Sensitivity to 3D Orientation in Textured Surfaces

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General Goal of Data Visualization

Improve clarity, increase expressive power in visualization of large, complex, multidimensional data sets
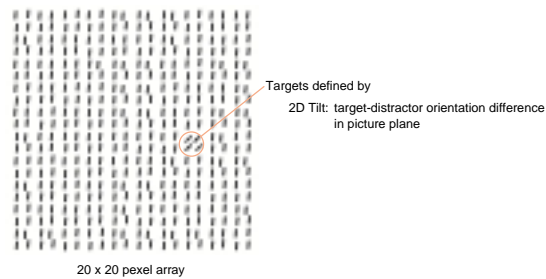
Current Goal

Facilitate data visualization via oriented rectangular elements (pexels)

Perception Background

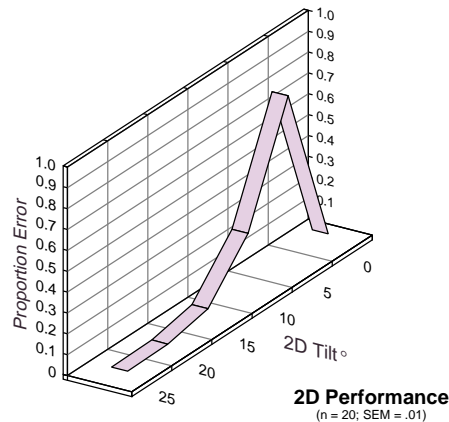Visual search based on 3D orientation can be preattentive (Enns & Rensink, Psychological Science, 1990)
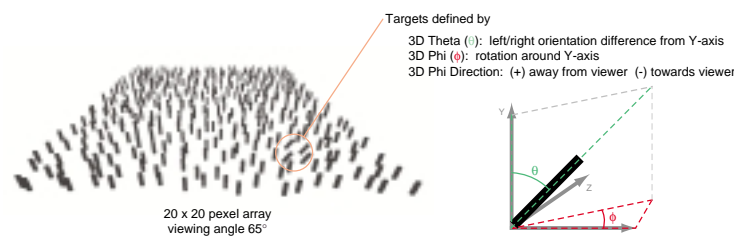
## I. Human Sensitivity to Oriented Pexels

Flat (2D) Arrays

Targets defined by
2D Tilt: target-distractor orientation difference in picture plane

20 x 20 pexel array

- 15° orientation differences improve detection by 57%

2D Performance
(n = 20; SEM = .01)

Slanted (3D) Arrays

Targets defined by
3D Theta (θ): left/right orientation difference from Y-axis
3D Phi (φ): rotation around Y-axis
3D Phi Direction: (+) away from viewer (-) towards viewer

20 x 20 pexel array
viewing angle 65°

- 15° differences in theta *improve* detection by 48%
- 15° differences in phi *impair* detection by 4.5%
- near locations are 12% more accurate than far locations

3D Performance
(n = 30; SEM = .005)
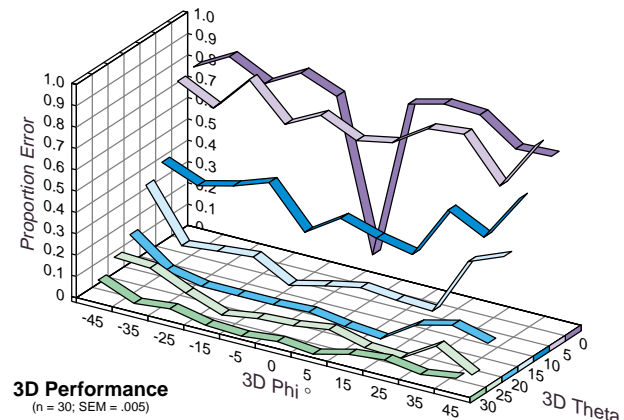
II. Is Detection Based on 2D or 3D Orientation?

Multiple Regression Approach

4 Factors:
- 2D Tilt
- 3D Theta
- 3D Phi
- 3D Phi Direction

Results:
- all 4 factors explain 86% of detection variance . . . but only 3D Theta & 3D Phi are significant
- 2 factor regression model still explains 86% of variance
- 2D Tilt unnecessary in model!

Conclusions

Similar sensitivity to 2D and 3D orientation

Pexel detection is based on 3D representation
(2D Tilt in image contributes nothing)

Unique issues of 3D displays
- foreshortening impairs search (3D Phi result)
- near locations yield better sensitivity than far locations

Future Work

How to enhance 3D displays for even greater sensitivity?
(e.g., shading, stereo, motion parallax)

Active vs. passive viewing of depicted surfaces?