



# Higher-order texture statistics influence and enable segmentation in synthetic and natural textures

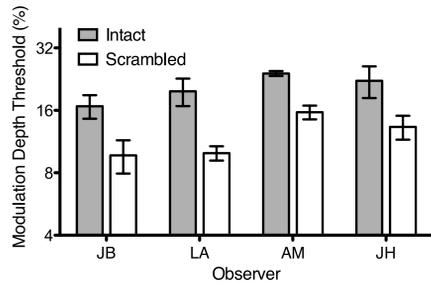
Elizabeth Zavitz<sup>1,2</sup>, Curtis Baker<sup>1</sup>

1. McGill University, Montreal, Canada 2. Monash University, Melbourne, Australia



## Introduction

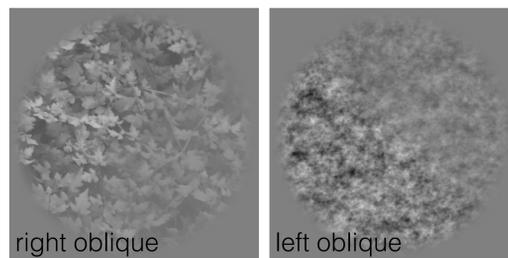
Higher-order statistics impair segmentation of contrast-defined boundaries in natural textures.<sup>1</sup>



Can conventional models capture how texture structure affects segmentation?

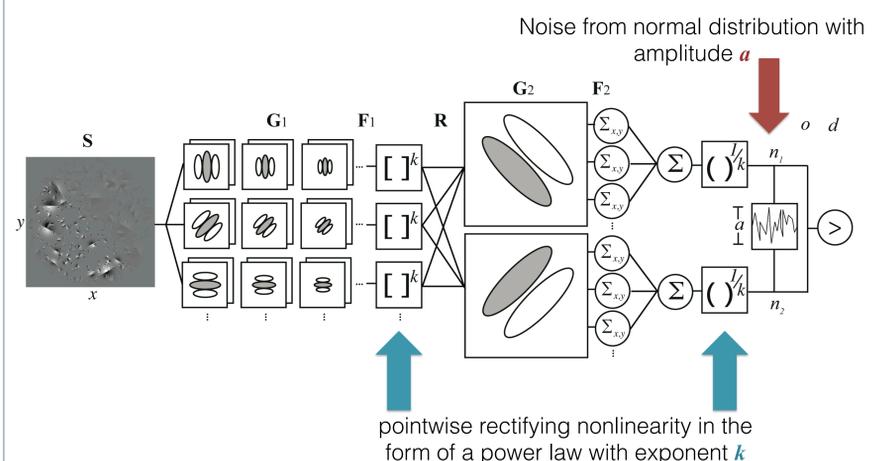
## Methods

Human psychophysics, model simulation



2AFC: Right- or left-oblique?  
75% correct modulation-depth threshold  
What texture properties affect threshold?

## Model

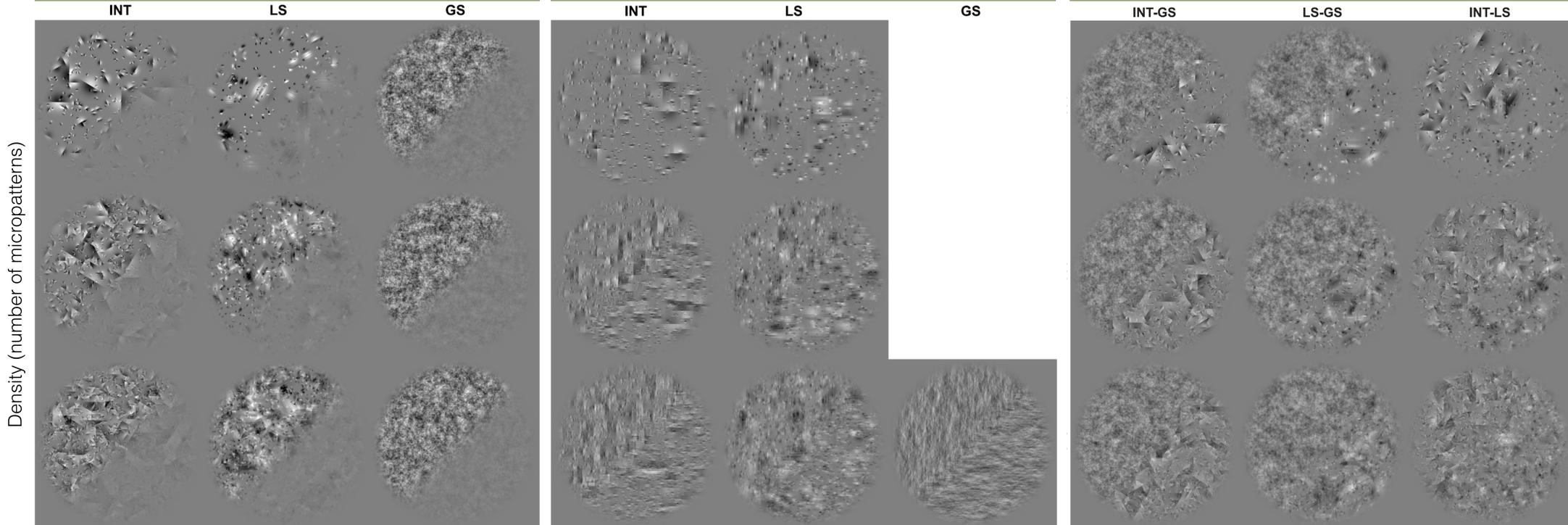


## Contrast

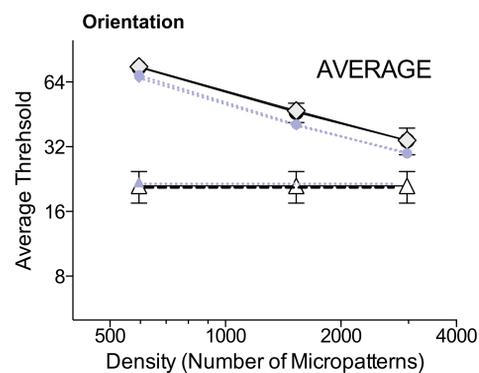
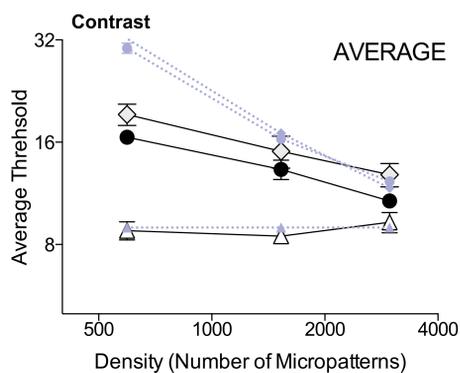
## Orientation

## Structure

Stimuli

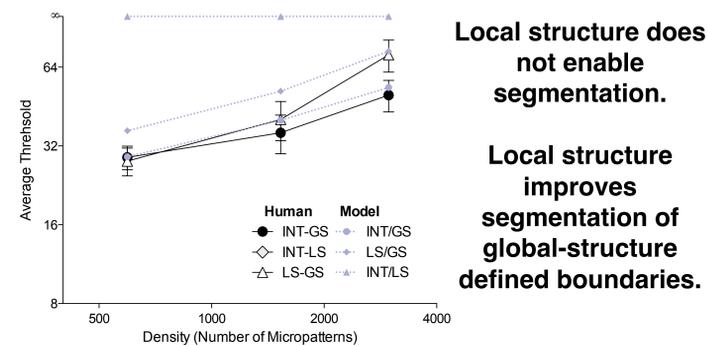


Results



Global phase structure (and sparseness in particular) impair segmentation.

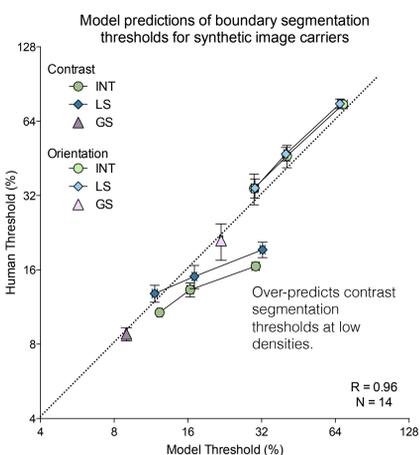
Local structure does not influence segmentation.



Local structure does not enable segmentation.

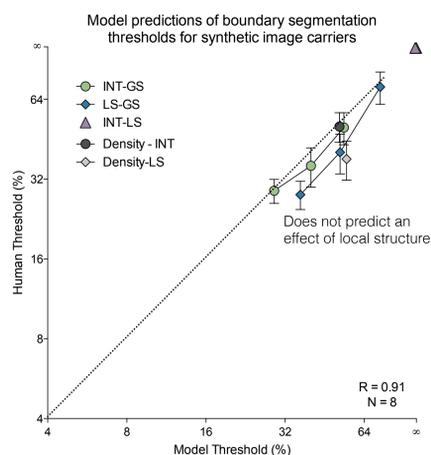
Local structure improves segmentation of global-structure defined boundaries.

Model Fit

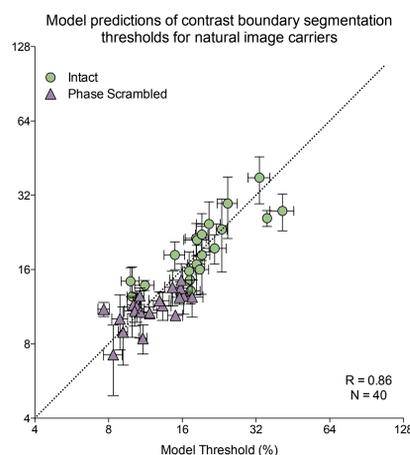


Fits to orientation and contrast segmentation data are best when  $k < 1$

Model Predictions



Same parameters provide excellent predictions for (left) structure-defined boundaries and (right) contrast defined boundaries in natural texture images



## Conclusions

- Higher-order statistics influence and enable segmentation
- An FRF model is capable of capturing many of the effects of higher-order statistics
- An intermediate compressive nonlinearity provides the best fit to human data

## Discussion

Compressive nonlinearities might emulate the effects of neuronal suppression<sup>2</sup>, and sublinear summation may be a general property of early visual processing.<sup>3</sup>

References: (1) Arsenault, Yoonessi & Baker (2011). "Higher-order texture statistics impair contrast boundary segmentation" *Journal of Vision*.  
 (2) Mineault, Khawaja, Butts & Pack (2012). "Hierarchical processing of complex motion along the primate dorsal visual pathway" *PNAS*.  
 (3) Vu, Ravikumar, Naselaris, Kay, Gallant & Yu (2011). "Encoding and decoding V1 fMRI responses to natural images with sparse nonparametric models" *The Annals of Applied Statistics*.

This research was funded by an NSERC grant (OPG0001978) to CB

