Noise masking and crowding reveal two very different kinds of spatial integration

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Demos

Masking

Identification becomes harder as the noise radius grows, up to a point. We call that radius the *masking distance*.

Crowding

Identify the middle digit in each triplet. Triplets on the right are smaller but have larger spacing, so you'll have the same thresholds for both sides when you're limited by crowding.

Question

Is there a universal mechanism that captures how the visual system integrates information over space?

Introduction

Contrast → Spatial integration → Masking

Features → Spatial integration → Crowding

Methods

Masking

Design: Superimpose Gaussian noise. Manipulate letter size, noise radius and eccentricity.

Task: Identify the letter.

Measure *masking distance*: radius beyond which further noise no longer increases threshold.

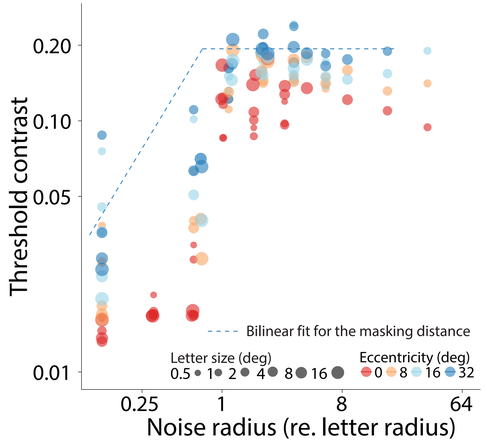
Crowding (published data, Pelli et al. 2016)

Design: Manipulate letter size, letter spacing and eccentricity.

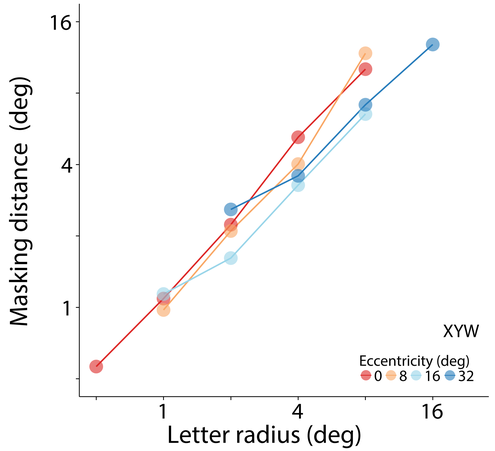
Task: Identify the middle letter.

Measure *crowding distance*: minimal center-to-center spacing between letters that still permits identification.

Results

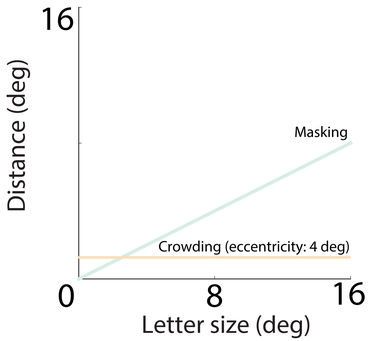


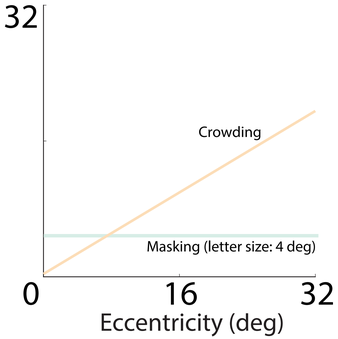
For each eccentricity and letter size, we observe a saturation of masking. Dashed line is the fit for the largest letter at largest eccentricity.



Masking distance is nearly equal to letter radius, independent of eccentricity.

Discussion





Crowding distance is roughly 0.15 deg at fovea (Pelli et al. 2016) and is independent of letter size.

Masking distance roughly equals letter radius, and is independent of eccentricity.

The ratio of crowding to masking distance ranges widely, e.g., from just 2 for a 0.3 deg letter at 1 deg eccentricity, to 10 for a 2 deg letter at 32 deg eccentricity.

Conclusion

- The mechanism of spatial integration is very different in masking and crowding.
- Letter size, eccentricity and spacing determine which mechanism dominates.

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Citation

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Reference

Pelli, D. G., Waugh, S. J., Martelli, M., Crutch, S. J., Primativo, S., Yong, K. X., Rhodes, M., Yee, K., Wu, X., Famira, H. F., & Yiltiz, H. (2016) A clinical test for visual crowding. F1000Research 5:81

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