Mollon & Danilova (1996), Three remarks on perceptual learning

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The paper

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- Of the “three remarks” I’m only going to talk about #1.
Background

- Perceptual learning experiments on Vernier acuity (AKA hyperacuity) have shown that learning is
  - specific to the trained retinal location

Mollon & Danilova describe a plausible alternative explanation for the specificities that does not imply anything about localisation. There is an obvious and less exciting alternative hypothesis that needs to be ruled out in each such case: the site of the learning may in fact be central and what is specific may be what is learned.
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“There is an obvious and less exciting alternative hypothesis that needs to be ruled out in each such case: the site of the learning may in fact be central and what is specific may be what is learnt.”
The argument

- Vernier learning is specific to the trained eye & retinal location *because there is something specific to be learned there.*
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- Sources for specificity:
  - Optical
  - Variability in receptor mosaic
  - Variability in connections from receptor cells to downstream cells
Optical variability

▶ The optics of the eye produce “aberrations”: if you shine a point light source into the eye, you get something quite different on the retina.
▶ This is measured by the Point Spread Function:

(image from Artal et al., JOV, 2004)
Optical variability

(image from Artal et al., *JOV*, 2004)

- The PSF varies with accommodation distance (because the eyeball changes shape), and presumably with retinal location, although I haven’t found a reference specifically on that.
Variability in receptor mosaic

(Hofer et al., *J Neuro*, 2005)
Variability in connectivity

- In addition to the variability in the receptor mosaic over space, there might be some variability in how receptors are connected to ganglion cells.

▶ Soo et al., 2011, *J Neuro* (salamander retina)

▶ Ganglion cell RFs vary in shape.
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Population coding view

To do the Vernier task you have a bunch of V1 cells that give you some relevant information. All you need are orientation-tuned cells at the right location (Yair et al. 1994, *Neur Comp*)

![Diagram showing excited and inhibited cells with RFs](image-url)
Population coding view

Optimal weights for the task will change if the exact tuning of the cells changes.
Population coding view

- Optimal weights for the task will change if the exact tuning of the cells changes.
- Having specificity tells us nothing about learning site since *input weighting could happen anywhere*
Evidence for the Mollon-Danilova hypothesis

- As far as I know no direct test of the hypothesis has been done.
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- There is evidence that neural coding adapts to the global optics of the eye: Artal et al (2004) used adaptive optics to rotate subjects’ PSF. This doesn’t affect optical quality of the eye itself, but strongly increases the perceived bluriness of the image.
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- As far as I know no one has actually tested the Mollon-Danilova idea.
- For another argument against the localisation hypothesis, see Adrien’s presentation next week.