Probing contrast sensitivity and adaptation in the head-fixed mouse

Miles J. Wells, Peter Zatka-Haas, Kenneth D. Harris and Matteo Carandini

University College London, London, UK

Introduction

Prolonged viewing of a high-contrast grating increases the threshold of contrast detection [1,2].

To establish the neural basis of this contrast adaptation, it would be ideal to observe it in mice.

Do mice exhibit contrast adaptation? Are its effects specific to orientation, as they are in humans?

Methods

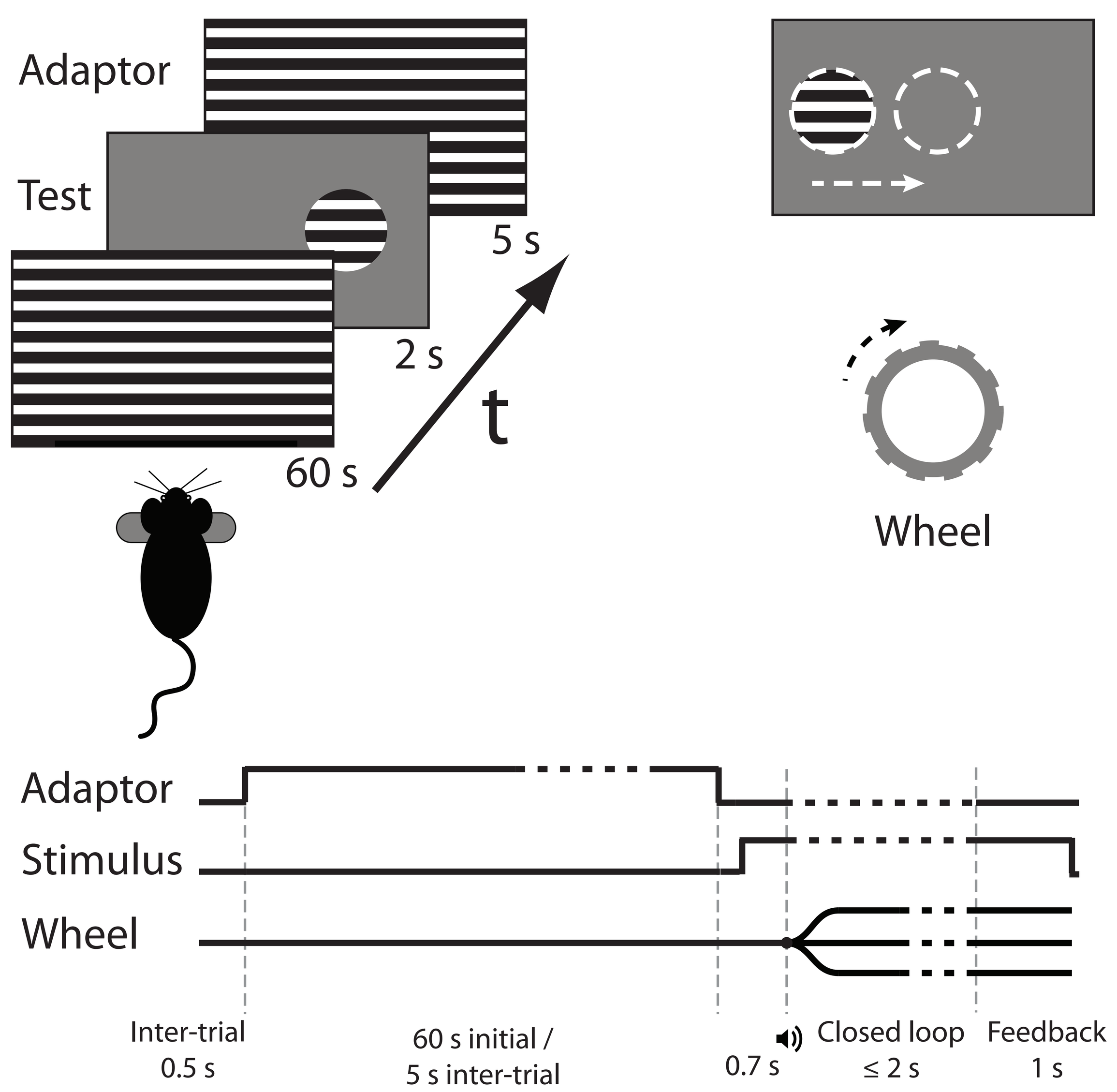
► 3 mice were trained to perform a 2-alternative un-forced choice stimulus detection task [3].

► Headfixed, the mice turned a wheel to move a test stimulus to the center of their visual field for a water reward.

► In zero-contrast trials, mice were rewarded for holding the wheel still.

► Between trials, the mice viewed a full-field 'adaptor' grating, randomly phase shifted at 5Hz.

► Adaptor contrast (5% or 100%) and orientation (parallel or orthogonal to the test) changed across sessions .



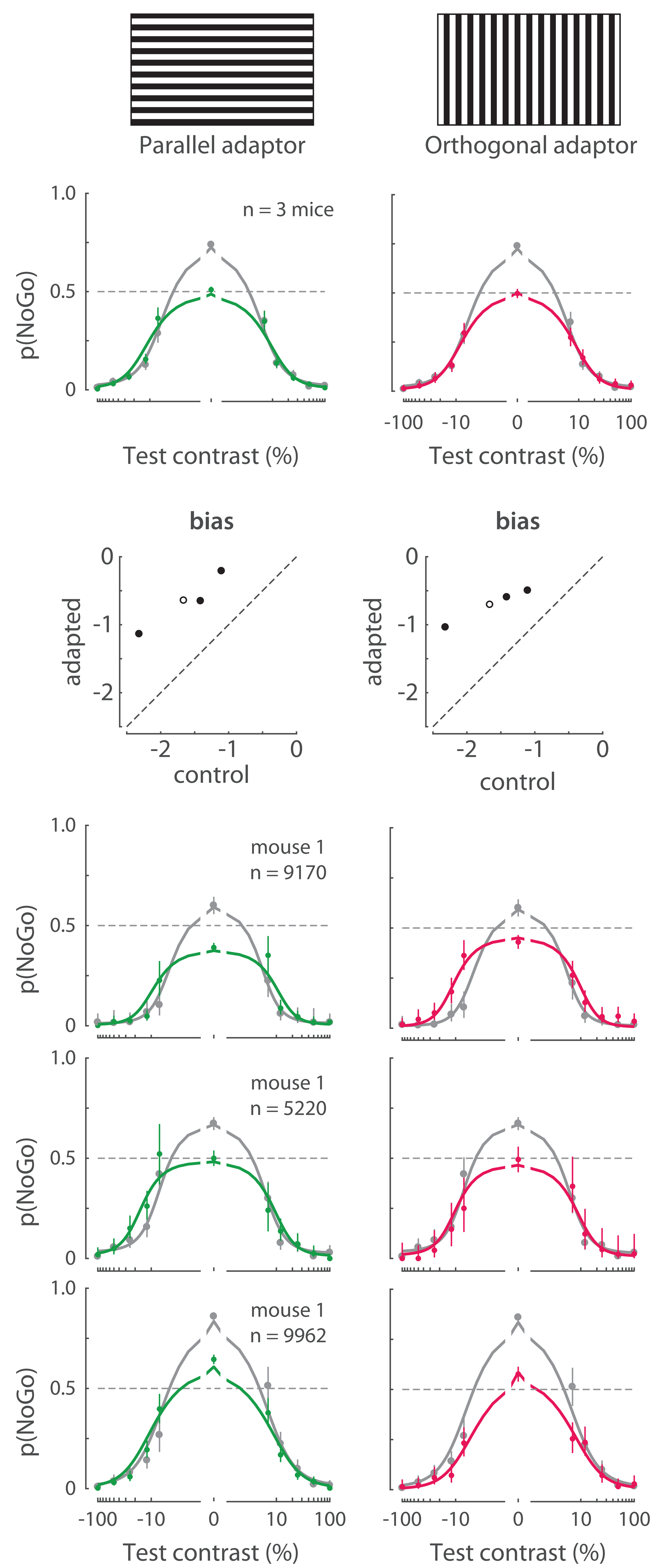
Model

The data were fit with a probabilistic observer model [3], where bias and c_{50} could vary across adapter conditions:

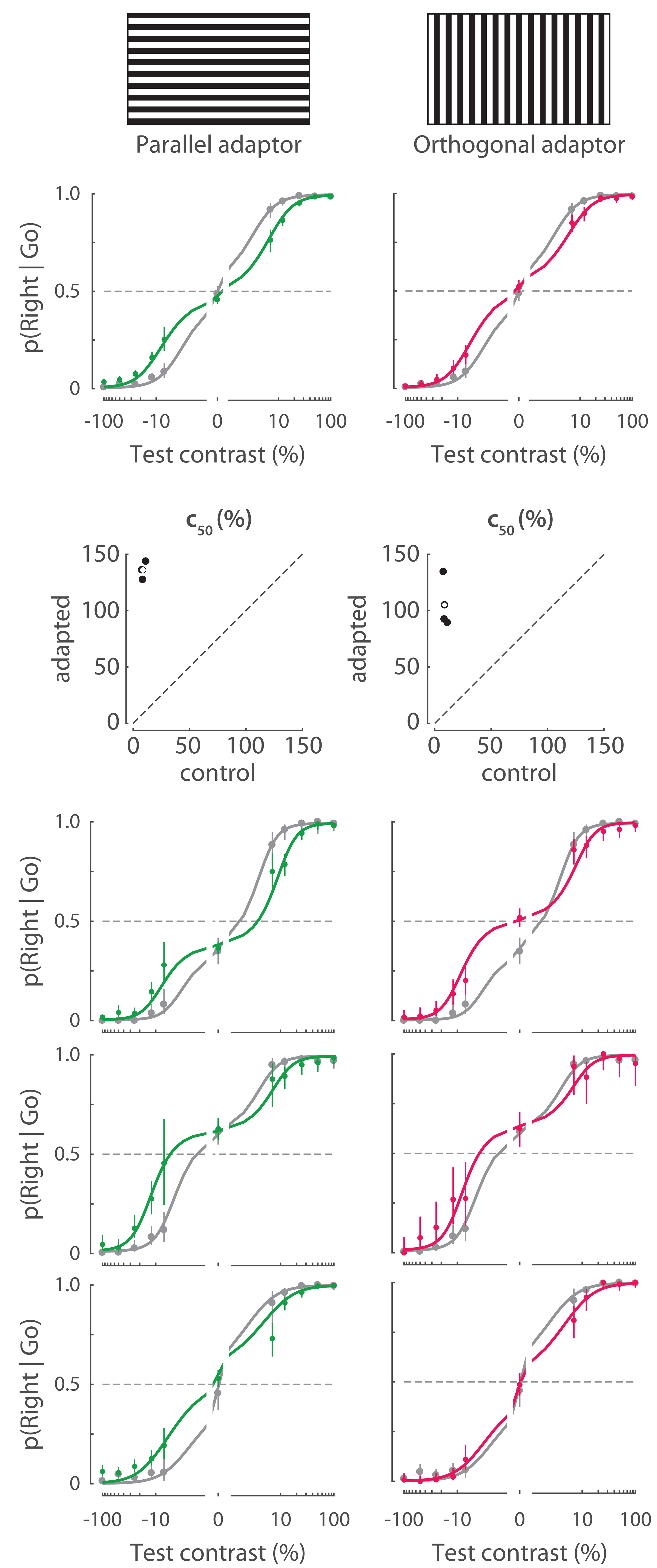
$$ln\frac{p(Right)}{p(NoGo)} = bias_R + sens_R\left(\frac{c_R^n}{c_R^n + c_{50R}^n}\right)$$

$$ln\frac{p(Left)}{p(NoGo)} = bias_L + sens_L\left(\frac{c_L^n}{c_L^n + c_{50L}^n}\right)$$

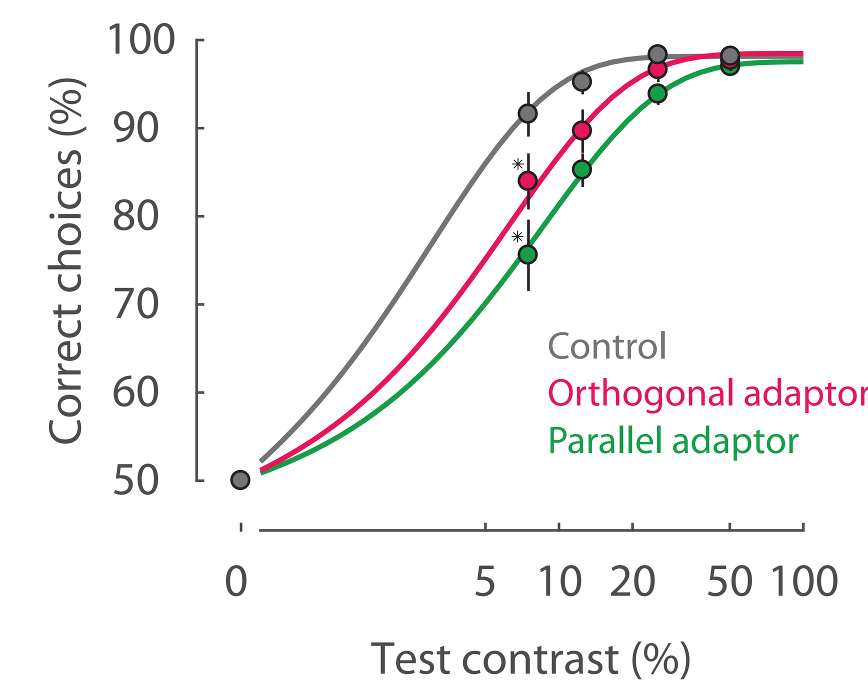
1. Effects of adaptation on no-go responses



2. Effects of adaptation on L and R responses



3. Mean performance across all mice



Conclusions

► Mice exhibit contrast adaptation.

► The probabilistic observer model fits the data well with only two free parameters.

► Adaptation increases bias (tendency to 'go').

► Adaptation increases c_{50} (decreases sensitivity).

► The effect of adaptation depends on orientation (stronger when adaptor and test stimulus are parallel).

► These results will facilitate concurrent measurements of perceptual and neural adaptation.

References

1. Gilinksy AS, *J Opt Soc Am*, 1968.

2. Blakemore C & Campbell FW *J Physiol*, 1969.

3. Burgess CP et al. *Cell Reports*, 2017.