V1 Saliency Hypothesis and Central-Peripheral Dichotomy (CPD)

Li Zhaoping, University of Tübingen, and Max Planck Institute for Biological Cybernetics.

Submission to MODVIS 2023, a satellite meeting for VSS, May, 2023, Florida, USA

Visual attention selects only a tiny fraction of visual input information for further processing. Selection starts in the primary visual cortex (V1), which creates a bottom-up saliency map to guide the fovea to selected visual locations via gaze shifts (Li 2002). This motivates a new framework (Zhaoping 2019) that views vision as consisting of encoding, selection, and decoding stages, placing selection on center stage. It suggests a massive loss of non-selected information from V1 downstream along the visual pathway.

Central-Peripheral Dichotomy (CPD) is motivated by the attentional bottleneck starting from V1. It states that peripheral vision is for looking and central vision is for seeing. Looking selects a tiny fraction of visual input information for further processing inside the attentional bottleneck. It typically involves orienting, or saccading, to place the selected visual location in the fovea or central visual field. Seeing decodes, recognizes, or infers object or object feature properties from the selected information. CPD also asserts that top-down feedback, from higher to lower cortical areas such as V1 to aid seeing, is mainly directed to foveal region or central visual field only. This feedback uses analysis-by-synthesis computation to verify initial hypotheses about the visual objects, thus querying for more information from lower cortical areas to aid visual recognition in light of the bottleneck. Accordingly, non-foveal vision is not only poorer in spatial resolution, but also more susceptible to many illusions due to a lack of verifying feedback.

I will demonstrate two new visual illusions (Zhaoping & Ackermann 2018, Zhaoping 2020) predicted by CPD in the peripheral visual field. In addition, I will show two or three visual phenomena (Zhaoping 2017, Zhaoping 2021, Zhaoping & Liu 2022) supporting the prediction that top-down feedback for seeing is directed mainly or more strongly to the central visual field.

References

Li, Z 2002. A saliency map in primary visual cortex. *Trends in Cog. Sci.* 6:9-16.

Zhaoping L. (2017) Feedback from higher to lower visual areas for visual recognition may be weaker in the periphery: glimpses from the perception of brief dichoptic stimuli. Vision Research, 136: 32–49.

Zhaoping L. and Ackermann J. (2018) Reversed Depth in Anticorrelated Random-Dot Stereograms and the Central-Peripheral Difference in Visual Inference Perception, 47(5) 531-539.

Zhaoping, L. (2019) A new framework for understanding vision from the perspective of the primary visual cortex Current Opinion in Neurobiology, volume 58, page 1-10.

Zhaoping, L. (2020) The flip tilt illusion: visible in peripheral vision as predicted by the Central-Peripheral Dichotomy (CPD). i-Perception, 11(4), 1–5.

Zhaoping, L. (2021) Contrast-reversed binocular dot-pairs in random-dot stereograms for depth perception in central visual field: Probing the dynamics of feedforward-feedback processes in visual inference, Vision Research, vol. 186, pages 124-139.

Zhaoping, L. and Liu, Y. (2022) The central-peripheral dichotomy and metacontrast masking Perception. 2022;51(8):549-564.