Visual perception of impossible geometries: local and global constraints in stereopsis

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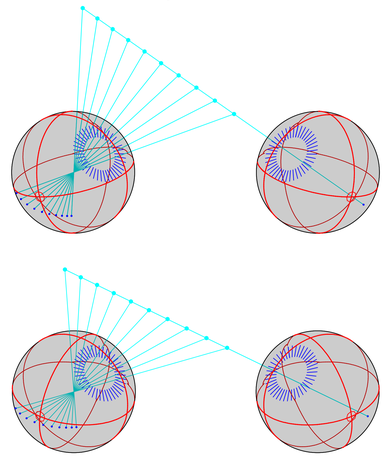
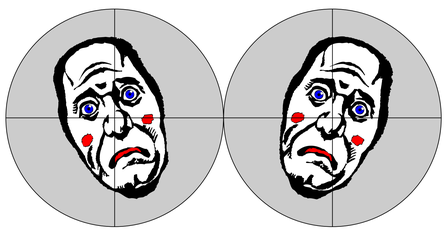
INTRODUCTION

- To achieve stereopsis, the brain must search for matching images on the two retinas---a complex task.
- Geometry restricts the matches to epipolar lines; if the brain could locate these lines, its search would be simplified.
- But epipolar lines move on the retinas when the eyes move, so locating them would require the brain to keep track of eye position.



- Stereopsis can work without *motor* or *proprioceptive* information about eye position.
- But the retinal images themselves contain eye-position information; e.g. if the images are cyclorotated, the eyes must be cycloverged.

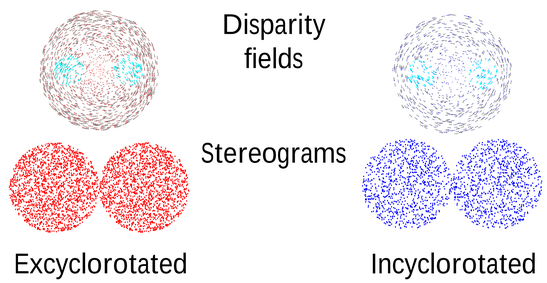


QUESTION

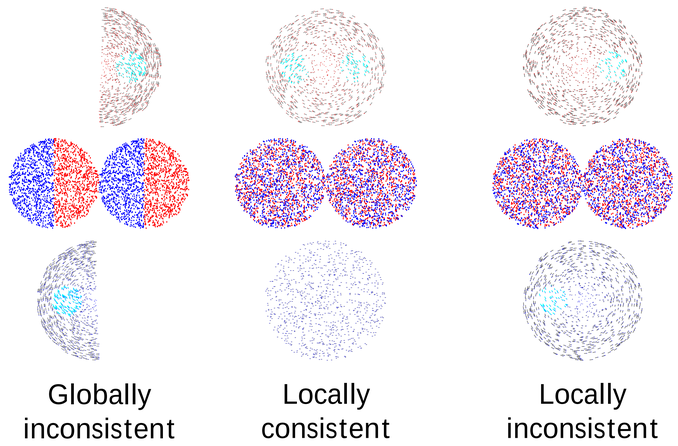
- Does the brain use 'visual bootstrapping': does it use a few matched elements to compute eye position so as to speed the search for other matches?

METHODS

- If matching works by bootstrapping, we should have trouble seeing 'impossible' stereograms that contain contradictory information about eye position.



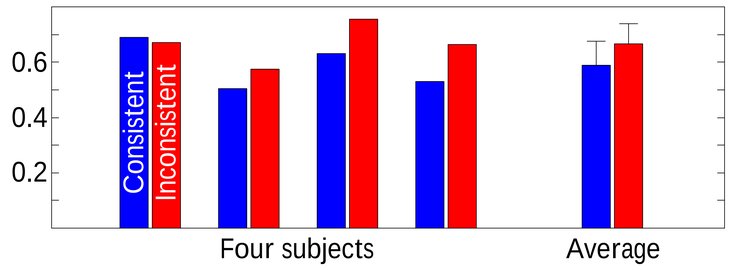
Globally consistent stimuli



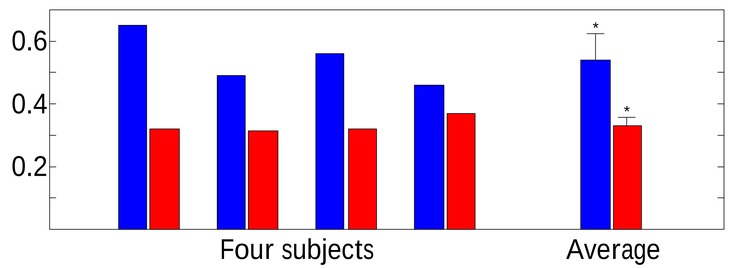
RESULTS

- When contradictory information is spatially segregated, stereopsis is unimpaired.
- When every region of the image contains contradictory information, stereopsis is impaired.

Percent correct answers, global stimuli



Percent correct answers, local stimuli



CONCLUSIONS

- The brain uses visual information about eye position to constrain stereo matching locally but not globally; i.e.
- It doesn't compute a single estimate of eye position that constrains matching over the whole visual scene.
- But local interactions in the matching algorithm favour nearby matches that are consistent with local information about eye position.