B9
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Perceptual learning increases the tilt aftereffect

Erik Blaser*, Fulvio Domini+, & Larry A. Raymond*

*Human Vision Laboratory, University of Massachusetts, Boston

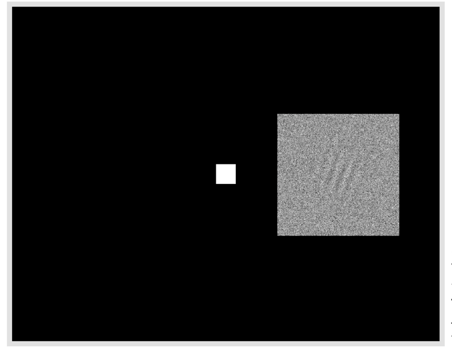
+3D Shape Perception Laboratory, Brown University

Purpose: To constrain models, and localization of function, of perceptual learning and aftereffects by studying their interaction.

Method: Determine if orientation discrimination training affects the magnitude of the tilt aftereffect.

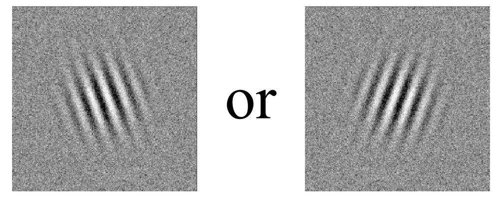
Calibration

First, we determine contrast thresholds for each observer.



500ms exposure
3 deg eccentric,
fixation to center

tilt either -20 or +20



(contrast exaggerated)

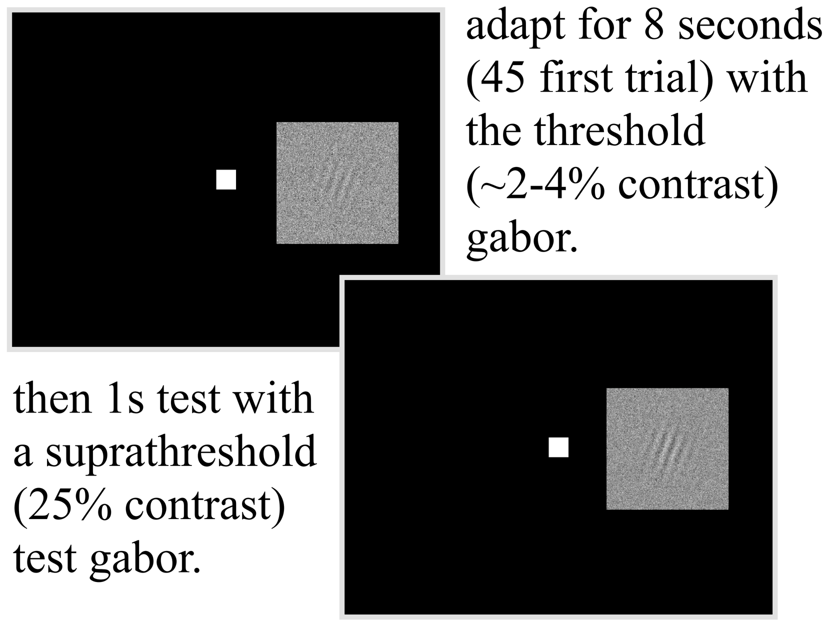
Was the gabor tilted left or right?

- vary contrast
- give feedback

Contrast thresholds averaged 2-4%

Pre-training adapt

Using the threshold gabor from Calibration as an adaptor, we now measure pre-training tilt aftereffect.



adapt for 8 seconds (45 first trial) with the threshold (~2-4% contrast) gabor.

then 1s test with a suprathreshold (25% contrast) test gabor.

Test tilts were <-2.5, -1.25, 0, 1.25, or 2.5>

Was test gabor tilted left or right?

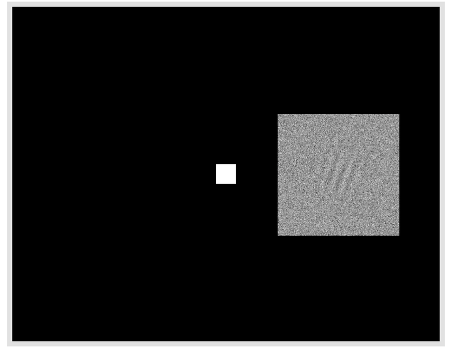
- no feedback

Angular bias reflects tilt aftereffect.

Tilt AE's averaged 0.44 deg.

Training

Now observers train in a tilt discrimination task with the gabor.

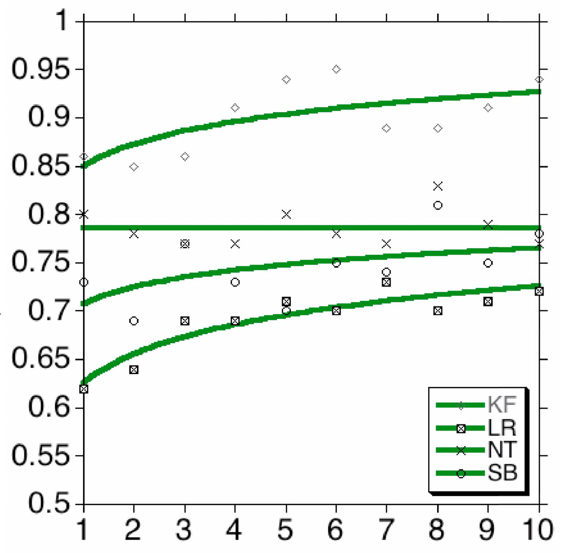


500ms exposure
3 deg eccentric

tilt either -20 or +20

Was the gabor tilted left or right?

- give feedback

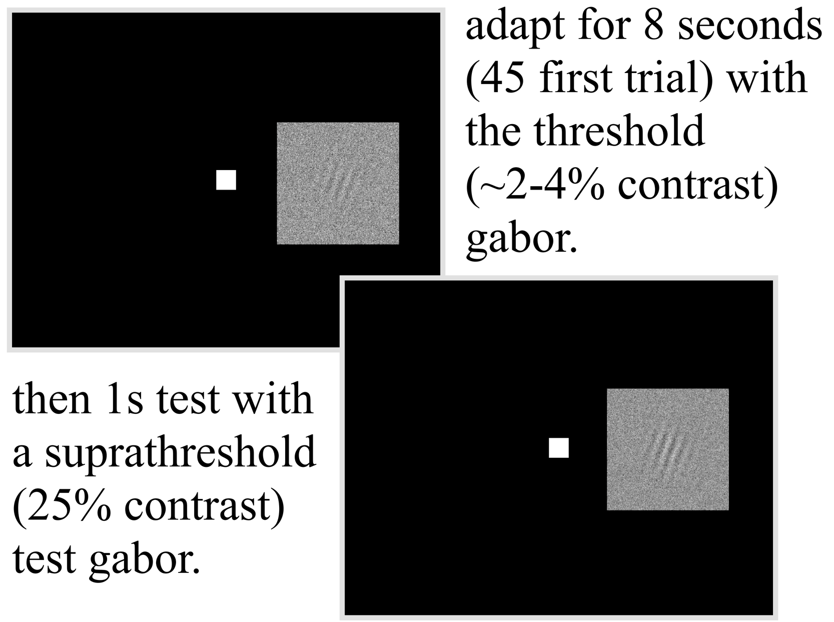


0.85 --> 0.93 KF
0.62 --> 0.71 LR
0.79 --> 0.79 NT
0.71 --> 0.77 SB

As expected, learning is modest.

Post-training adapt

We again measure the tilt AE, now after training, with same gabor.



adapt for 8 seconds (45 first trial) with the threshold (~2-4% contrast) gabor.

then 1s test with a suprathreshold (25% contrast) test gabor.

Test tilts were <-2.5, -1.25, 0, 1.25, or 2.5>

Was test gabor tilted left or right?

- no feedback

Angular bias reflects tilt aftereffect.

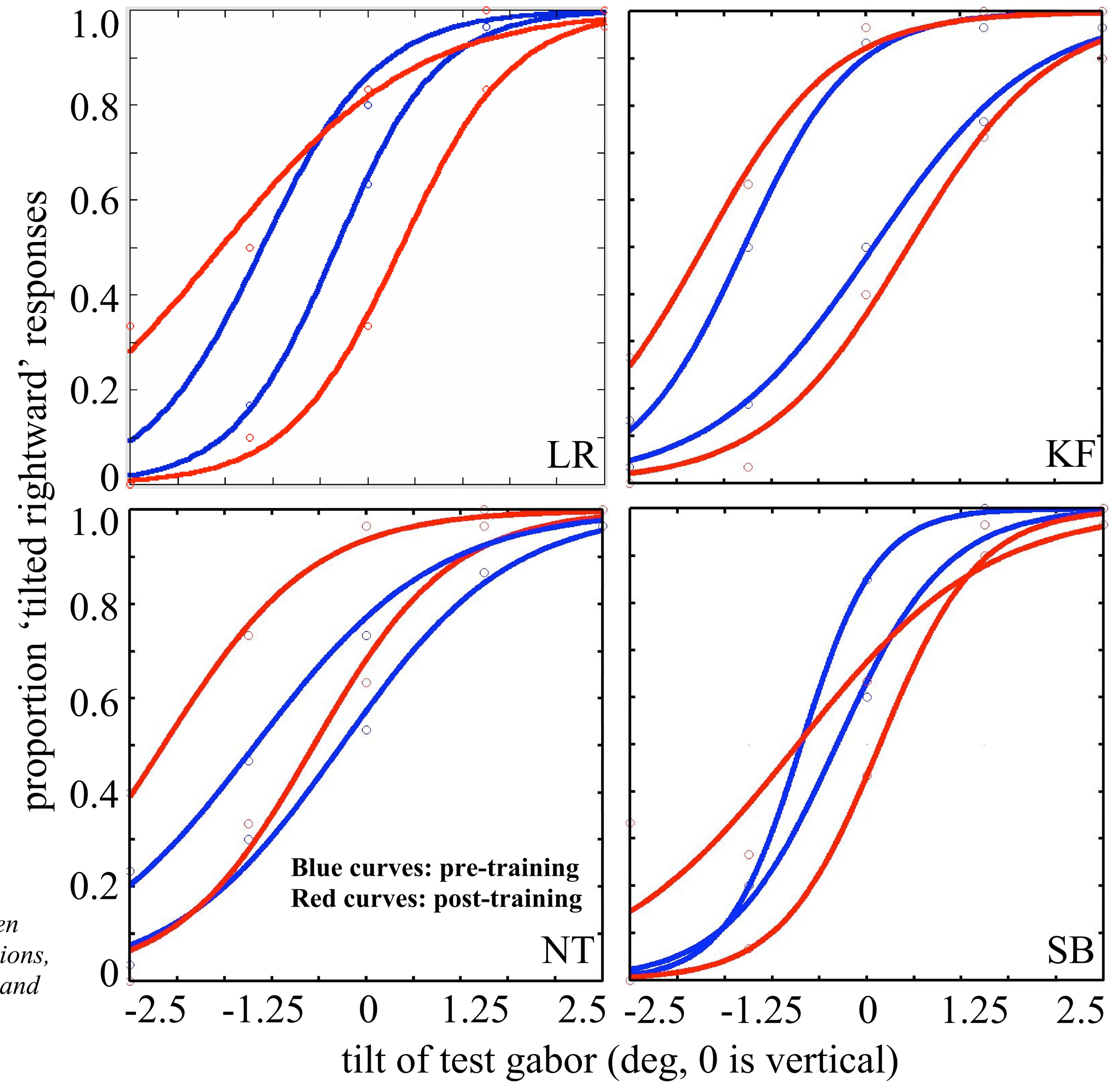
Tilt AE's now averaged 0.84 deg.

Tilt AE's were double after training.

Results

Biases in tilt judgements - induced via adaptation with a near-threshold gabor patch - are greater after discrimination training with that gabor.

Psychometric functions measuring tilt AE pre- and post-training



If we take 1/2 the difference between the means of the pre-training functions, and do the same for post-training, and average over observers, we get:
pre-training tilt AE = 0.44 deg
post-training tilt AE = 0.84 deg

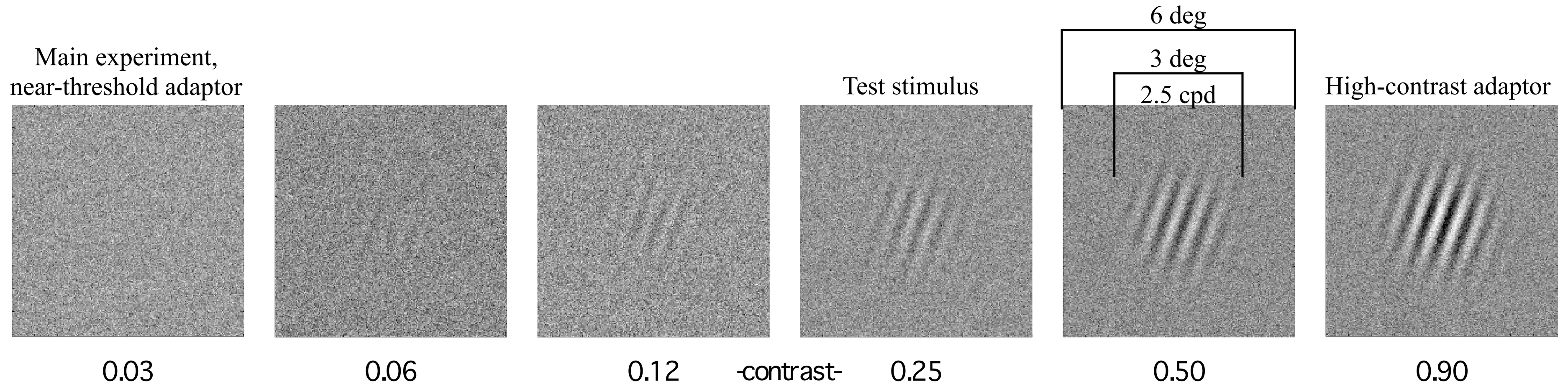
Summary, conclusions

Training results in only a modest gain in orientation discrimination.

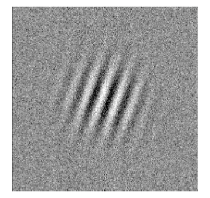
Even so, after training, the tilt aftereffect is double that from before training.

Further experiments are required for detailed modeling, but a working model uses the training to more heavily weight the orientation/frequency channel carrying the signal; this stronger weight means higher activity during prolonged exposure, yielding greater adaptation and hence larger tilt aftereffects.

Stimuli were gabor patches embedded in Gaussian noise. Only contrast & tilt were manipulated.



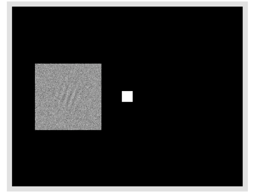
High-contrast control



To have a reference for the magnitude of the main experiment's aftereffects, we ran a control using a high contrast (90%) adaptor, instead of the near-threshold (2-4%) adaptor.

High-contrast tilt AE's averaged 2.1 degrees.

Other-side adapt control



To determine to what extent our pre- vs. post-training effect exhibited classic perceptual learning lack of transferability, we had observers adapt post-training on the left side of the screen, instead of the right.

Untrained-location tilt AE's were unchanged

Dosher BA, Lu ZL. Mechanisms of perceptual learning. Vision Res. 1999; 39(19):3197-221.
Fine I, Jacobs RA. Comparing perceptual learning tasks: a review. J Vis. 2002; 2(2):190-203.
Fine I, Jacobs RA. Perceptual learning for a pattern discrimination task. Vision Res. 2000; 40(23):3209-30.
Gold J, Bennett PJ, Sekuler AB. Signal but not noise changes with perceptual learning. Nature. 1999; 402(6758):176-8.
He S, MacLeod DI. Orientation-selective adaptation and tilt after-effect from invisible patterns. Nature. 2001; 411(6836):473-6.
Humphrey GK, Goodale MA. Probing unconscious visual processing with the McCollough effect. Conscious Cogn. 1998; 7(3): 494-519.
Lu ZL, Dosher BA. Perceptual learning retunes the perceptual template in foveal orientation identification. J Vis. 2004; 4(1):44-56.
Matthews N, Liu Z, Geesaman BJ, Qian N. Perceptual learning on orientation and direction discrimination. Vision Res. 1999; 39 (22):3692-701.
Matthews N, Liu Z, Qian N. The effect of orientation learning on contrast sensitivity. Nature. 1999; 402(6758):176-8.
Saarinen J, Levi DM. Perceptual learning in vernier acuity: what is learned? Vision Res. 1995; 35(4):519-27.
Schoups A, Vogels R, Qian N, Orban G. Practising orientation identification improves orientation coding in V1 neurons. Nature. 2001; 412(6846):549-53.
Sowden PT, et al. Perceptual learning of luminance contrast detection: specific for spatial freq & retinal location but not orientation. Vis Res 2002; 42(10):1249-58.
Teich AF, Qian N. Learning and adaptation in a recurrent model of V1 orientation selectivity. J Neurophysiol. 2003; 89(4):2086-100.
Vis Res. 2001; 41(4):463-71.
Wainwright MJ. Visual adaptation as optimal information transmission. Vision Res. 1999; 39(23):3960-74.
Watanabe T, Nanez JE, Sasaki Y. Perceptual learning without perception. Nature. 2001; 413(6858):844-8.