Tilt aftereffect from untilted adaptators and motion aftereffect from static adaptors: Counterintuitive predictions of Li and Atick's efficient binocular coding theory

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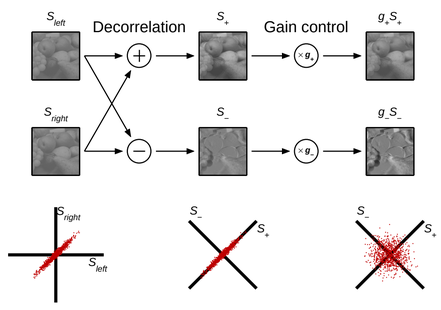
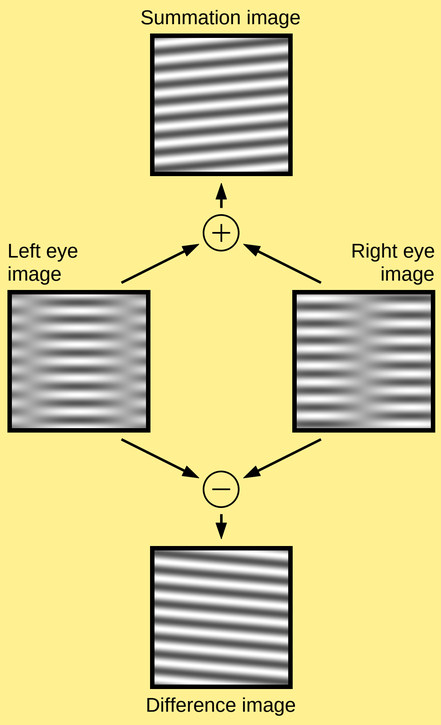
Background

- Li and Atick's theory of efficient binocular coding (Li & Atick, 1994, *Network*, *5*, 157−174)
- Summation (S_+) and differencing (S_-) channels decorrelate the ocular signals
- Gain control maximizes information capacity
- Optimal gains vary from moment to moment, so channels should be selectively adaptable



Our binocular test stimulus

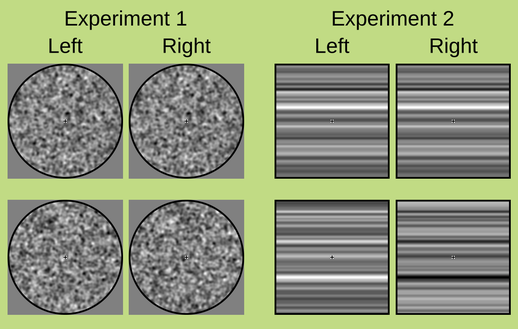


- Tilt could be relative to horizontal (as shown) or vertical
- The summation channel sees tilt in one direction
- The differencing channel sees tilt in the other direction
- We should be able to control perceived tilt by selectively adapting S_+ or S_- channel

Our binocular adaptation stimuli

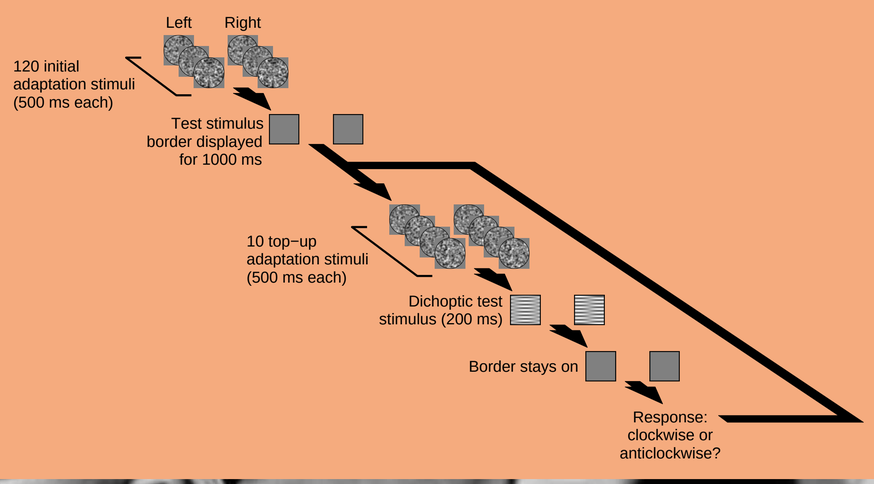
Correlated adaptation
- both eyes see the same image
- S_+ channel stimulated
- S_- channel silent

Anticorrelated adaptation
- each eye sees the photonegative of the other eye's image
- S_+ channel silent
- S_- channel stimulated

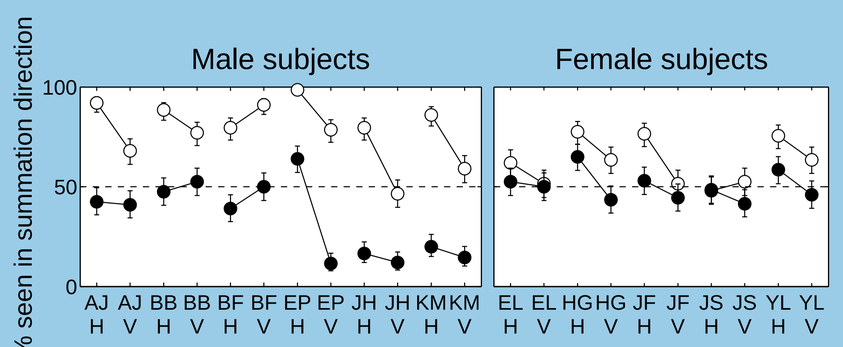


- Experiment 1 stimuli had isotropic noise
- Experiment 2 stimuli were horizontal or vertical

Procedure



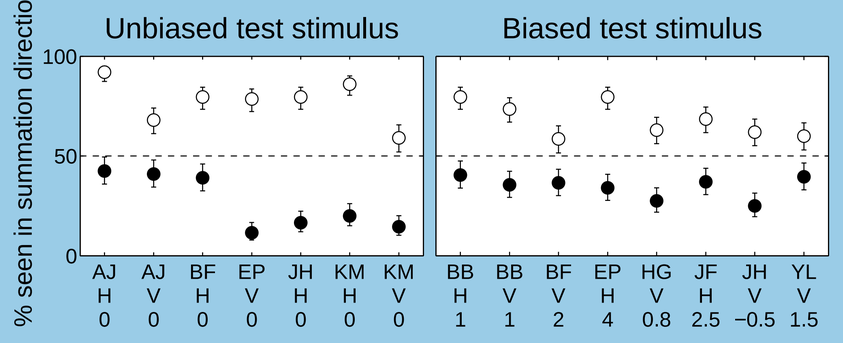
Results: Experiment 1



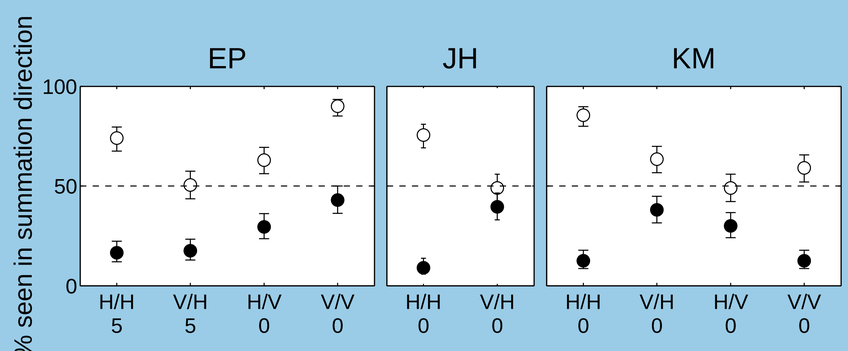
- 2−letter abbreviations are subjects' initials
- H and V indicate test stimulus components close to horizontal or vertical, respectively
- Surprisingly, male subjects showed much bigger adaptation effect than female subjects

○ Anticorrelated adaptation
● Correlated adaptation

- Many subjects were biased towards S_+ or S_- direction, so we added gratings of opposite contrast to each eye's test stimulus to bias the contrast of the S_- signal
- Results shown below (numbers under abscissa give Michelson contrast of added gratings; zero indicates data with unbiased stimuli selected from above figure)



Results: Experiment 2



- H and V indicate adaptation/test orientation
- For subject JH, adaptation is highly orientation−selective
- For subjects EP and KM, adaptation is only moderately orientation−selective

Conclusions

- A tilt aftereffect can be generated by adaptors that are untilted (Experiment 2) or have equal energy at each orientation (Experiment 1)
- Adaptation at least partly mediated by cells with non−oriented receptive fields
- Summation channel partly implemented by cells with identical isotropic receptive fields in the two eyes
- Differencing channel partly implemented by cells with isotropic receptive fields that have opposite polarities in the two eyes − a few cells like this have been reported (Livingstone & Hubel, 1984, *J Neurosci*, *4*, 309−356; Snodderly & Gur, 1995, *J Neurophysiol*, *74*, 2100−2125)

Motion aftereffect from static adaptors

- Our tilt aftereffect from untilted adaptors is analogous to our previous work, in which we controlled the perceived direction of motion of the Shadlen−Carney stimulus using static adaptors (May, Zhaoping & Hibbard, 2012, *Current Biology*, *22*, 28–32)
- The test stimulus images in our current work are the space−time plots of the test stimuli in our previous work
- The space−time plaids are stationary, flickering (counterphase) gratings used in the Shadlen−Carney stimulus (Shadlen & Carney, 1986, *Science*, *232*, 95−97)
- Gratings tilted in space−time are smoothly drifting gratings
- We selectively adapted the binocular channels using static adaptors, and showed that this affected the perceived direction of motion of the Shadlen−Carney stimulus

This work was supported by a grant from The Gatsby Charitable Foundation to Li Zhaoping