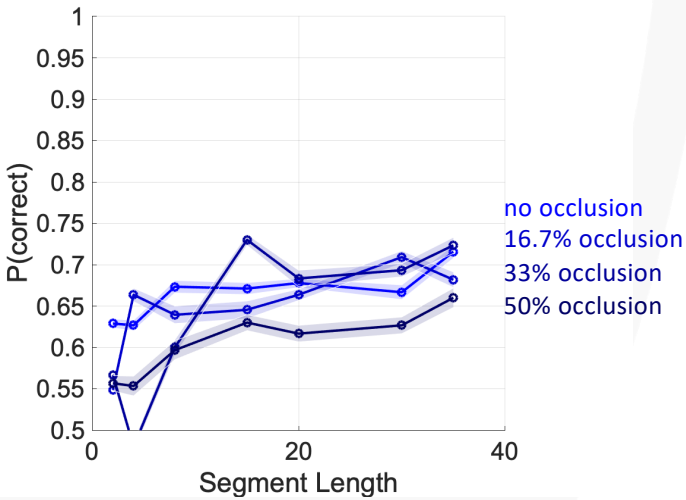
convexities



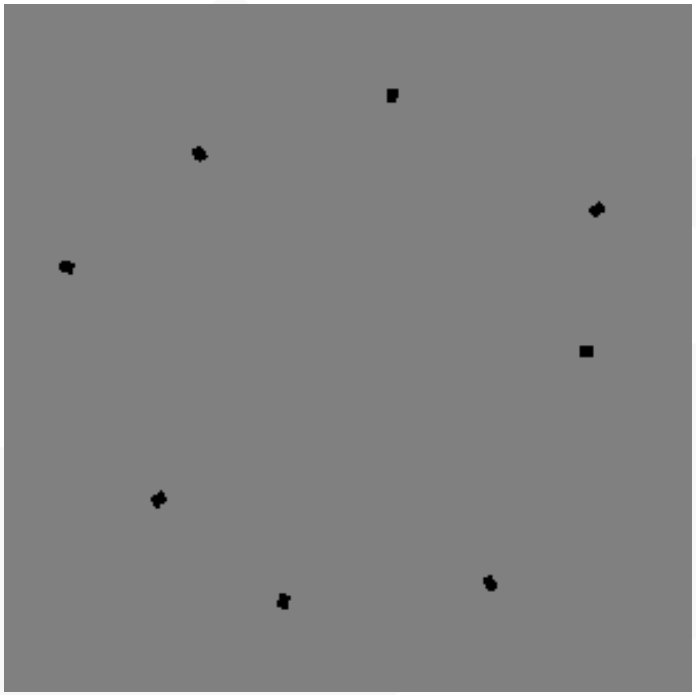
concavities

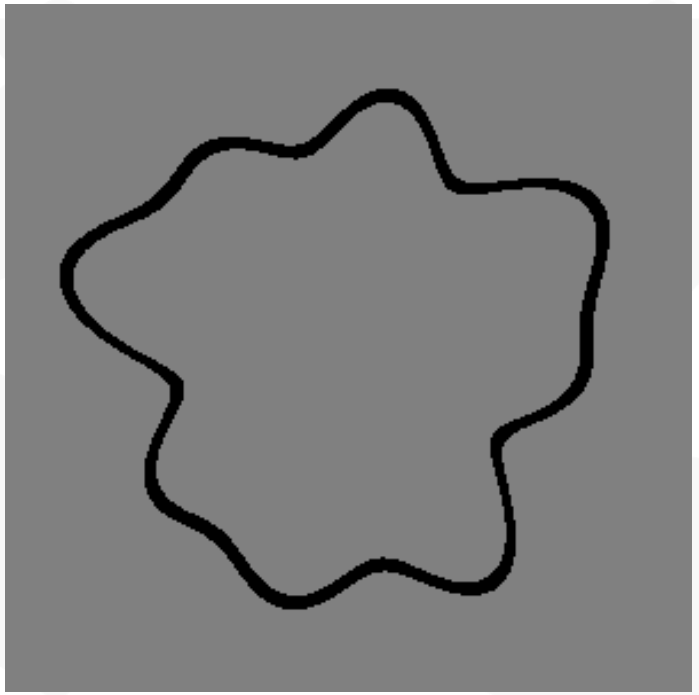


intermediate

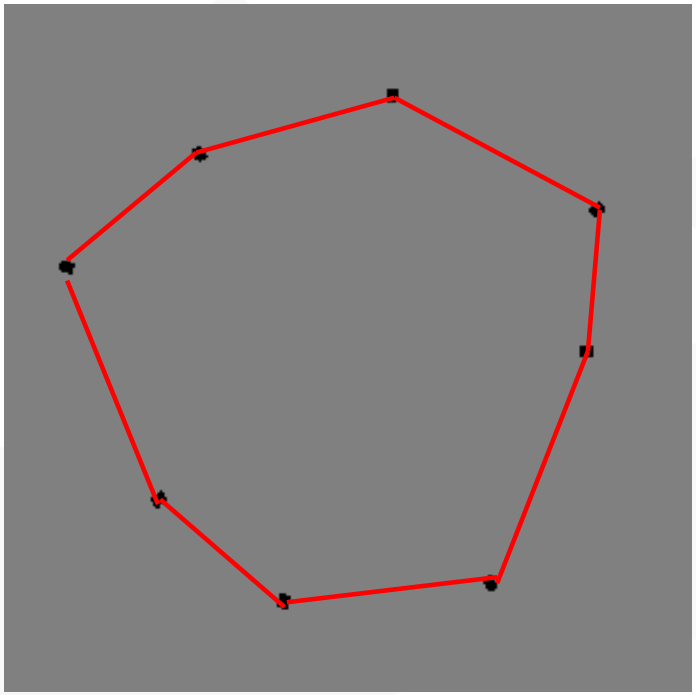


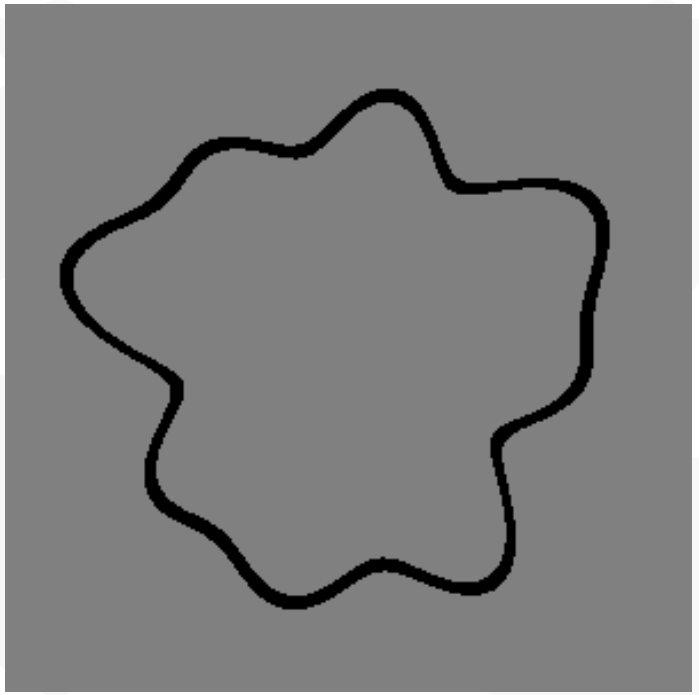
Model – Schmidtmann et al. (2015)



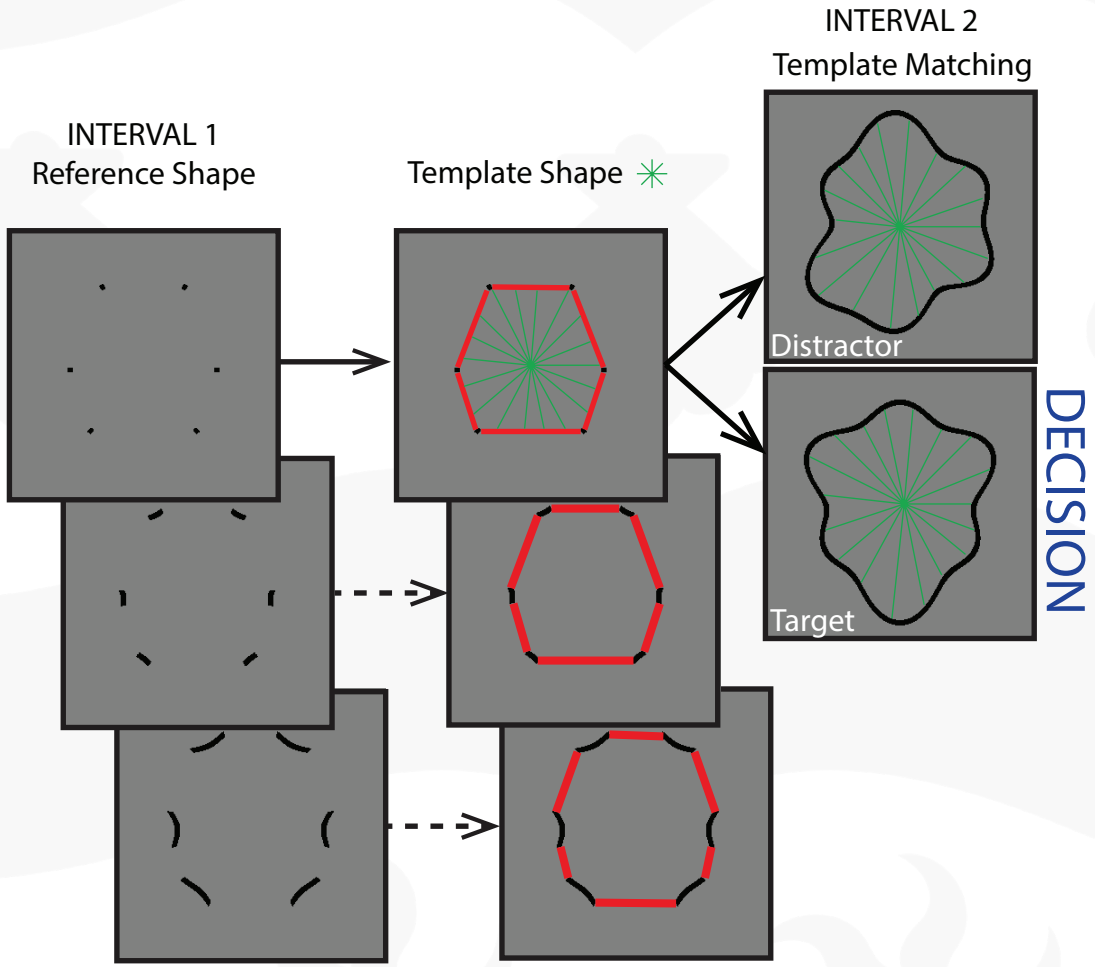


Model – Schmidtmann et al. (2015)

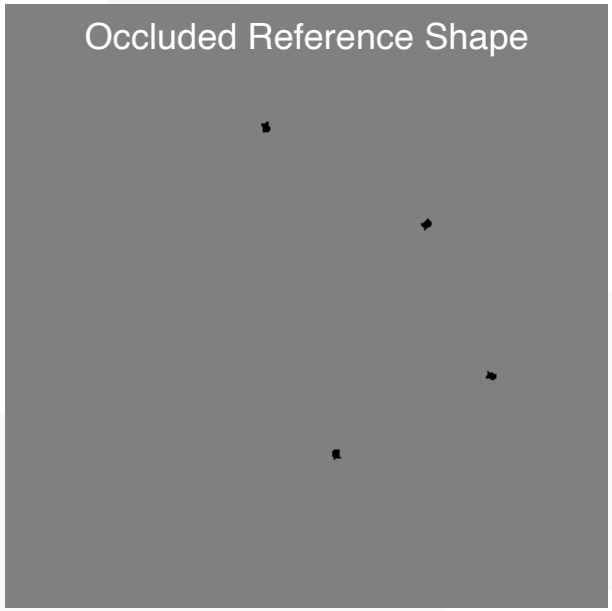


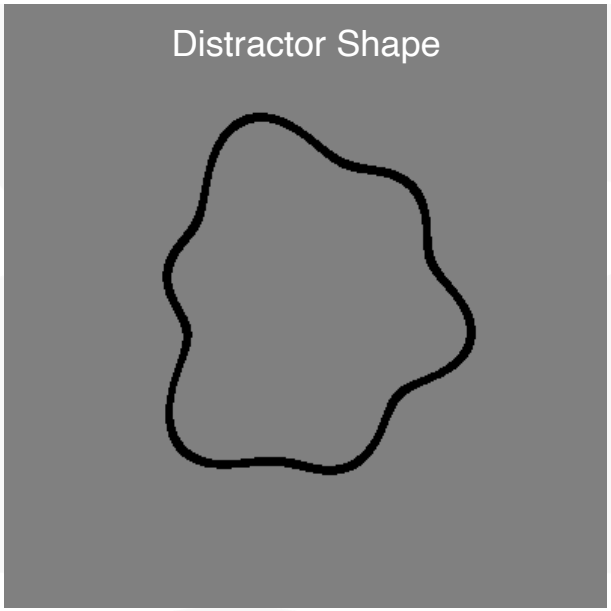


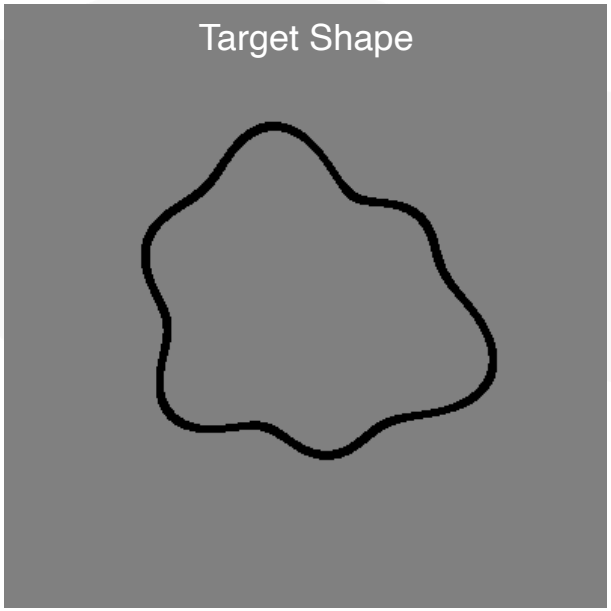
Model – Schmidtmann et al. (2015)



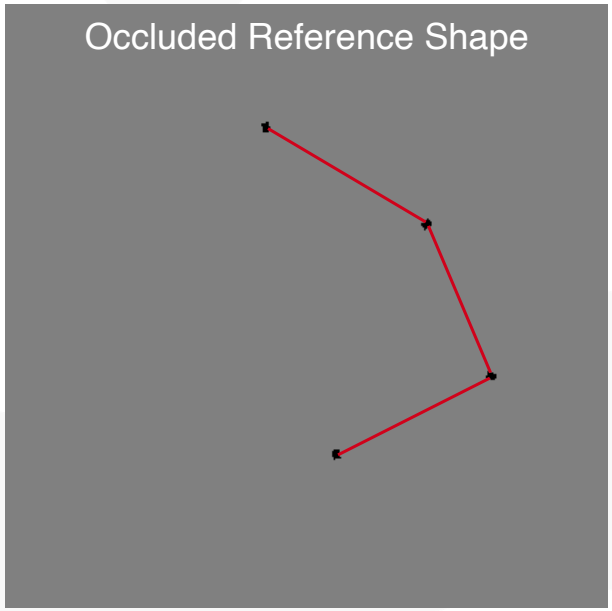
Proposed Model Idea

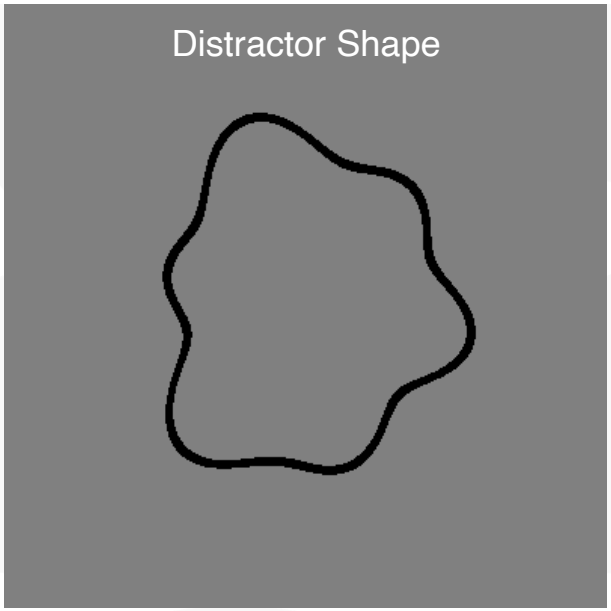


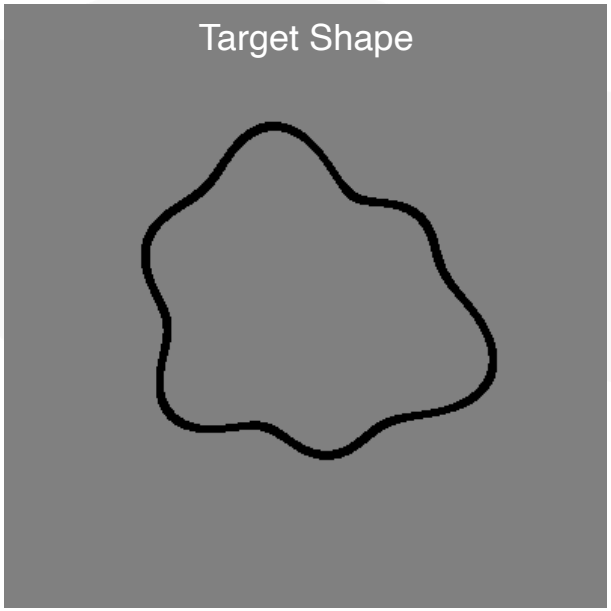




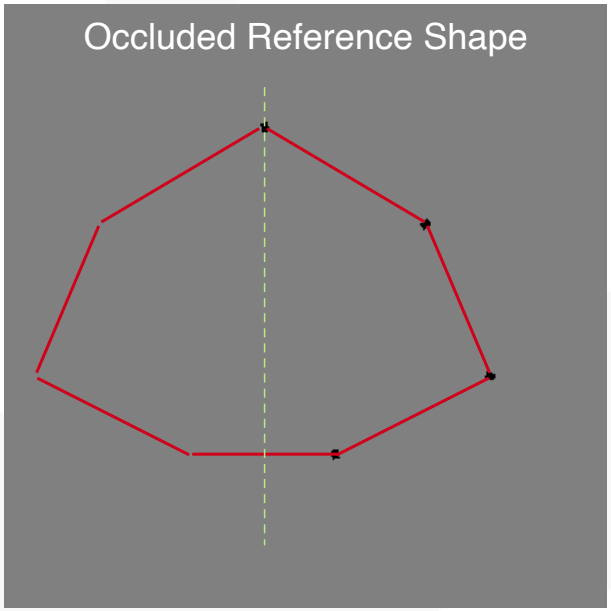
Proposed Model Idea

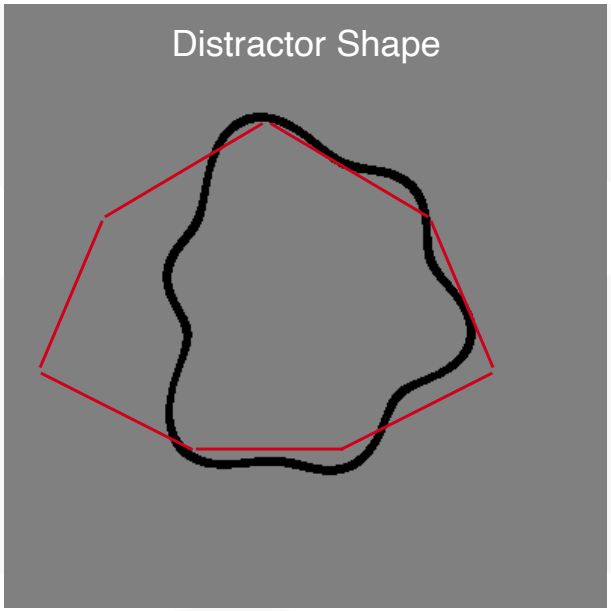


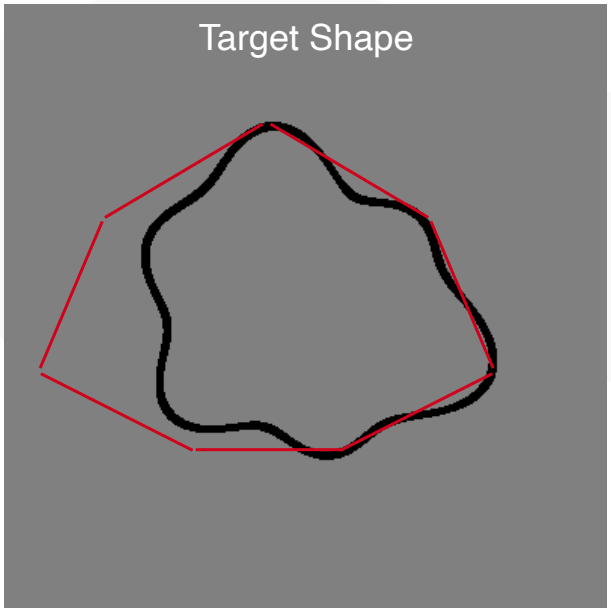




Proposed Model Idea







Summary

- Performance for convex features is superior to the other shape features and independent of segment length, replicating Schmidtmann et al. (2015)
- Points at the location of convex curvature maxima are sufficient to extract shape information
- Performance is only significantly impaired when 50% of the shape is occluded
- Results demonstrate the importance of convexities maxima for shape encoding, and the flexibility of the visual system to deal with partially occluded shapes

Acknowledgments

Optometry students (University of Plymouth)

- Abdulfatai Shonuga
- Abigail Medland
- Lucy Cooper
- Sarah Beachus
- Sohaib Naseem

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The influence of partial occlusion on shape recognition

Gunnar Schmidtmann

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AVA Christmas Meeting 2020