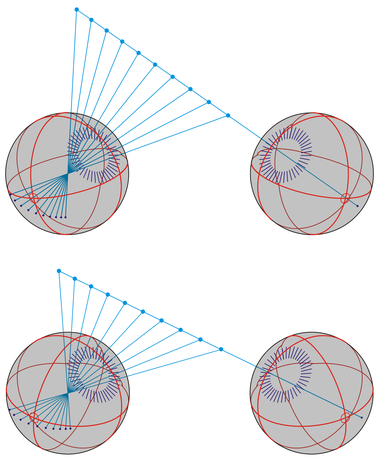
Visual bootstrapping in the stereovisual system

Kai M. Schreiber and Douglas B. Tweed

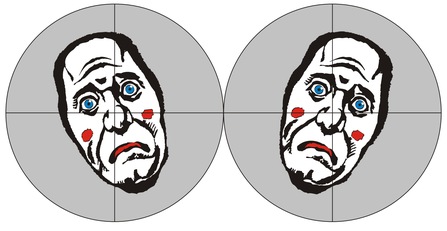
CIHR Group for Action and Perception; U. of Toronto; Centre for Vision Research, York U., Toronto

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.

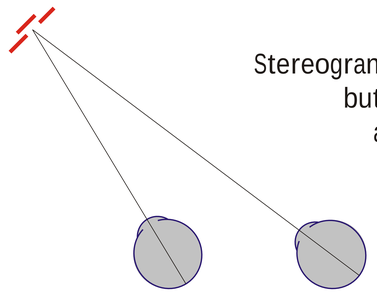


QUESTION

- 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?

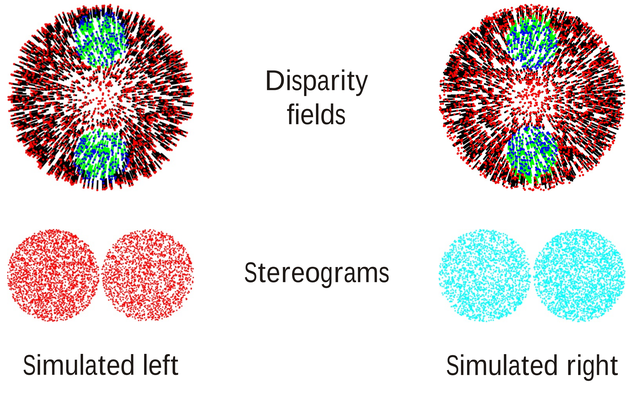
METHODS

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

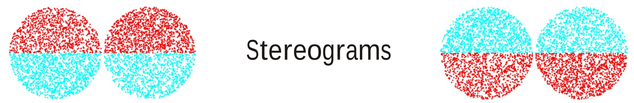


Stereograms are presented frontally but are computed to appear as though they were seen at a horizontal angle

Consistent stimuli

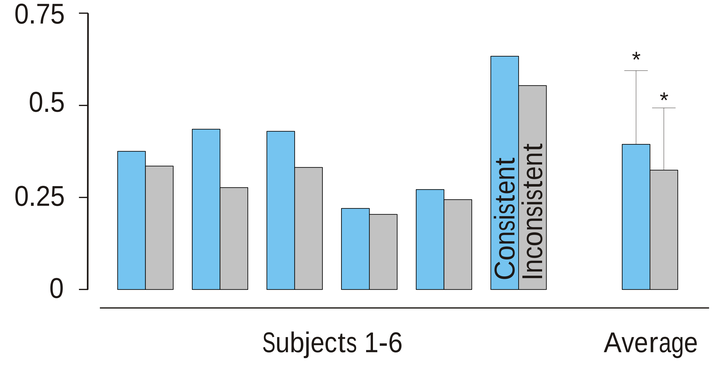


Inconsistent stimuli



RESULTS

- Stereopsis is worse ($p < 0.05$) when the image allows no consistent computation of eye position.



CONCLUSIONS

- The brain uses visual information about eye position to help stereopsis.
- Most likely it computes an estimate of eye position that constrains stereo matching.
- Matching is influenced by image geometry on remote parts of the retina, i.e. there is one global estimate of eye position, not separate estimates for different parts of the image.