



A Cross-Cultural Test of the Independence of the Representation of Generalized Cone Dimensions



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Background

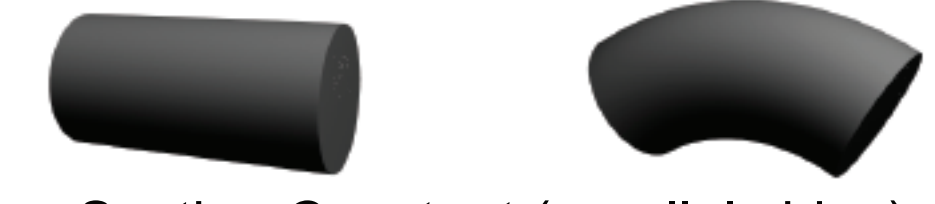
- Generalized cones provide a good model of recurring shape elements in the world.
- Geons are distinguished by non-accidental (= viewpoint invariant) differences in the dimensions of generalized cones.



1. Cross Section: Straight vs. Curved



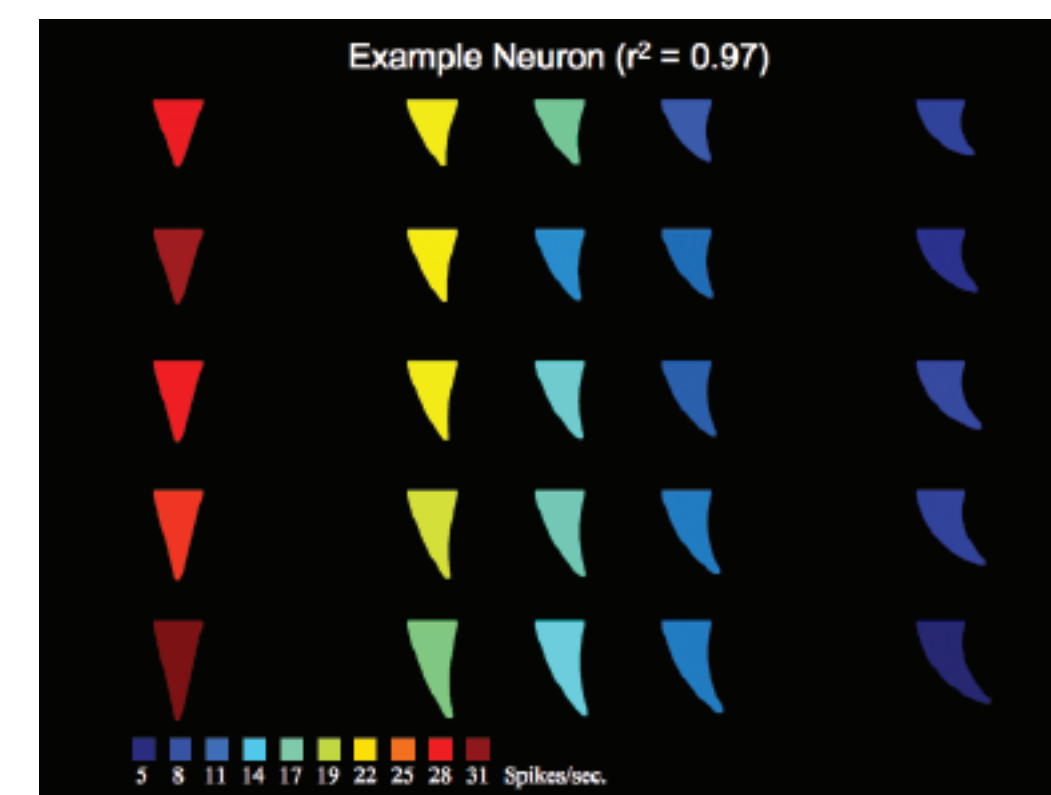
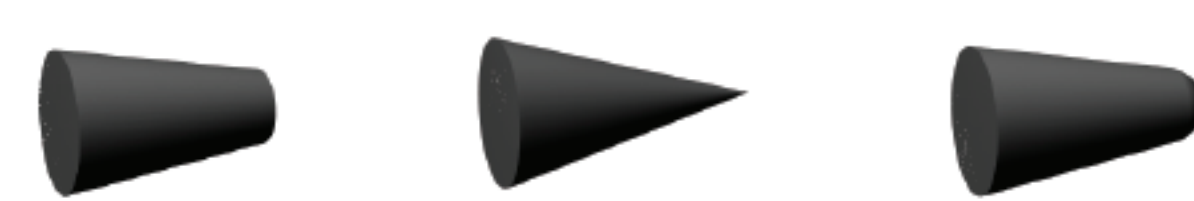
2. Axis: Straight vs. Curved



3. Size of Cross Section: Constant (parallel sides) vs. Expand vs. Contract vs. Contract & Expand



4. Termination of Geon when Nonparallel: Truncated vs. Pointed vs. Rounded



- Both humans (Stanckiewicz, 2002) and cells in macaque IT cortex (Kayaert, Biederman, & Vogels, 2005 [above left]) have been shown to be independently sensitive to dimensions of generalized cones, such as axis curvature, aspect ratio, and taper.

The Question

- Would people raised in a much less “geonic” environment show the same sensitivity?



- The Himba are a semi-nomadic tribe in Northwestern Namibia with minimal contact with Western artifacts.

Experimental Task: texture segregation

- Subjects viewed a 5x5 array of shapes that differed metrically in both aspect ratio (thick vs. thin) and axis curvature (high vs. low), defining two fields that differed in either a single dimension (with the other varying randomly) or in two dimensions.

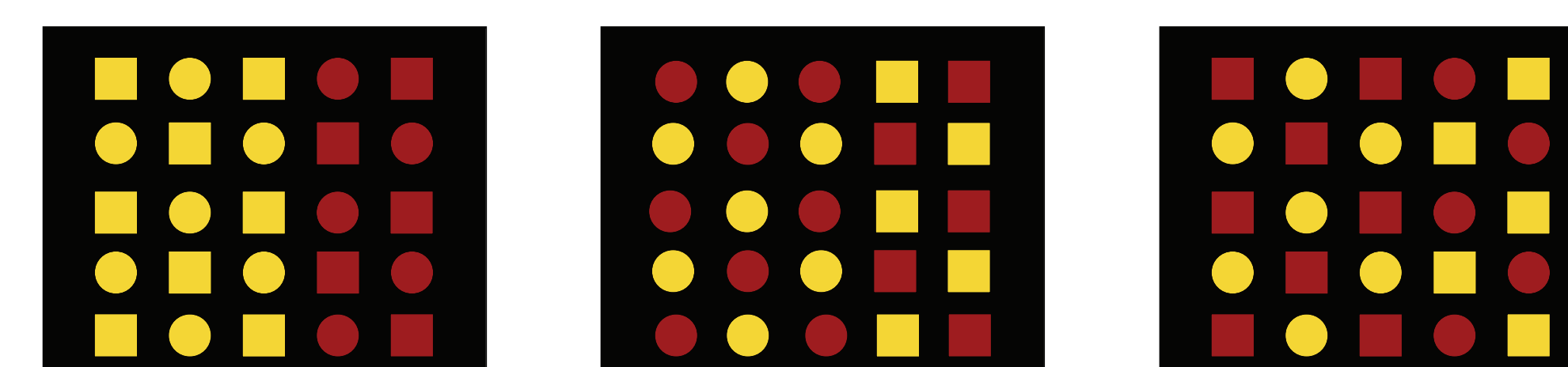


(1) Single dimension (2) Single dimension (3) Conjunction (Two dimensions)

- The subjects' task was to indicate whether the boundary, which could be between the second or third column or row, was vertical or horizontal.
- All displays were composed of the same four shapes; orientation and size of each shape varied randomly. Feedback was provided after each trial in the form of a green line over the correct divide.



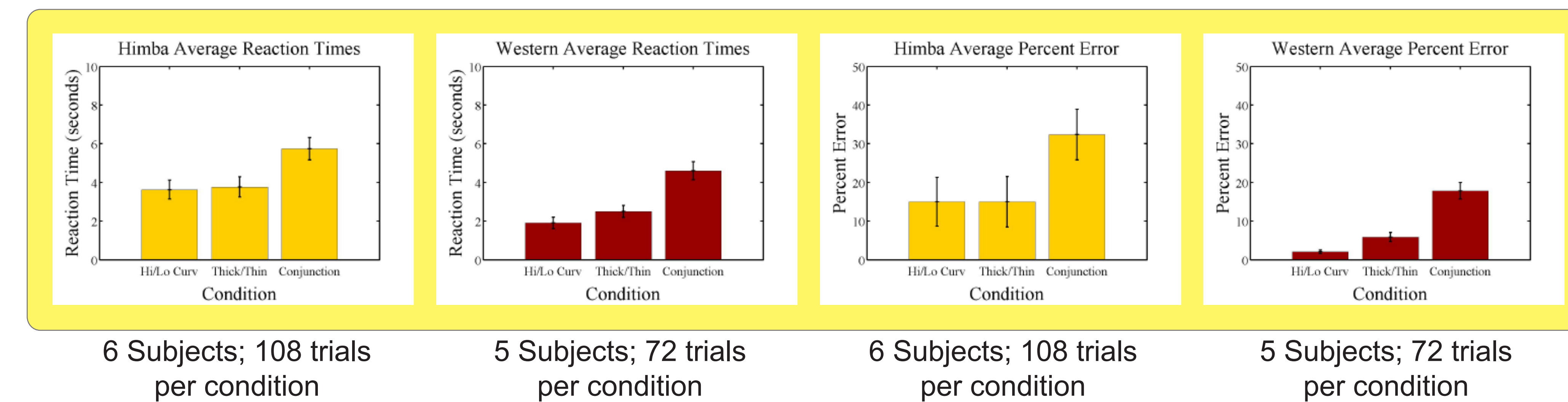
- Two independent dimensions (e.g. shape and color) produce a conjunction effect: the far right is much harder than the other two.



- If shape really is only one dimension, or if all shape dimensions are equal, all three conditions should be equally difficult.

Results

Reaction Times Tribe: ■ Himba ■ Trojans Error Rates



6 Subjects; 108 trials per condition

5 Subjects; 72 trials per condition

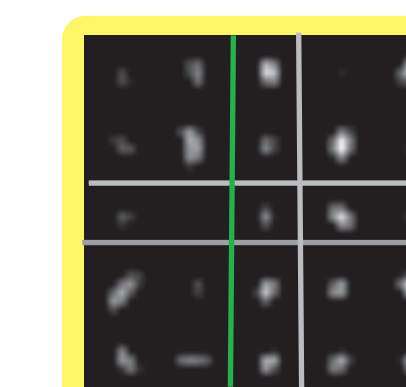
6 Subjects; 108 trials per condition

5 Subjects; 72 trials per condition

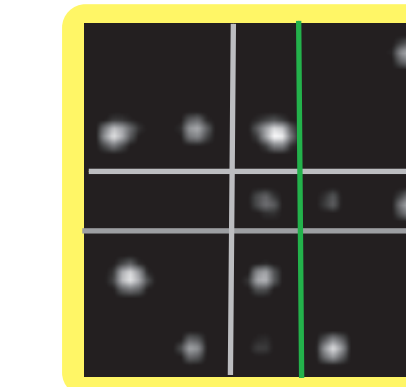
Could this effect be explained by low-level features (such as orientation and intensity)? Answer: NO

- We took orientation and intensity feature values from the Itti & Koch (2000) model of visual saliency, and used them to create a simple classifier.
- For each experimental image, the classifier compared the mean and variance of each side of the feature map given each possible divide, and chose the divide that gave the maximum difference (shown below in green).
- We also created an ideal observer model based on the same feature values.
- Neither model indicated that the conjunction condition was more difficult than the other two conditions.

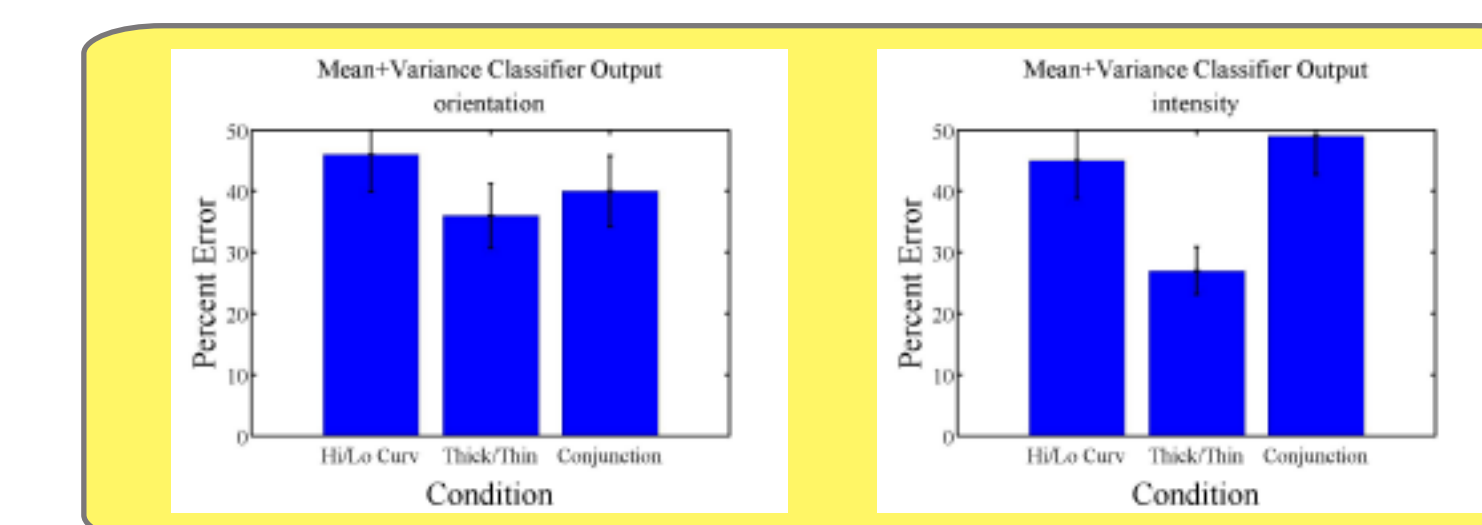
Intensity values (Example Image)



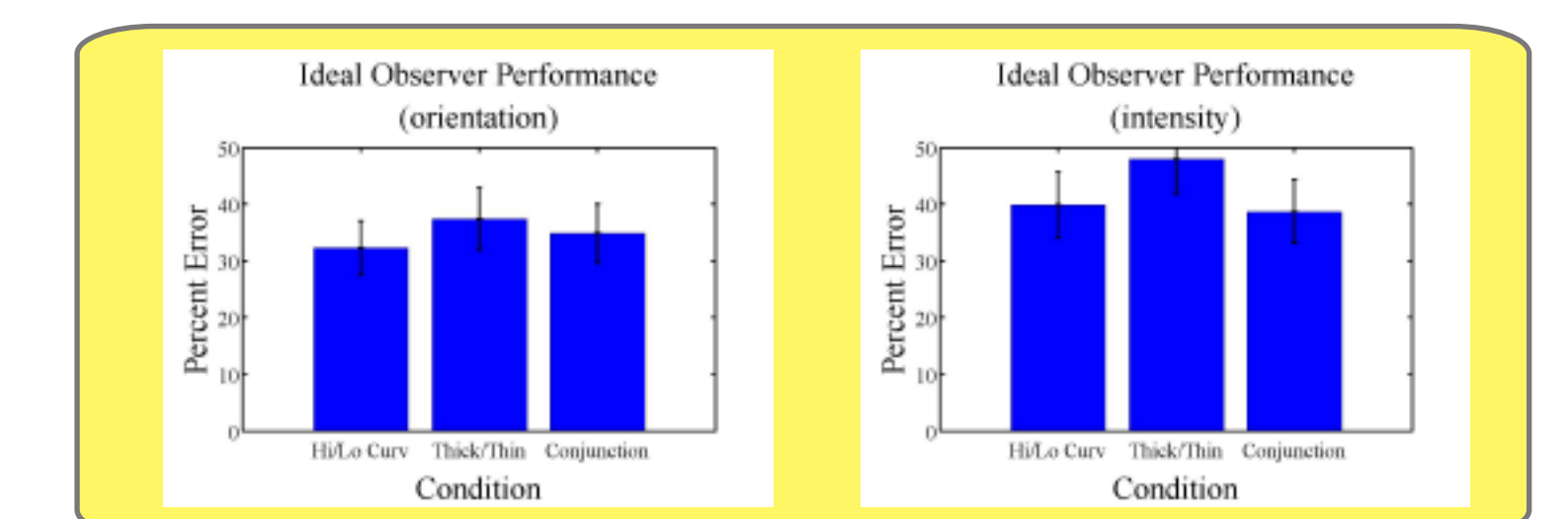
Orientation values (Example Image)



Classifier Performance: Near chance, without human-like ordering of conditions



Ideal Observer Performance: No difference between conditions



Conclusions

- For both Westerners (USC students) and the Himba, the conjunction task was markedly more difficult (higher error rates and longer RTs) than the single dimension tasks.
- The sensitivity of both the Himba and USC students to underlying dimensions of generalized cones suggests that such sensitivity does not require immersion in a geonic environment.