Two Contrast-Adaptation Processes: One Old, One New

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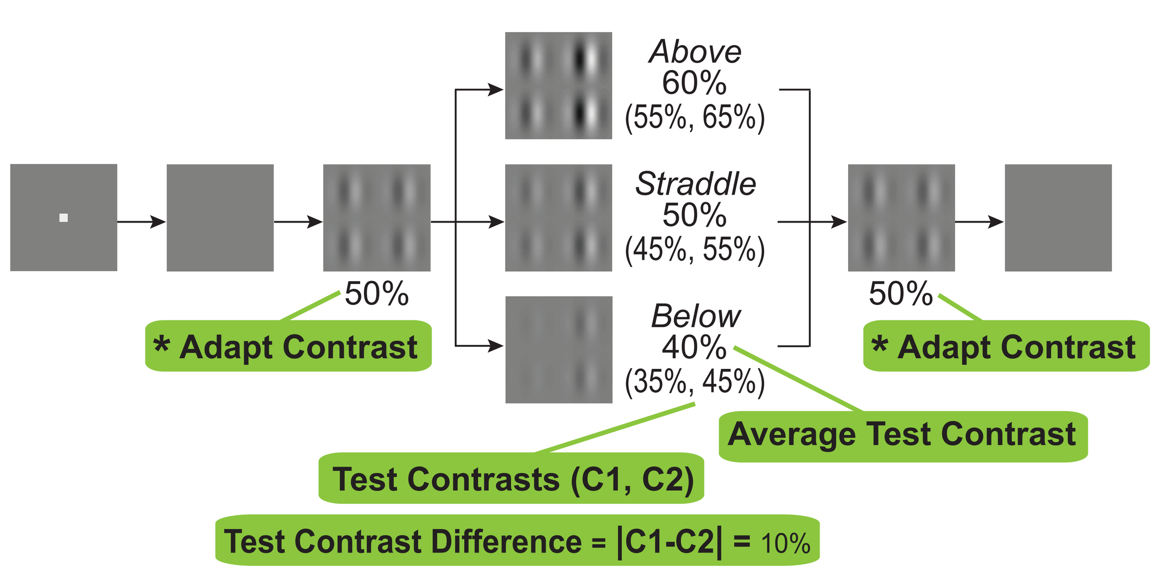
Introduction

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 timecourse is probably shorter than that of a typical fixation.
- We have nicknamed this "Buffy adaptation".

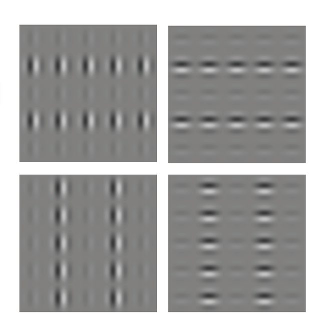
Here we show how this interacts with an **old** kind of contrast adaptation:
- We call this "contrast normalization" since it is consistent with a contrast-gain control implemented as a normalization network.
- Ater adapting to a blank gray field, some patterns are hard to identify due to contrast normalization.
- 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



Task

Identify orientation of contrast-defined stripes in the test pattern



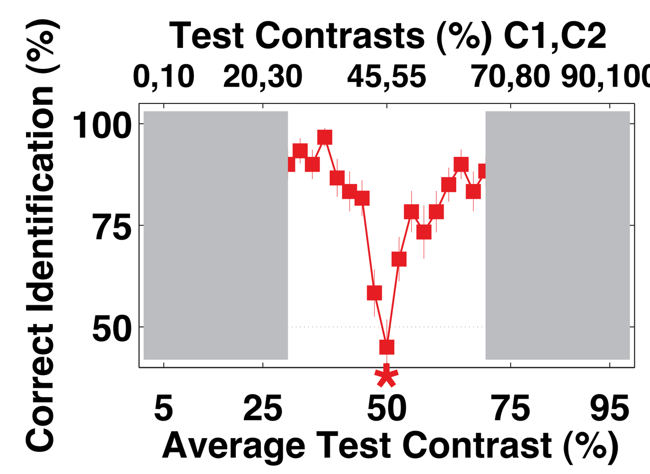
Some details of the methods

- 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/m^2.
- The test contrast difference was always 10% in these experiments.

New adaptation effect

(with 50% adapt contrast)

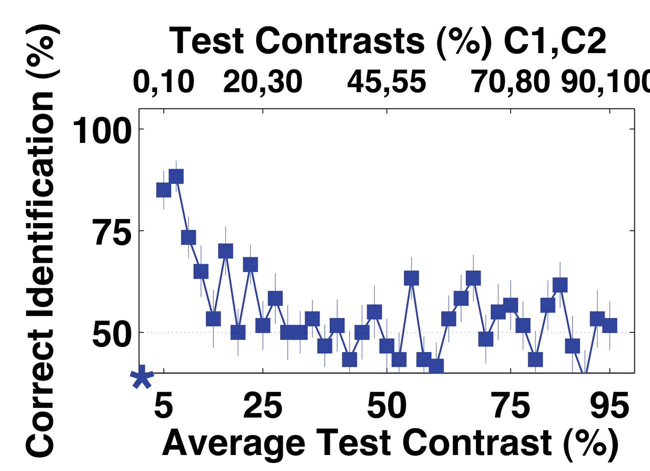
Performance is poor when average test contrast equals the adapt contrast (marked with *)



Old adaptation effect

(with 0% adapt contrast)

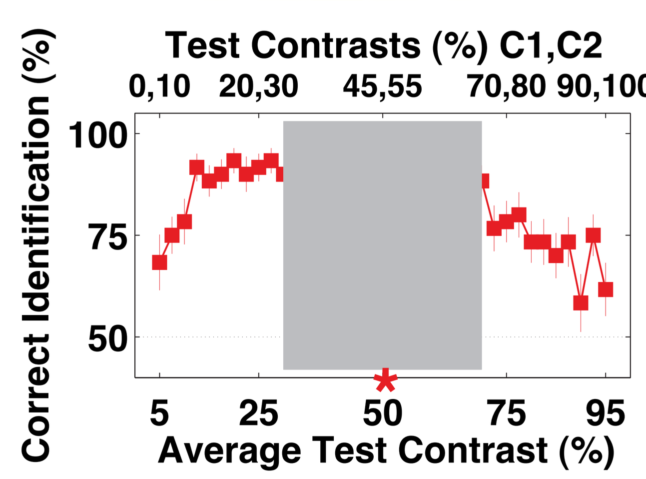
Performance declines as average test contrast increases



Old adaptation effect extended

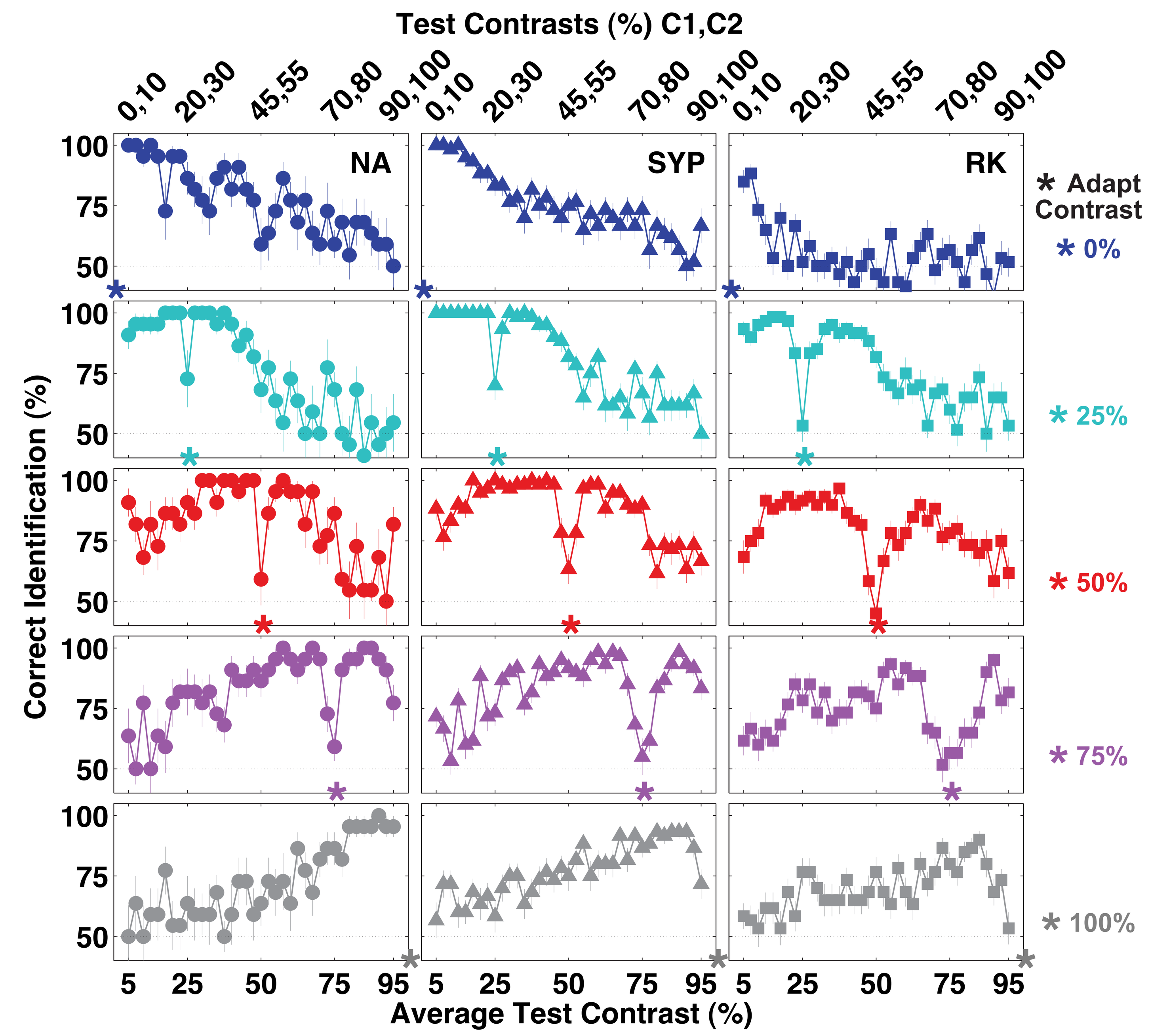
(with 50% adapt contrast)

Performance declines when average test contrast is very far below (or very far above) the adapt contrast (marked with *)



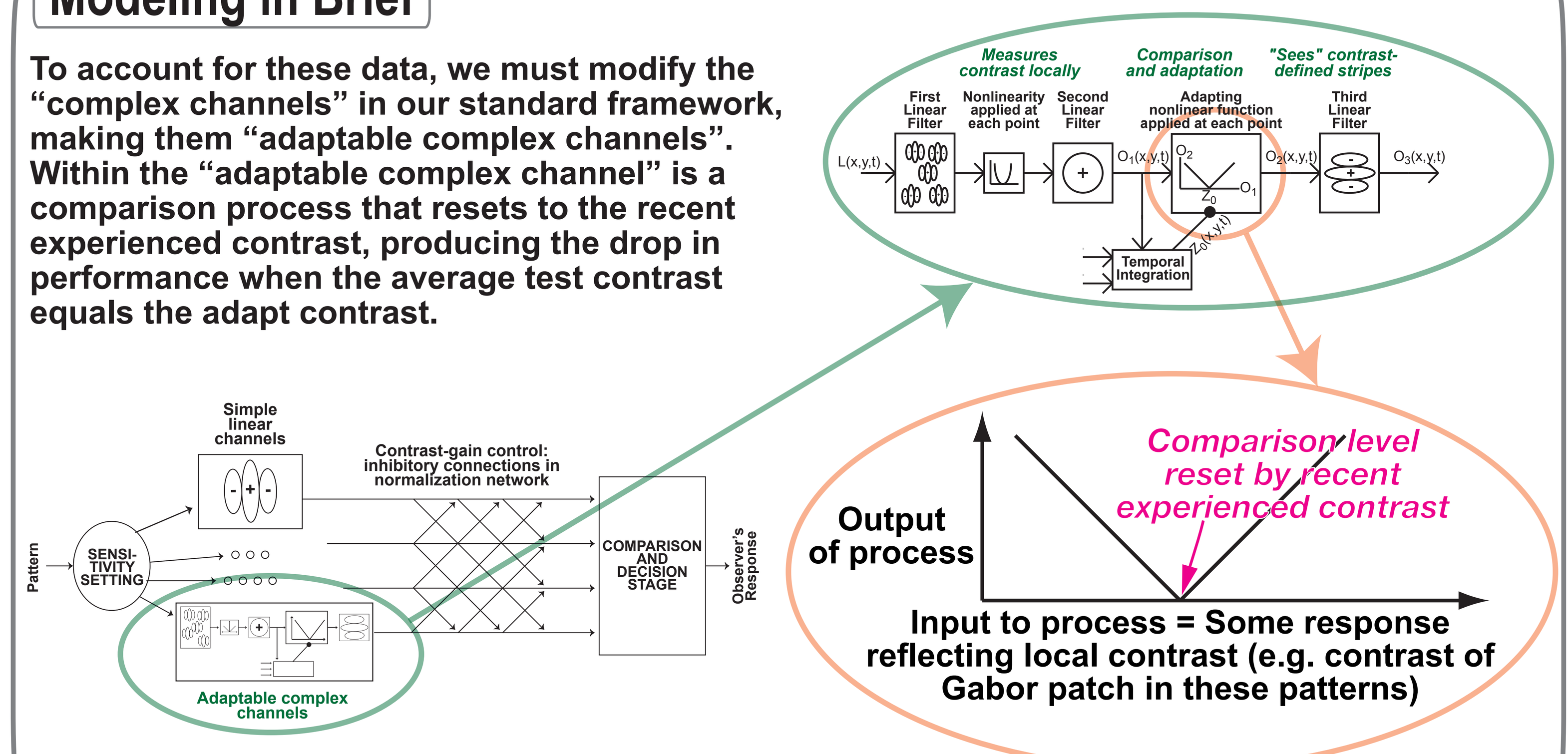
New & Old adaptation (with many adapt contrasts)

Performance is high when average test contrast a bit above or below the adapt contrast



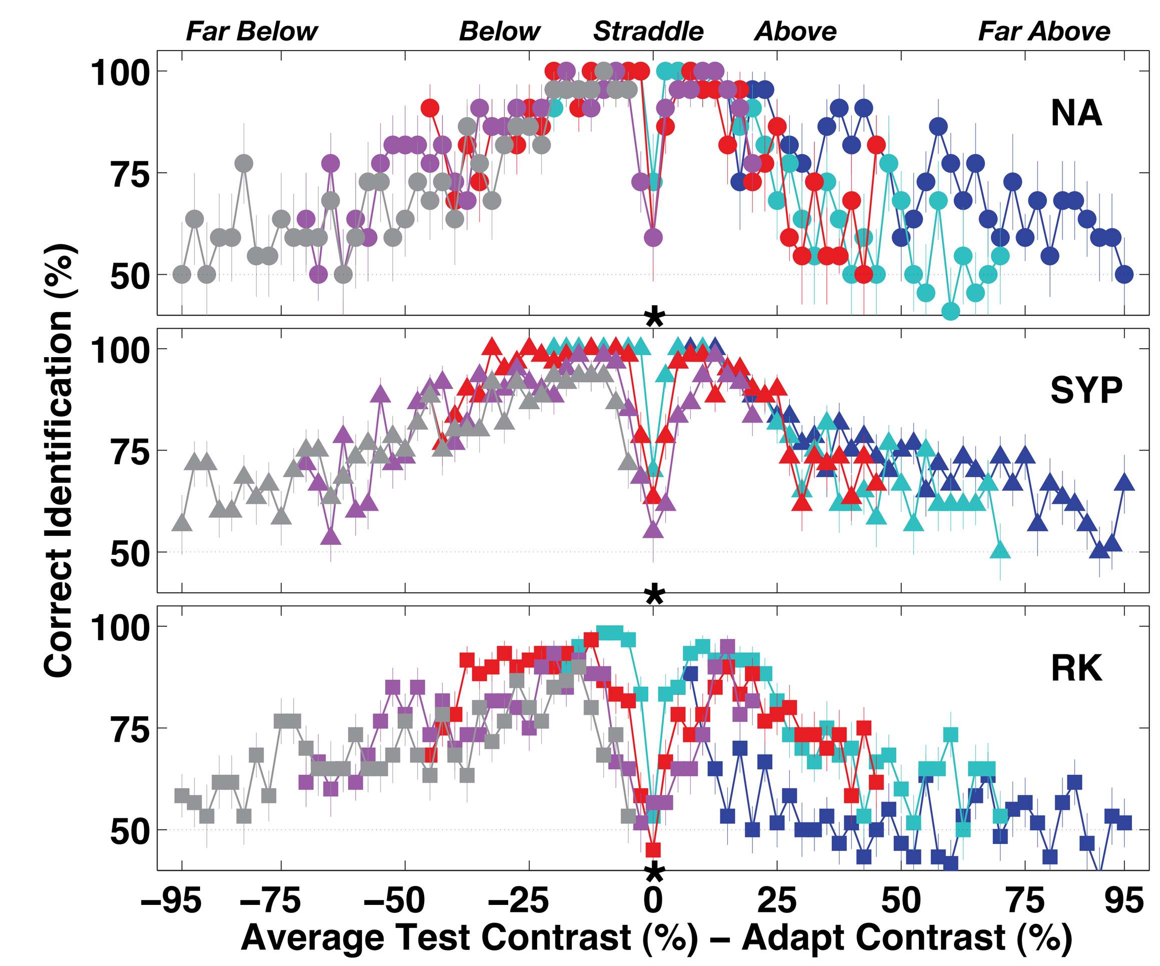
Modeling in Brief

To account for these data, we must modify the "complex channels" in our standard framework, making them "adaptable complex channels". Within the "adaptable complex channel" is a comparison process that resets to the recent experienced contrast, producing the drop in performance when the average test contrast equals the adapt contrast.



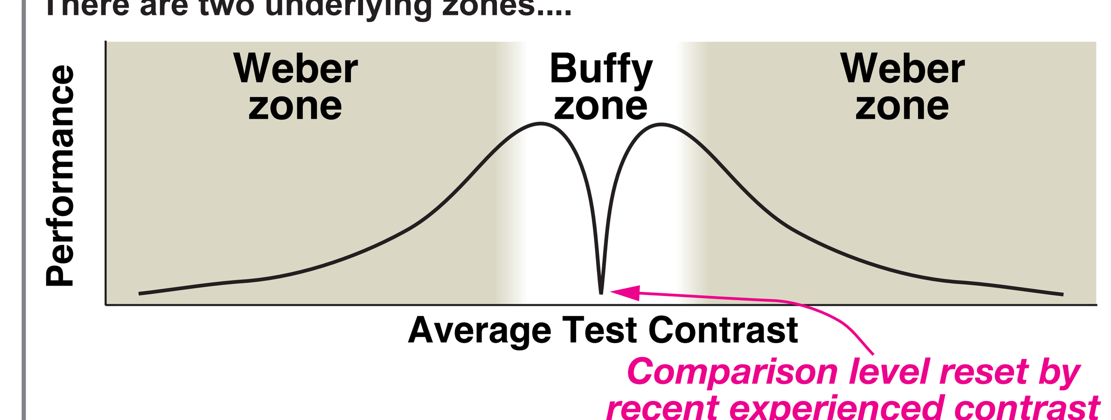
New & Old adaptation summary...

Performance is shaped like butterfly wings



Conclusions & Questions

There are two underlying zones....



At the ends are the Weber zones in which we see the **old** 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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Supported in part by NIH grant EY08459

Vision Sciences Society, 2008
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Abstract #26.326