**De-confounding the effects of attention and expectation in sensory processing**

Predictive coding theories of perception propose different mechanisms and effects of expectation vs attention in sensory processing. However, it is extremely difficult to tease apart the effects of the two due to confounding (Summerfield and Egner 2009). For example, if I expect to perceive a stimulus at a particular location in visual space, I might naturally attend to that location in anticipation of its arrival. Much of the literature on attention is confounded in this manner.

Careful experimental design allows disassociation of the two by intentionally decorrelating task-relevance (attention) from frequency of presentation (expectation). Such experiments have demonstrated differential effects on detection sensitivity for stimuli presented at threshold (Wyart, Nobre, and Summerfield 2012) and detection reaction time (Zuanazzi and Noppeney 2018) However, this is more challenging to achieve for studies of stimulus representation, as opposed to measures of detection sensitivity (Cheadle et al. 2015). This project will examine the interacting effects of attention and expectation on sensory representations under varying levels of noise, which we will interpret in light of predictive coding and ideal observer models.

For students

Why interesting and why clinically relevant? AQ, schizotypy score

What’s the problem → why it’s interesting

Here’s the task → compare via eg t-test

Example of attention/expectation: things that happen frequently but not particularly relevant, things that happen infrequently but important

**References**

Cheadle, Sam, Tobias Egner, Valentin Wyart, Claire Wu, and Christopher Summerfield. ‘Feature Expectation Heightens Visual Sensitivity during Fine Orientation Discrimination’. *Journal of Vision* 15, no. 14 (27 October 2015): 14. https://doi.org/10.1167/15.14.14.

Summerfield, Christopher, and Tobias Egner. ‘Expectation (and Attention) in Visual Cognition’. *Trends in Cognitive Sciences* 13, no. 9 (1 September 2009): 403–9. https://doi.org/10.1016/j.tics.2009.06.003.

Wyart, Valentin, Anna Christina Nobre, and Christopher Summerfield. ‘Dissociable Prior Influences of Signal Probability and Relevance on Visual Contrast Sensitivity’. *Proceedings of the National Academy of Sciences* 109, no. 9 (28 February 2012): 3593–98. https://doi.org/10.1073/pnas.1120118109.

Zuanazzi, Arianna, and Uta Noppeney. ‘Additive and Interactive Effects of Spatial Attention and Expectation on Perceptual Decisions’. *Scientific Reports* 8, no. 1 (30 April 2018): 6732. https://doi.org/10.1038/s41598-018-24703-6.

**Questions/design decisions:**

- How to manipulate attention? Spatial (L vs R), reward-driven (\ vs /), or (inefficient) response-requirement-based (\ vs /)

- Response: continuous (rotate bar) or binary (CW/CCW)

*→ Previous discussion: reward-driven attention, continuous response*

- Distribution of stimuli:

Cheadle et al (2015) ask subjects to indicate direction of rotation about vertical (CW/CCW). Task relevance is manipulated by spatial cue, expectation by cue indicating likely rotation direction. Distribution of stimulus rotation is bimodal – with peaks ~5 degrees from vertical. Uses a complicated-seeming reverse correlation/decision kernel method for analysis.

They argue that expectation leads to greater sensitivity to more informative (for the task) features. In other words, boosts gain for most useful features for discrimination given likely rotation. Seems to me there is a degree of residual confounding between this expectation and something more like attention.

One difference with our proposal is the distributions of stimulus rotations. Cheadle uses a bimodal distribution with peaks very close to each other – a continuous distribution of orientations. Ours – with peaks at the obliques – might be better thought of as a categorical distribution, or two entirely separate continuous unimodal distributions.

In our proposal: expectation provides categorical information on likely stimulus category but no information on location of stimulus within the distribution

Cheadle: expectation provides information about location of stimulus within distribution and hence which features would be more informative to (for want of a better term) attend to.

We could compare effects of ‘coarse-grained’ or categorical task-relevance (i.e. cue that reward is greater/more probable for accurate rotation discrimination close to one of the two obliques) and expectation (cue as to which oblique is more likely) – with ‘fine-grained’ or continuous task-relevance (greater/more probable reward for accurate discrimination of CW vs CCW) and expectation (CW or CCW more likely).