Adaptation Aftereffects as a Result of Bayesian Categorization

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Introduction

Short-term perceptual history (what we saw) affects subsequent perceptual processing (what we see) in two ways:

- **Contrastive effects:** New object features are shifted away from the previously perceived ones: new object seems **more different**.
- **Assimilative effects:** New object features are shifted towards the previously perceived ones: new object seems **more similar**.

These two types of effects could occur in very similar and even identical experimental settings (Uznadze, 1958; Fritsche et al., 2017; Chopin & Mamassian, 2012).

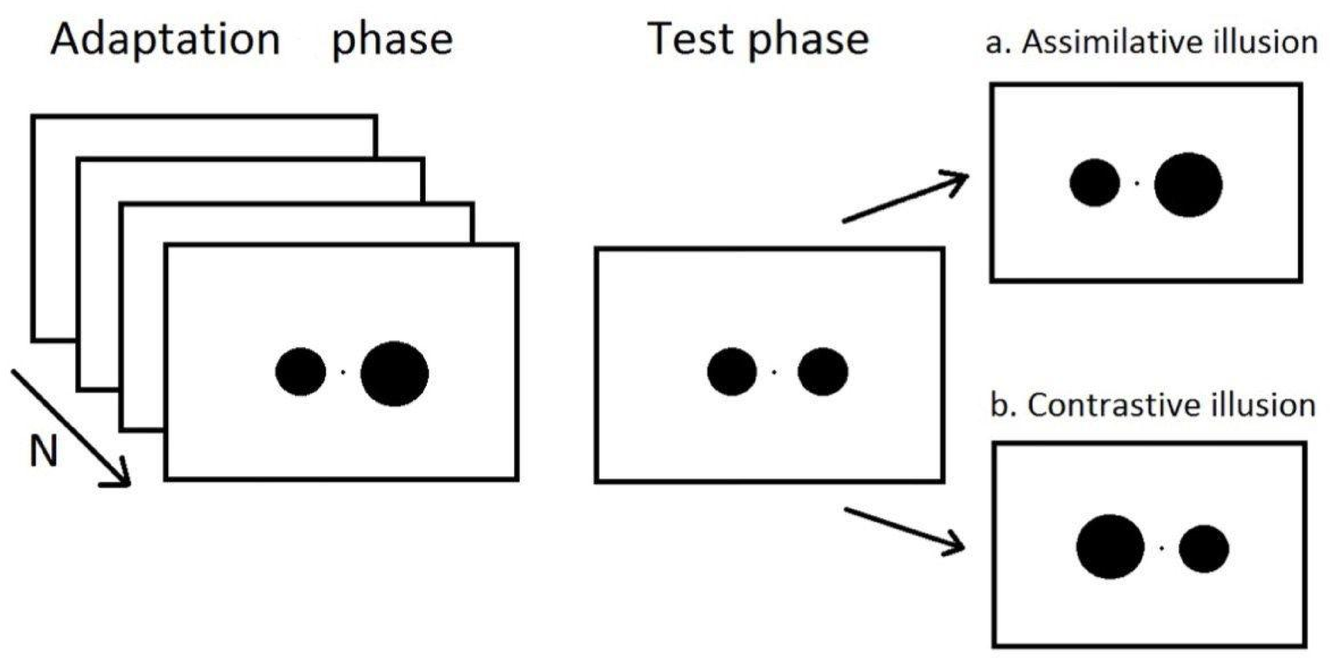
What determines the aftereffect type?

REPLICATION 1 & 2 (Uznadze, 1958):

1. the number of adaptive stimuli seen
2. the difference between previous and the new stimuli

↑ probability of contrastive effects

↓ probability of assimilative effects



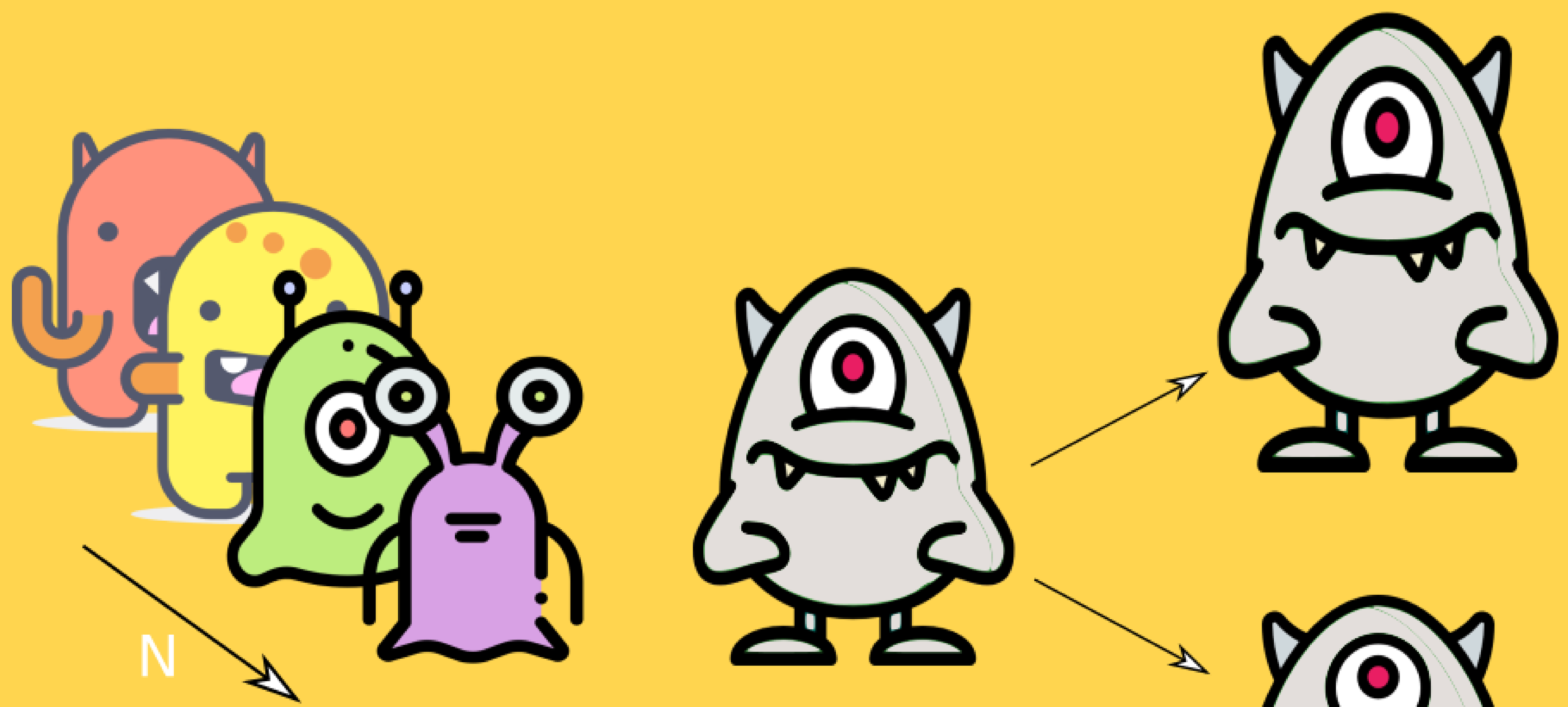
Results

	number of adaptation trials	difference between adaptive and test stimuli
Replication 1 (N = 26, conditions per participant = 24)	$p < .001$ $BF = 2.5$	$p < .001$ $BF = 47995$
Replication 2 (N = 50, conditions per participant = 30)	$p < .001$ $BF = 56.3$	$p < .05$ $BF = 4.8$

Note: half of our data consists of trials where no illusion was reported

We propose a **uniform explanation** of both **assimilative** and **contrastive** visual aftereffects

Adaptation aftereffects may be seen as a consequence of **rational categorical perception**



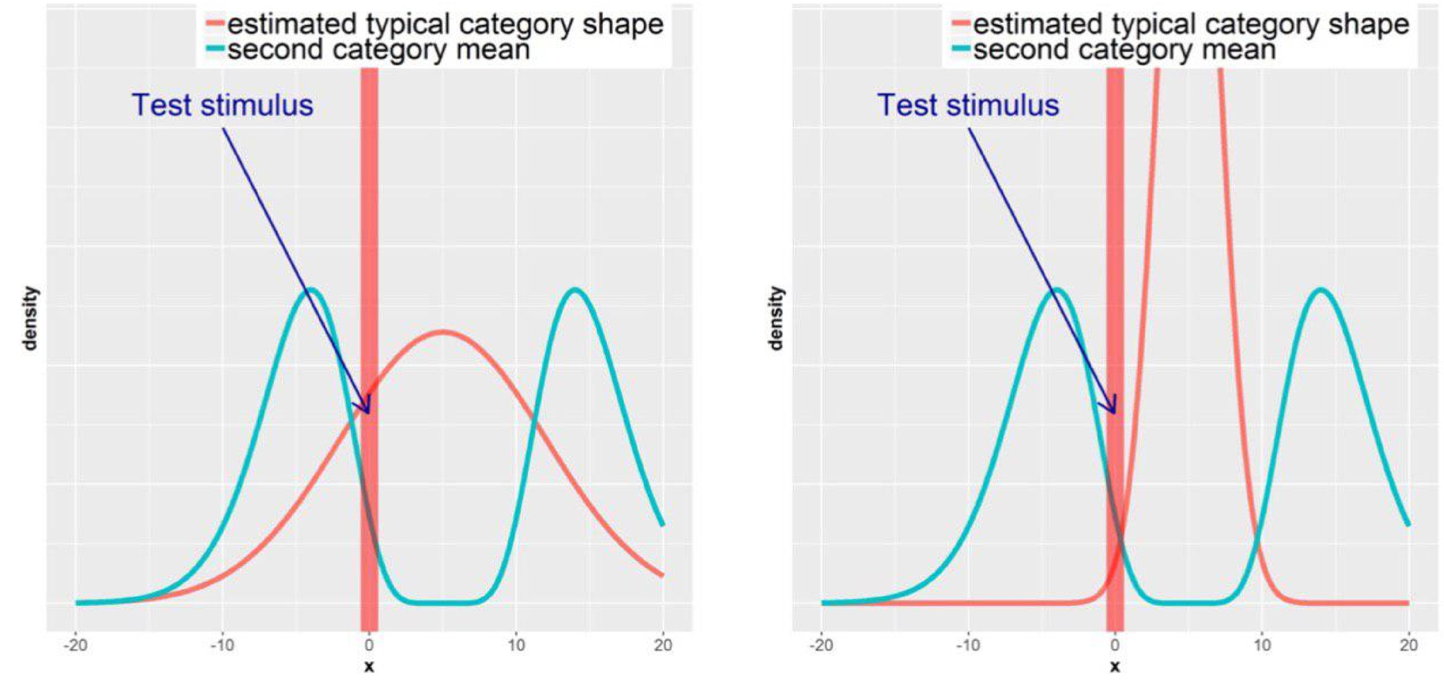
Code, data, and other materials

Can adaptation aftereffects support perception efficiency?

The goal of perception is to reconstruct incoming noisy perceptual signals as accurately as possible. Utilizing high-level prior knowledge could make perception more efficient. We show how contrastive and assimilative aftereffects could result from assuming categorical structure of the environment.

Rational model

1. **Inter-category distance assumption:** An observer assumes that centers of any two categories are more likely to be relatively distant from each other in perceptual space than to be close → acquisition of a new category shifts the expectations of the unknown ones.
2. **Adaptation phase:** A rational observer forms a category of "typical" stimuli using Bayesian inference.
3. **Test phase:** When an observer sees a new stimulus she decides which category it most likely belongs to.
4. **Perceptual inference:** An observer reconstructs the most likely perceptual characteristics of the stimulus combining the actual perception and prior expectations of the assigned category ("typical" or unknown).



Model Analysis

- **Cross-validation.** Cognitive model predicts hold-out data better than logistic regression based on *precision* and *recall*
- **Qualitative patterns.** Cognitive model repeats the main regularities in data replicated in two experiments

	Measure	Bayesian LR	Cognitive Model
Experiment 1: assimilative	Recall	0.296 (0.086)	**0.577** (0.082)
	Precision	0.521 (0.12)	**0.522** (0.034)
Experiment 1: contrastive	Recall	**0.817** (0.065)	0.65 (0.056)
	Precision	0.637 (0.018)	**0.701** (0.032)
Experiment 2: assimilative	Recall	0.057 (0.0049)	**0.293** (0.057)
	Precision	0.378 (0.228)	**0.426** (0.044)
Experiment 2: contrastive	Recall	**0.97** (0.03)	0.845 (0.032)
	Precision	0.73 (0.006)	**0.754** (0.012)

Further directions

- Testing the model on realistic, multidimensional stimuli (e.g. faces)
- Applying the model to explain other perceptual effects of assimilative and contrastive nature