Feature Integration Theory

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Course: SE367

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Feature Integration Theory

Treisman, Sykes, & Gelade, 1977

Features are registered early, automatically, and in parallel across the visual field, while objects are identified separately and only at a later stage, which requires focused attention.

Feature

luminance

color

orientation

motion detection

velocity

form

FIT domain of application

Visual search

Serial search: One item at a time.

Parallel search: processing involves allocating points to objects in order to recognize them

Metaphor of Human Visual Attention

Near distracters produce interference

Distant distractors fall outside spotlight => not identified.

Criticism:

Distant distracters suffer from reduced acuity. [1]

[1] Hagenaar and Van der Heijden (1986)

Qualitative representation of the perceived image

(a) Image of a text displayed on a standard video monitor

(b) the simulated acuity depending on the gaze and eccentricity

Feature extraction and integration

The taxi above fixation cross is easier to read

Feature extraction is easier in less crowding

Crowding

Top-Down is attentional

cued

Serial processing

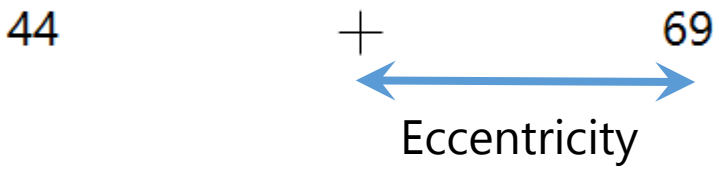
Bottom-Up is pre-attentional*

un-cued

Parallel preocessing

*Pre-attentive processing is the unconscious accumulation of information from the environment

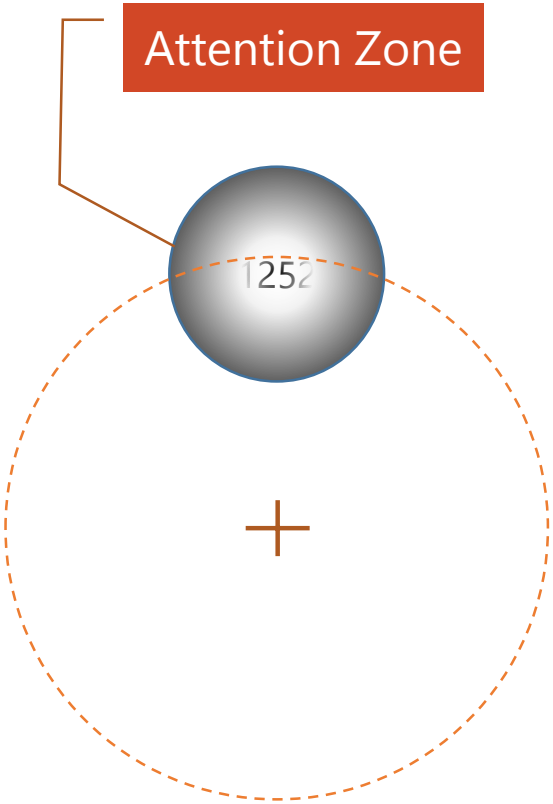
Term



Proposed idea

There is a attention spotlight

Identify the accuracy of subjects in identifying random numbers.



Experiment

Cohort of collage students

Random numbers flashed

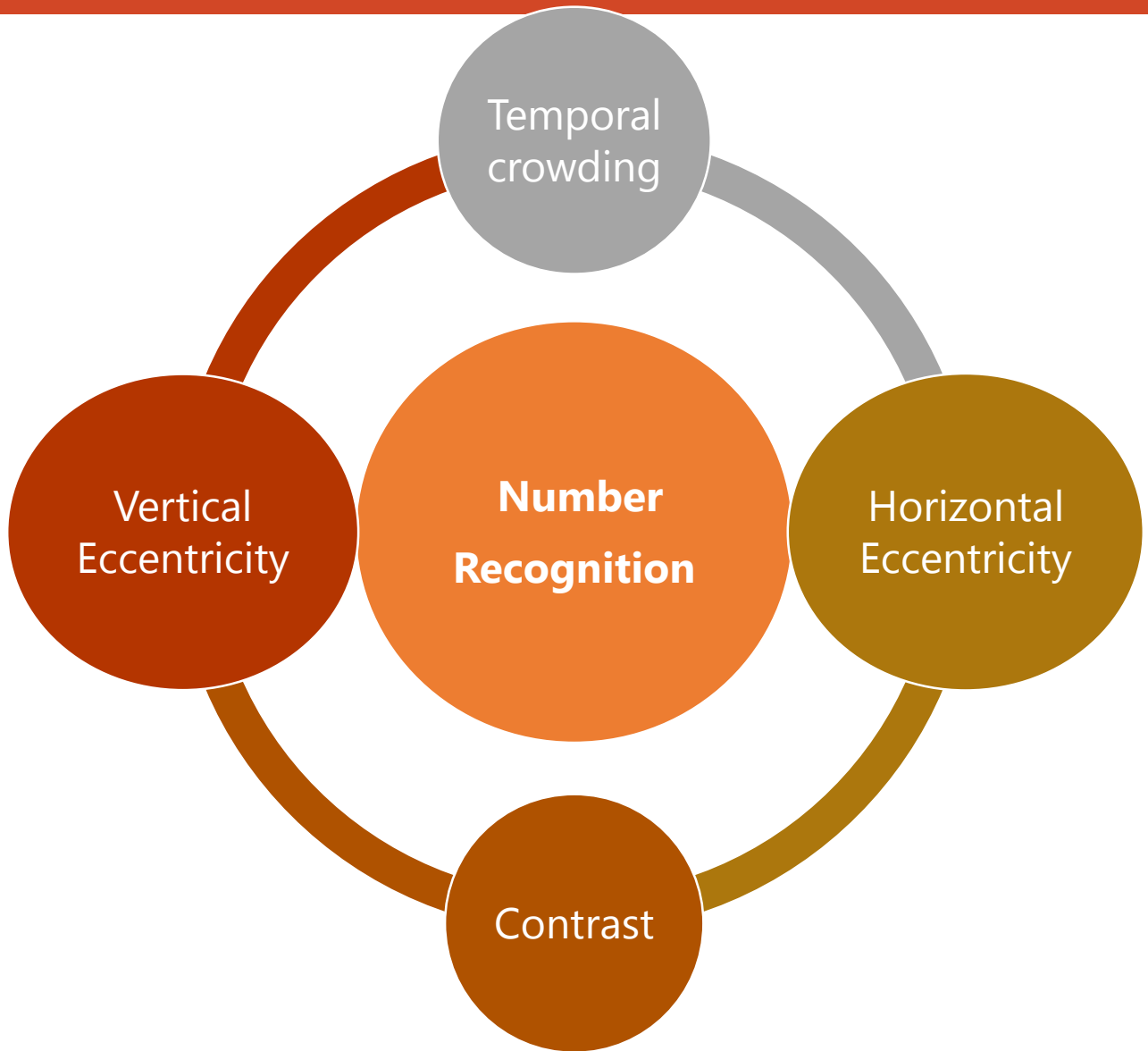
Accuracy of judgment noted

Results analyzed

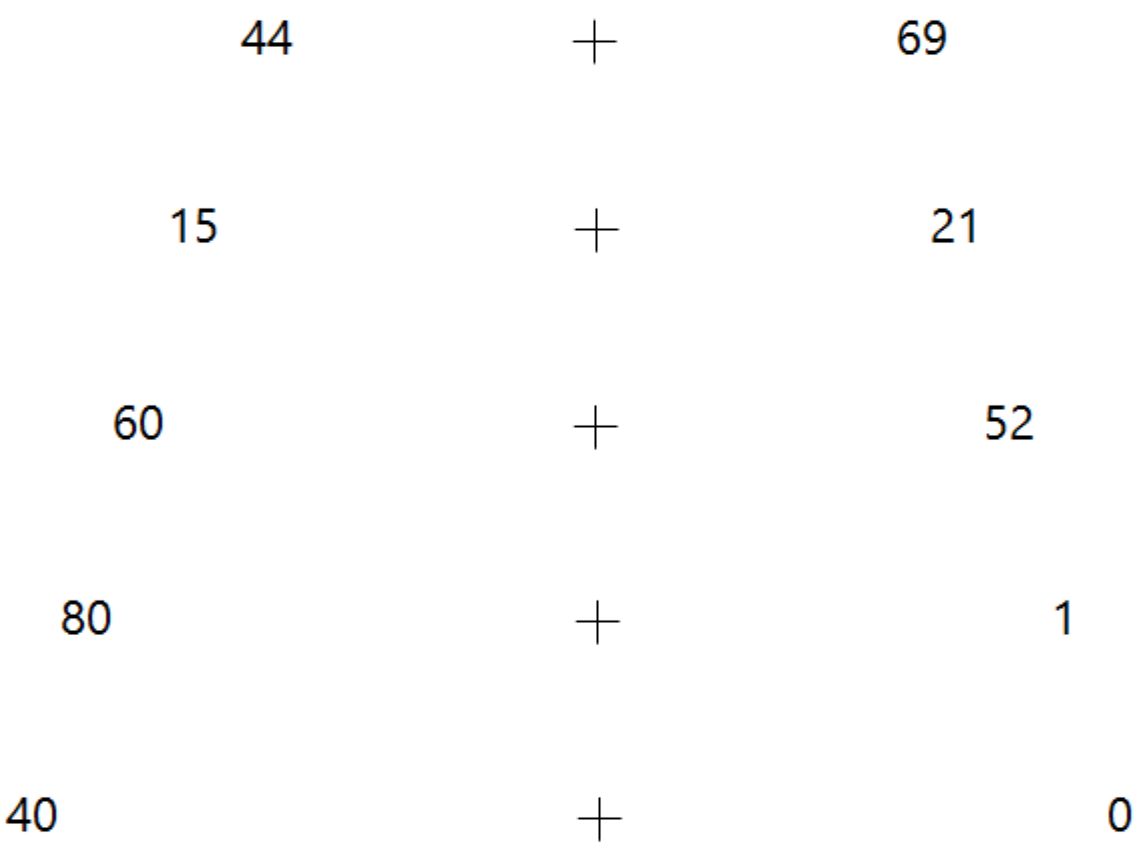
Take a standard reading speed test

Link to the program

Parameters in feature extraction process



Sample screen shots
Parameter varied: eccentricity in Horizontal direction direction



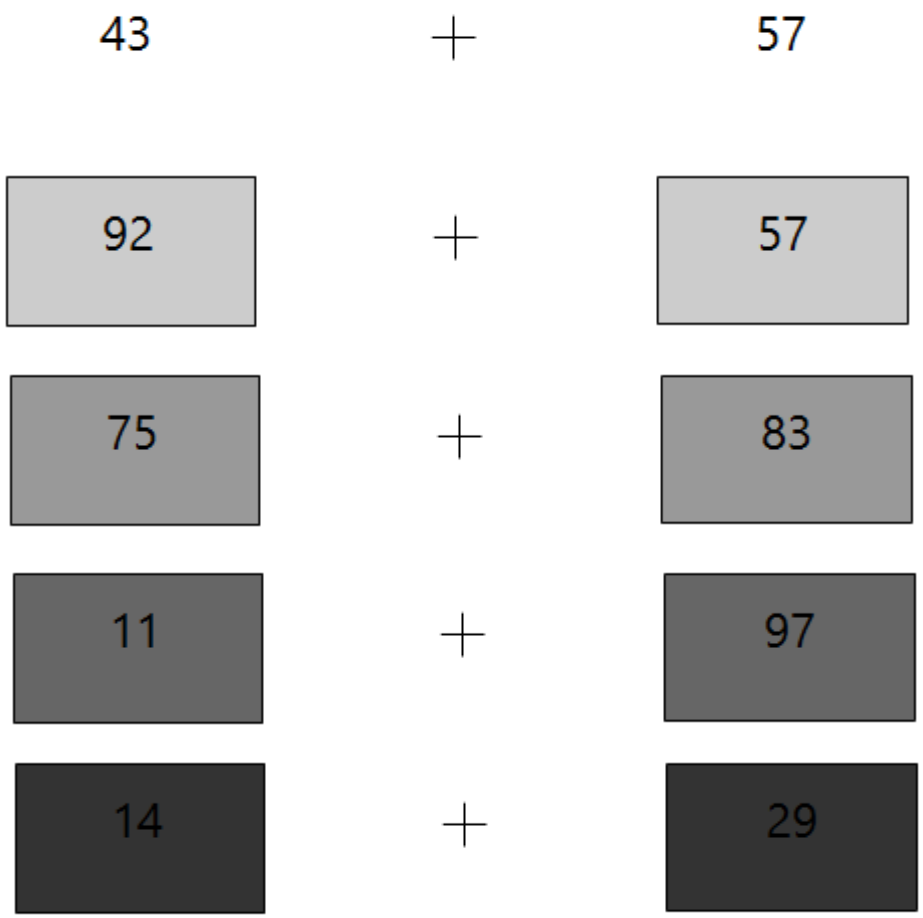
Sample screen shots
Parameter varied: eccentricity in vertical direction

Previous works done by Pelli et al.

Takes into account only the contrast of the distractors.

Pelli D G., Melanie Palomares, Najib J. Majaj.
Crowding is unlike ordinary masking: Distinguishing feature integration from detection. Journal of Vision(2004)

Sample screen shots
Parameter varied: Contrast as noise



Limitations

Subject may not faithfully look at the Fixation cross

Subject must maintain a constant distance form the Screen

Expectation

Vertical-horizontal asymmetry

Predict reading speed of the subject

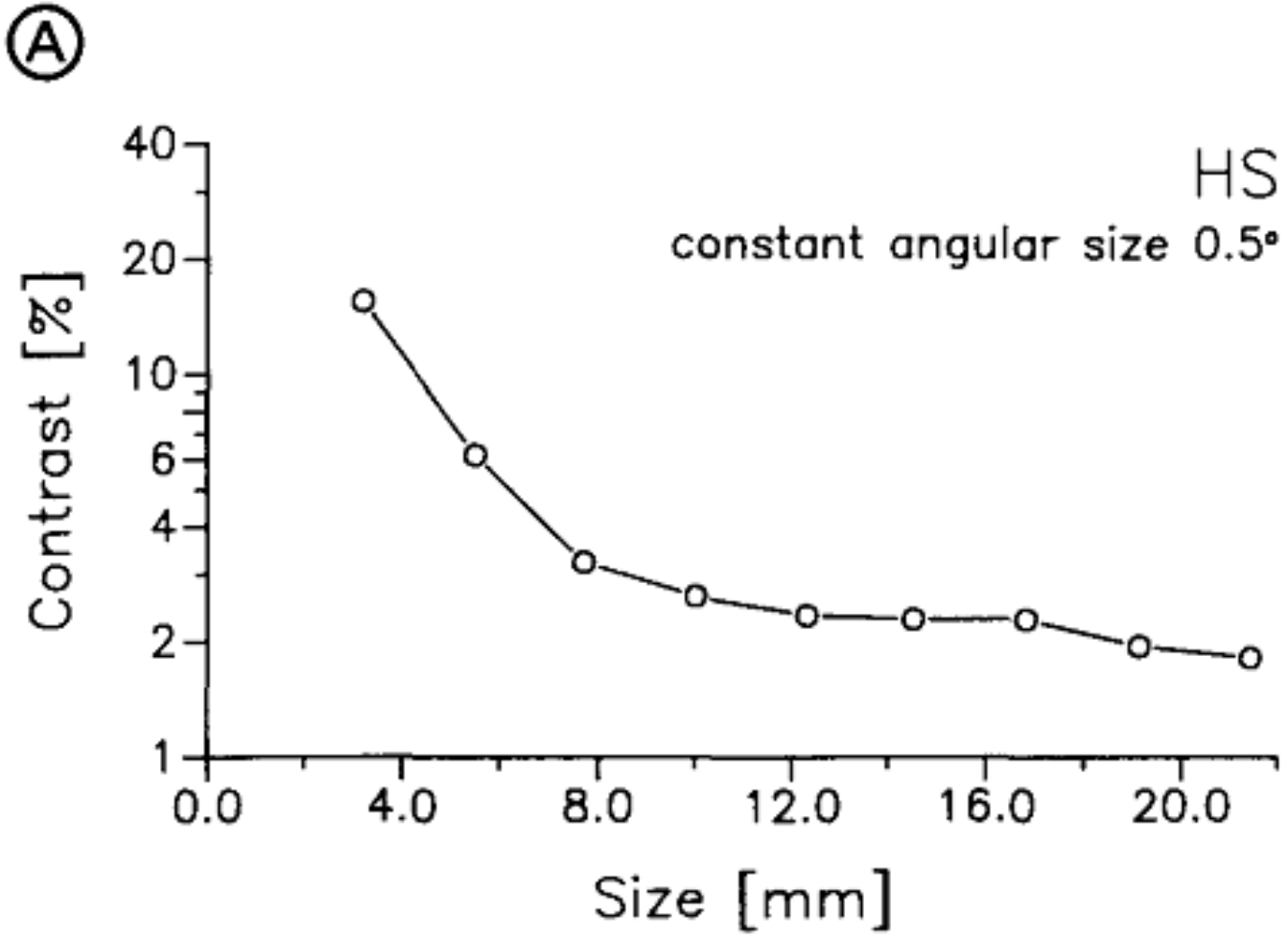
References

1. Van den Berg R, Roerdink JBTM, Cornelissen FW (2010) A Neurophysiologically Plausible Population Code Model for Feature Integration Explains Visual Crowding. PLoS Comput Biol 6(1): e1000646. doi:10.1371/journal.pcbi.1000646
   - These guys have conducted experiments that have a target and crowding is limited only to the flanker surrounding the target. Flanker's angle, number and target eccentricity have been changed.
2. Freeman, J., & Pelli, D. G. (2007). An escape from crowding.Journal of Vision, 7(2):22, 1–14, http://journalofvision. org/7/2/22/, doi:10.1167/7.2.22.
   - This paper is essentially an experimental study with scope being that crowding and cueing are the only two variable that have been varied across the subject's tests. They have tested with letters and foreign language letters.
3. EndelPo˜der. Crowding, feature integration, and two kinds of "attention".Journal of Vision(2006) 6, 163–169
   - In this paper the 3 experiments have been performed, each with increasing complexity of design. First has only color difference between distractors and target. Second has a unit cell of different kind spread over space crowding the target. Third has a combination of both above experiments color change and shape change.
4. Pelli D G., Melanie Palomares, Najib J. Majaj. Crowding is unlike ordinary masking: Distinguishing feature integration from detection. Journalof Vision(2004) 4,1136-1169
   - Very through study taking into account various parameters like spacing, eccentricity, size of target and flanker, font, number of flankers, flanker contrast, identification and detecting.
5. Jean-Baptiste Bernard et al , Navisio: Towards an integrated reading aid system for low vision patients.
   - Image credits for the image on slide 7

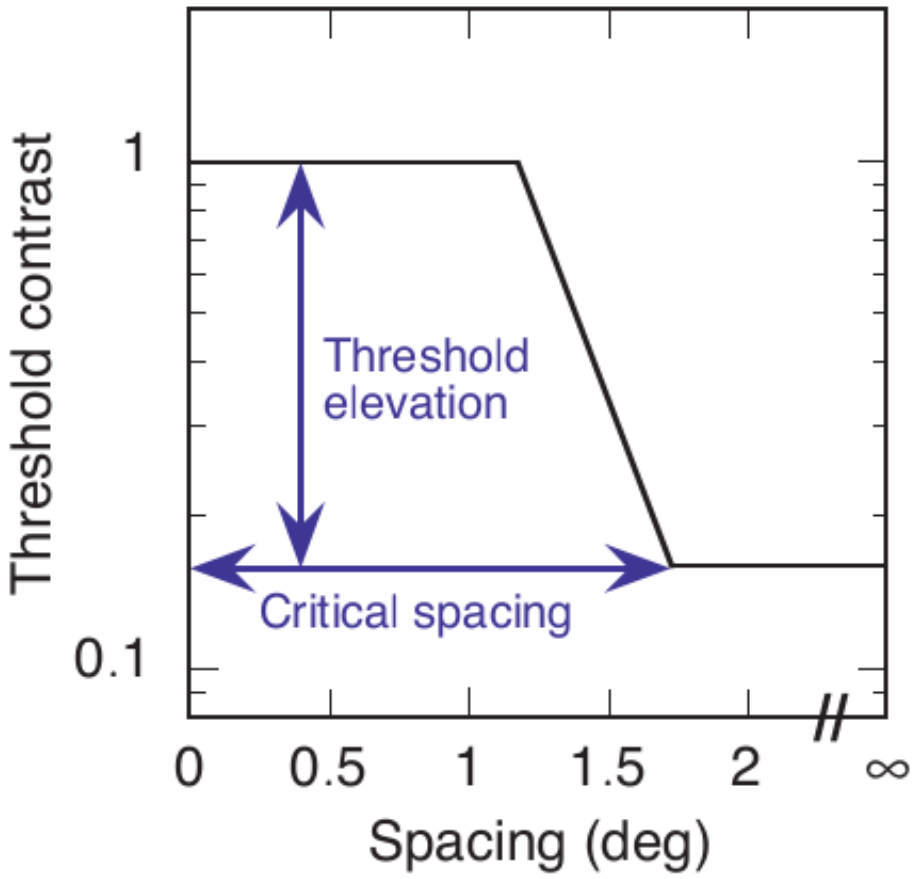
THANK YOU

QUESTIONS?

Threshold contrast



Background pictures



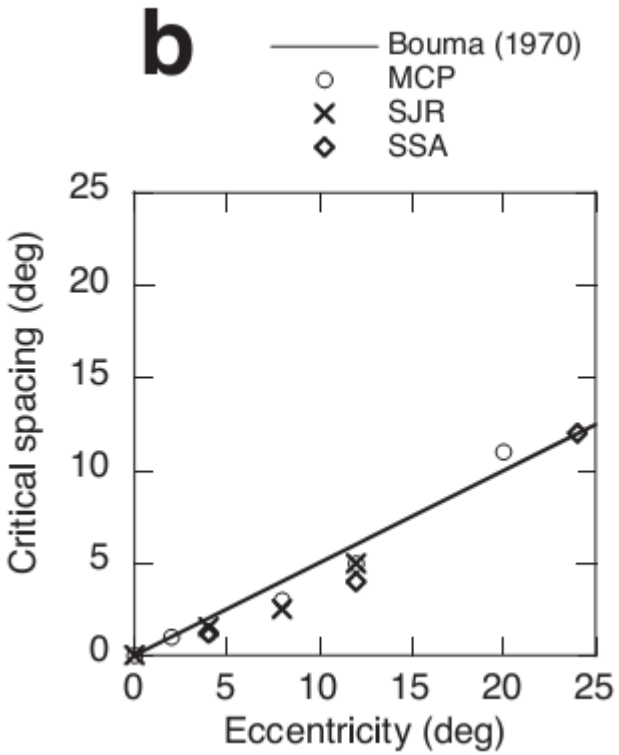
Clipped line fit: threshold contrast as a function of center-to-center spacing of signal and flanker

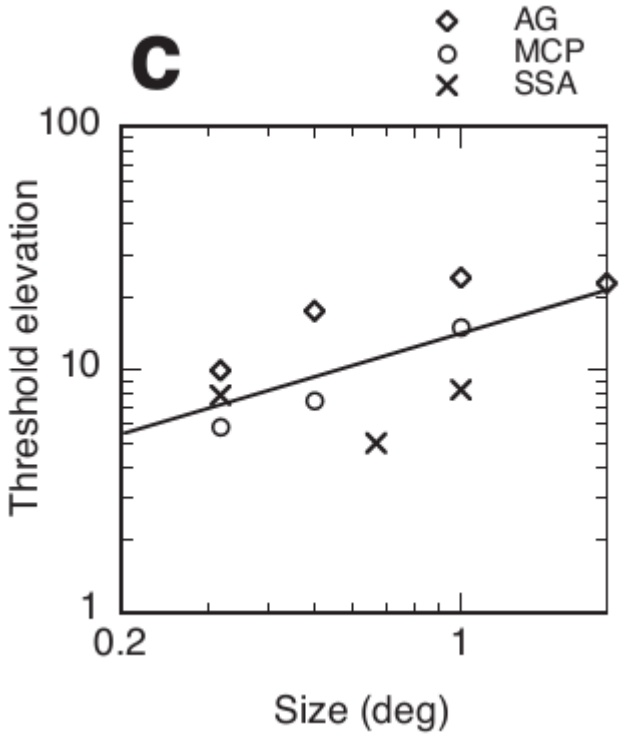
Threshold elevation is the ratio of thresholds at zero and infinite flanker spacing (i.e., ceiling: floor ratio). Critical spacingis the least spacing at which there is no threshold elevation (i.e., edge of the floor).

Pelli D G., Melanie Palomares, Najib J. Majaj. Crowding is unlike ordinary masking: Distinguishing feature integration from detection. Journalof Vision(2004) 4,1136-1169

Effects of spacing and eccentricity and size

Critical spacing is proportional to eccentricity (critical spacing is roughly half of the viewing eccentricity)

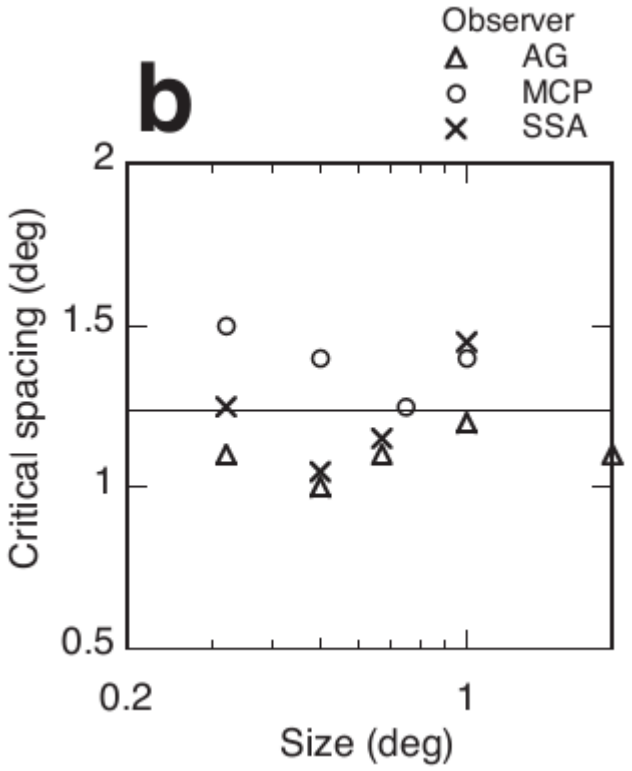




Threshold elevation increases somewhat with size: log-log slope of 0.6

Effect of flanker size

The range (spatial extent) of crowding is independent of signal size (Figure 1) and mask size, depending solely on eccentricity (Figure b on previous page).



Effect of font and complexity

Figures 1 and 1 plot critical spacing and threshold elevation as a function of complexity, showing no systematic effect of complexity.

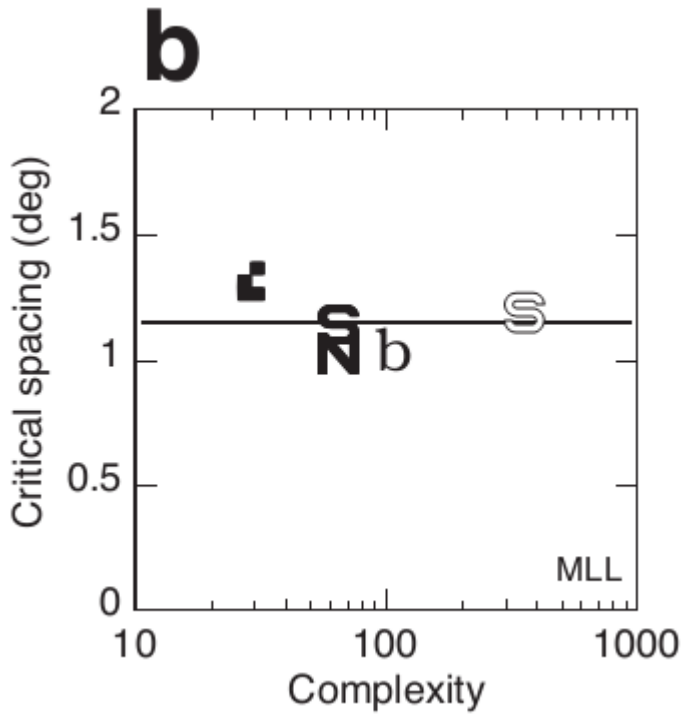


Figure 1

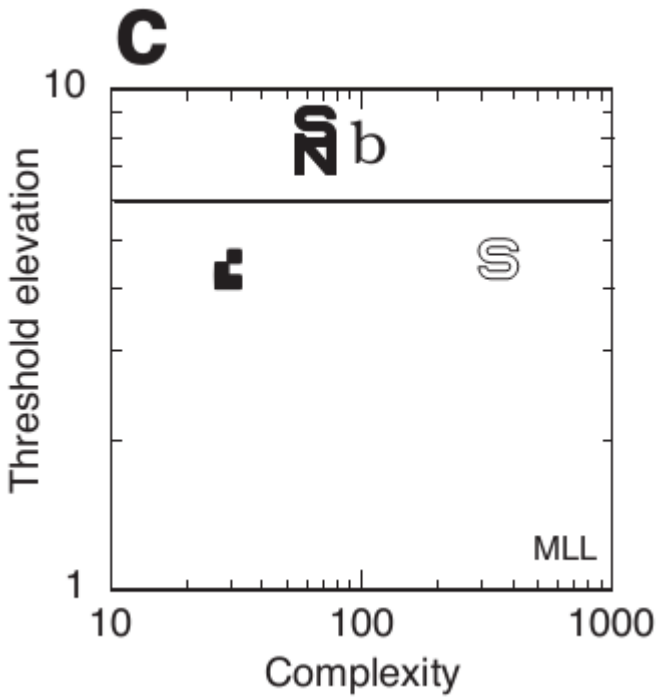


Figure 2

Effect of number of flankers

Figure below shows that critical spacing is independent of number of flankers.

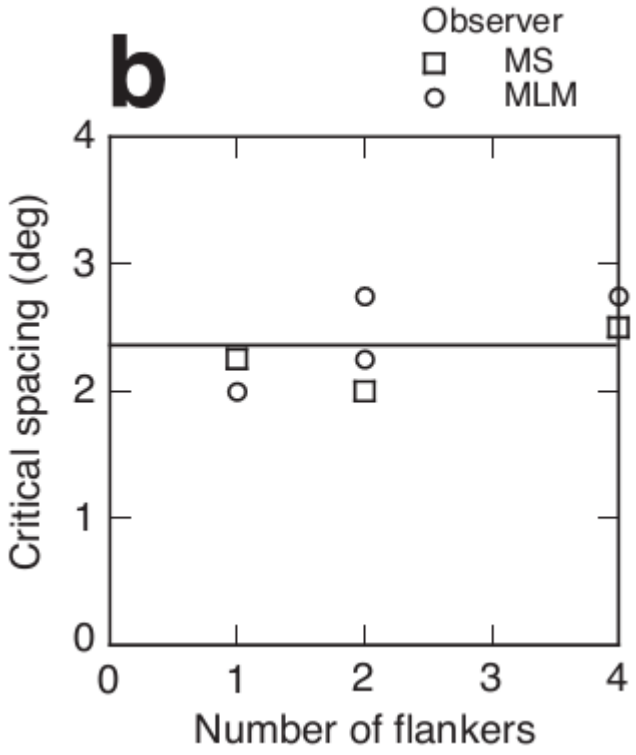


Figure 8cshows that threshold elevation increased when flankers were increased from 1 to 2, but threshold was not further elevated when flankers were increased from 2 to 4