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FEATURE CONTINGENT DEPTH AFTEREFFECTS SUPPORT A "SURFACE-BASED DEPTH" SYSTEM

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Introduction

What information does the visual system use to construct depth?

In addition to standard depth cues, images have properties which could aid in the segregation of surfaces.

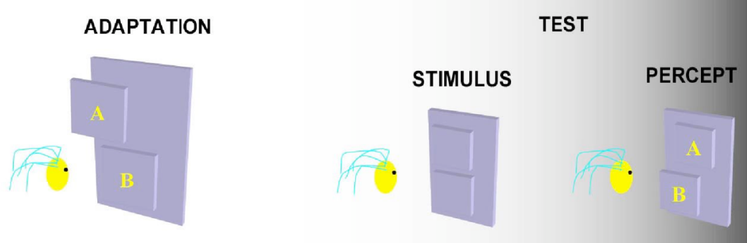
For instance, a statistical property of natural scenes is that regions composed of different features are likely to be associated with surfaces at different depths.

Feature contingent mechanisms

A resourceful depth system would exploit this regularity by combining information from feature and stereo-depth systems. Such a system would contain mechanisms sensitive to the conjunction of depth information and feature information. Our goal was to isolate these mechanisms psychophysically.

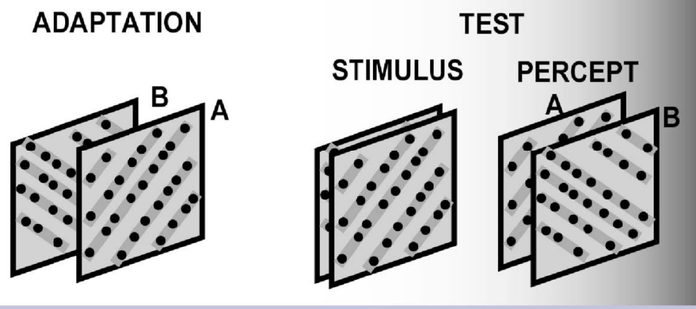
Depth aftereffects (Julesz)

Consider how disparity-tuned neurons were isolated psychophysically.
Prolonged exposure to a surface lying in depth produces a aftereffect
After adaptation, a test stimulus lying in the fixation plane is perceived to be either nearer or farther in depth, the reverse of the depth of the adapting stimulus.



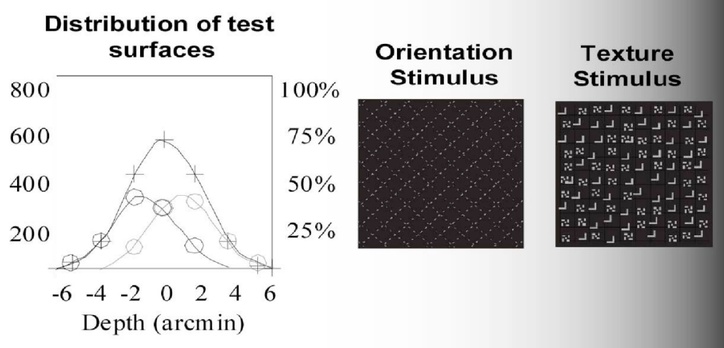
Feature contingent depth aftereffect

If feature-contingent mechanisms exist, then it should be possible to selectively adapt them, producing feature-contingent depth aftereffects. Adaptation to a surface, composed of a particular feature, appearing "in front" should influence the depth of a test surface composed of the same feature to appear "pushed back". Whereas, adaptation to a surface, composed of another feature, seen as lying "in back", should make a test stimulus of the same feature appear "pulled forward".

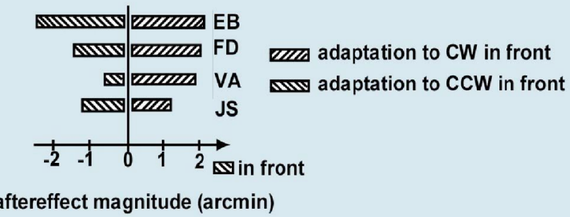


Stimuli

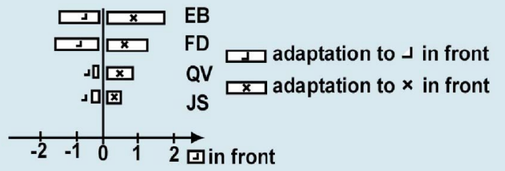
The surfaces in our displays were "transparent", defined only by hundreds of small dots. These dots were assigned disparities such that their distribution in depth was Gaussian. Different surface features were created by arranging the dots into an oriented pattern (clockwise (CW) or counter-clockwise (CCW) tilted lines), or a texture ("L" or "X" microelements). For the adapting stimulus, the surfaces had a considerable separation in depth (~8 arcmin). For the test stimulus, the two surfaces were actually interleaved in depth, forming a single unimodal distribution.



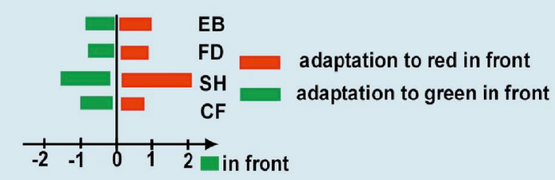
Orientation Contingent Depth Aftereffect Results



Texture Contingent Depth Aftereffect Results



Color Contingent Depth Aftereffect Results (Domini, Blaser, Cicerone, 2000)



Conclusions

Orientation-, texture and color-contingent depth aftereffects show that feature and depth information are co-processed. We speculate that the contingent aftereffects produced by prolonged exposure to feature-depth combinations reflect the adaptation of a general-purpose "Surface-based Depth" system, responsible for recognizing that two regions at different depths are more likely to belong to different surfaces if they also differ in some feature property.