Size of attentional suppressive surround

Sang-Ah Yoo[1, 4], John K. Tsotsos[2, 4], & Mazyar Fallah[3, 4, 5]

1. Department of Psychology, York University, Toronto, ON, Canada
2. Department of Engineering and Computer Science, York University, Toronto, ON, Canada
3. School of Kinesiology and Health Science, York University, Toronto, ON, Canada
4. Centre for Vision Research, York University, Toronto, ON, Canada
5. Canadian Action and Perception Network, York University, Toronto, ON, Canada

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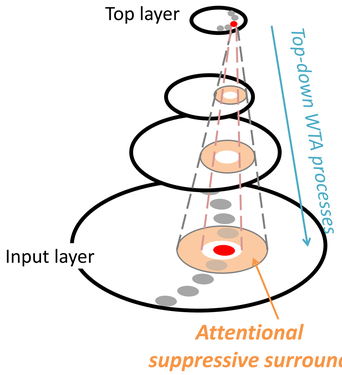
Introduction

- The Selective Tuning model of visual attention (Tsotsos et al., 1995; Tsotsos, 2011) predicts that spatial visual attention, for tasks requiring stimulus localization, has a center-surround organization with the surround being suppressive.
- Evidence has accumulated that supports this (e.g., Cutzu & Tsotsos, 2003; Hopf *et al*., 2006; Carrasco, 2011).
- The question of how the size of attentional suppressive surround is determined remains.
- If understood, the impact of experimental design as well as more practical applications, such as UI layout, would be significant.

Spatial selection component of the Selective tuning model



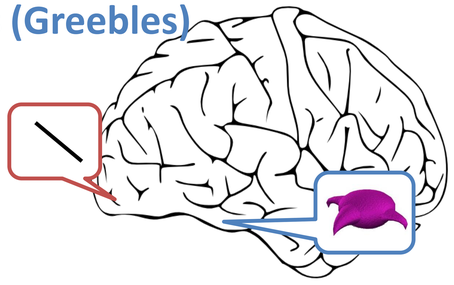
- In the process to localize the attended item, winner-take-all processes prune away irrelevant connections in top-down fashion.
- The pruned connections create a *suppressive surround* for the attended item.
- Connections located far from the attended item are not affected.

Prediction: *"The SIZE of the (suppressive) surround is determined by the attended neuron. … The SIZE of that RF is what sets the extent of the surround." (Tsotsos, 2011)*

Q. Does the size of attentional suppressive surround change depending on the level of the attended feature in the processing hierarchy?

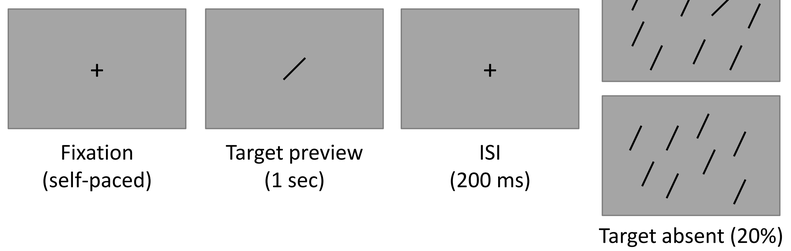
Size of attentional suppressive surround

Orientation < 3D objects (Greebles)



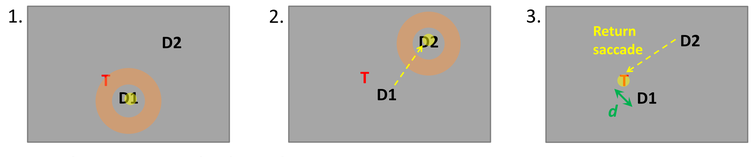
Visual search

4 complete, 3 in progress
Set size = 16,
Orientation 1 deg, Greebles 3 deg (Rolls et al., 2003)



Finding return saccades

Saccades that quickly return to the target from a distant distractor



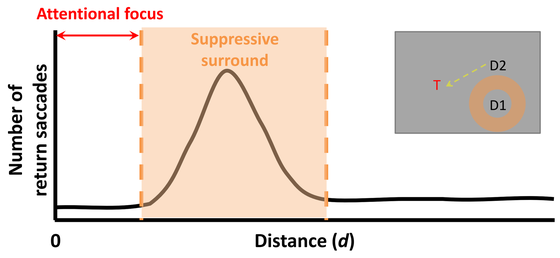
1. Looking at D1 which is close to T

→ *T is under the suppressive surround of D1, so neglected*

2. Make another saccade to D2 and suppressive surround moves
3. T is released and a return saccade occurs

❖ ***When a return saccade occurs, measure the distance between T and D1***

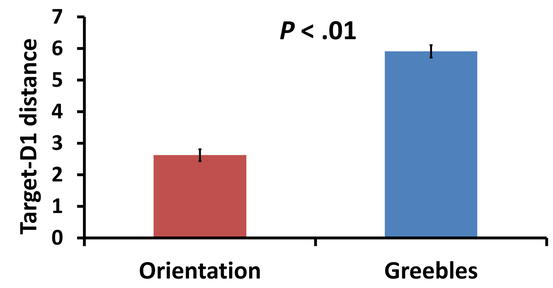
Theoretical distribution of return saccades



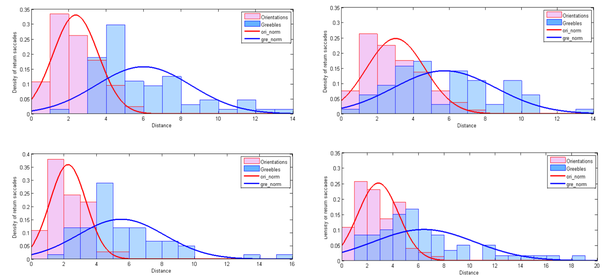
If target-D1 distance is *closer*, target will be easily detected
→Target is in the **attentional focus** of D1, so no return saccades occur
Whereas, if target-D1 distance is *greater*, target will not be under the suppressive surround of D1
→ Not considered as a return saccade

Size of attentional suppressive surround

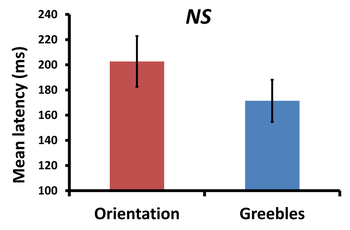
Orientation: 7~17 sessions (m = 13)
Greebles: 12~21 sessions (m = 14.5)

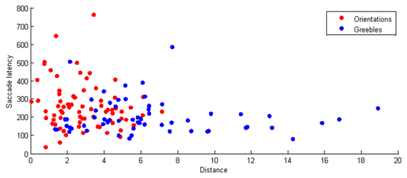


Empirical distribution of return saccades
Orientation: μ = 2.62, σ = 1.38 // Greebles: μ = 5.91, σ = 2.99



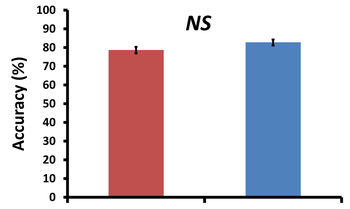
Latency of return saccades

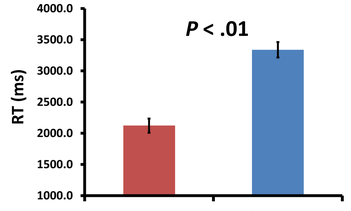




No correlation between latency and distance

Mean accuracy and RT





Summary

Larger suppressive surround for Greebles than orientation:
The level in the feature processing hierarchy determines the size of attentional suppressive surround.
It is necessary to consider the complexity of items to determine spacing between them.

References
Carrasco, M. (2011). Visual attention: The past 25 years. *Vision research, 51*(13), 1484-1525.
Cutzu, F., & Tsotsos, J. K. (2003). The selective tuning model of attention: psychophysical evidence for a suppressive annulus around an attended item. *Vision research*, *43*(2), 205-219.
Hopf, J. M., *et al.* (2006). Direct neurophysiological evidence for spatial suppression surrounding the focus of attention in vision. *Proceedings of the National Academy of Sciences of the United States of America*, *103*(4), 1053-1058.
Rolls, E. T., *et al.* (2003). The receptive fields of inferior temporal cortex neurons in natural scenes. *The Journal of Neuroscience*, *23*(1), 339-348.
Tsotsos, J. K. (2011). *A computational perspective on visual attention*. MIT Press.
Tsotsos, J. K., *et al.* (1995). Modeling visual attention via selective tuning. *Artificial intelligence*,*78*(1), 507-545.