Two Contrast-Adaptation Processes: One Old, One New

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Introduction
We have found a new kind of contrast adaptation:
• A contrast-comparison level is continually updated based on the recent average contrast.
• As this comparison level changes, some second-order patterns become much less (or much more) visible.
• In particular, patterns composed of contrasts that “Straddle” the comparison level (see example below) are hard to identify.
• The timescale is probably shorter than that of a typical fixation.
• We have nicknamed this “Buffy adaptation.”

Here we show how this interacts with an old kind of contrast adaptation:
• We call this “contrast normalization” since it is consistent with a contrast-gain control implemented as a normalization network.
• Ater adapting to a blank gray field, some patterns are hard to identify due to contrast normalization.
• These same patterns can be much easier to identify after adapting to non-zero contrast.
• This adaptation exhibits Weber-like behavior.

Psychophysical trial with example contrast values

Some details of the methods
• Observers were paid Columbia University undergraduates with normal or corrected-to-normal vision.
• Each pattern was a 2x2 grid of Gabor patches. We have also run many of these experiments with 15x15 grids and the main results are the same.
• The grid was centered at fixation and surrounded by a large gray field.
• Gabor patch orientation was the same through a trial.
• Feedback was provided.
• Each Gabor patch was ~1 deg at the viewing distance of 0.9 meters.
• The Gabor’s spatial frequency was about 2 cycle per deg.
• The mean luminance was approx 50 cd/m².
• The test contrast difference was always 10% in these experiments.

Introduction

New adaptation effect (with 50% adapt contrast)
Performance is poor when average test contrast equals the adapt contrast (marked with #)

Test Contrasts (%) C1,C2
50 75 95
Average Test Contrast (%)
Correct Identification (%)
100 75 50

Test Contrasts (C1,C2)
Test Contrast Difference = |C1-C2| / 100

Average Test Contrast
Correct Identification (%)

Old adaptation effect (with 0% adapt contrast)
Performance declines as average test contrast increases

Test Contrasts (%) C1,C2
50 75 95
Average Test Contrast (%)
Correct Identification (%)
100 75 50

Old adaptation effect extended (with 50% adapt contrast)
Performance declines when average test contrast is very far below (or very far above) the adapt contrast (marked with #)

Test Contrasts (%) C1,C2
50 75 95
Average Test Contrast (%)
Correct Identification (%)
100 75 50

Conclusions & Questions

There are two underlying zones:
- Weber zones
- Buffy zone

At the ends are the Weber zones, in which we see the adaptation effect. In this zone performance is Weber-like where the dimension is the unsigned difference between the comparison level and the average test contrast.

In the middle is the Buffy zone where we see the new adaptation effect. Here performance is poor on patterns whose average test contrast equals the recent contrast (that is, Straddle patterns).

We are left wondering...
What is the function of this adaptation?
Why did evolution produce it?

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