Efficient Stereo coding

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Methods

We selectively adapted the Si or S2 channel (analogous to adaptation of spatial frequency channels), and examined the effect on the channel gains.

Two adaptation types:

- Correlated: each eye sees the same natural image, Si channel stimulated, channel silent
- Anticorrelated: each eye sees the photo-negative of the other eye's image, Si channel stimulated, channel silent

- A range of adaptation between sessions, and trials of top-up adaptation between trials (each stereo pair presented for 1.5 secs)
- Adaptation contrast varied between sessions

Testing gains on binocular channels

Relative gains on binocular channels assessed from motion direction judgments for a dichoptic display in which the S1 signal contained motion in the opposite direction to the S2 signal (Shadlen & Carney, 1986).

Slight sinhT → SinhT = S2

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Results

- Summation (g; generally stronger for anticorrelated adaptation)
- Difference between adaptation type decreases with decreasing adaptation contrast
- Contrast of convergence point scales with test spatial frequency, as expected from 1/f spectrum (1 c/deg contrast is 4 times contrast of 4 c/deg contrast)

Conclusions

- Cortex adapts to interocular correlations by adjusting the gains on the S1 and S2 channels to optimize coding efficiency
- Gain control mechanisms in these channels suppress strong signals (whitening), but not very weak ones
- Unlike in the retina, cortical gain control may not need to suppress weak signals because these will be below threshold

References

- Li & Atick (1994) identified two conceptual stages to efficient stereo coding:
- But stereo integration occurs in the cortex, which can threshold out very weak signals, retina has high maintained firing rate, so weak signals can be suppressed only with gain control
- So cortex might only implement the whitening part of the above analysis

- Predicts more summation with anticorrelated adaptation
- Predicts more summation with correlated adaptation
- Predicts data should converge as adaptation contrast decreases

- This work was supported by The Gatsby Charitable Foundation and a Cognitive Science Foresight Grant BBSRC #GR/E002536/01

Efficient Stereo coding

Li & Atick (1994) identified two conceptual stages to efficient stereo coding

1. Whitening
2. Gap control

But at very low SNR, information is so low that it’s better to reduce the energy budget to avoid wasting energy by memory coding
- Predicts inverted-U shaped gain function

Experiments on psychophysical adaptation

- Contrast of convergence point scales with test spatial frequency, as expected from 1/f spectrum (1 c/deg contrast is 4 times contrast of 4 c/deg contrast)

Retina (from Brown & Wiesel, 1959) V1 (from Hubel & Wiesel, 1959)

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