Can Attention Filters for Spatial Frequency Be Sharpened through Training?

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Feature-Based Attention

- Human observers are able to distribute their attention broadly across space for purposes of picking out some sorts of information and ignoring others
- Attention of this sort is called “feature-based” attention (FBA)

Feature-Based Attention Example

- When you scan a bookshelf searching for a book whose cover you know is blue, you are using "feature-based attention" (FBA) to heighten the salience of the blue items in your visual field relative to items of other colors.

Literature Review

- Ball & Sekuler (1981) and Baldassi & Verghese (2005) confirm our ability to deploy FBA

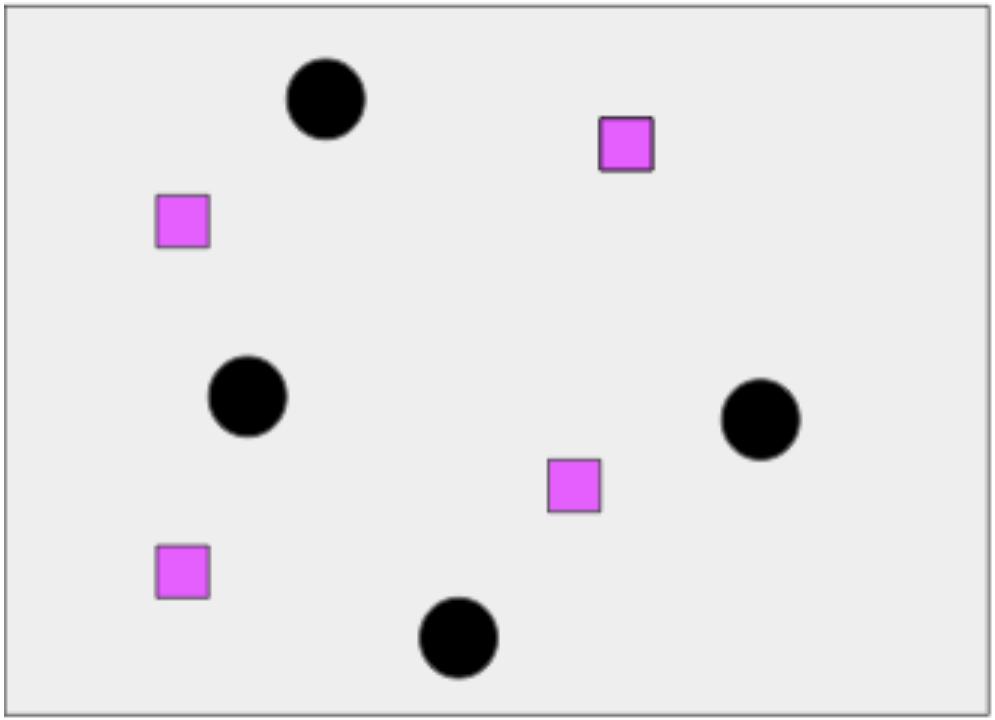
- Sun et al. (2015) described the centroid paradigm, a method for studying FBA

Centroid Paradigm

- This experiment adopts the centroid paradigm
- In the centroid task the subject is required to find the center-of-gravity of a subset of stimuli defined by a specified target property.

Example of a Centroid Task

Find the centroid of the squares



Example of a Centroid Task

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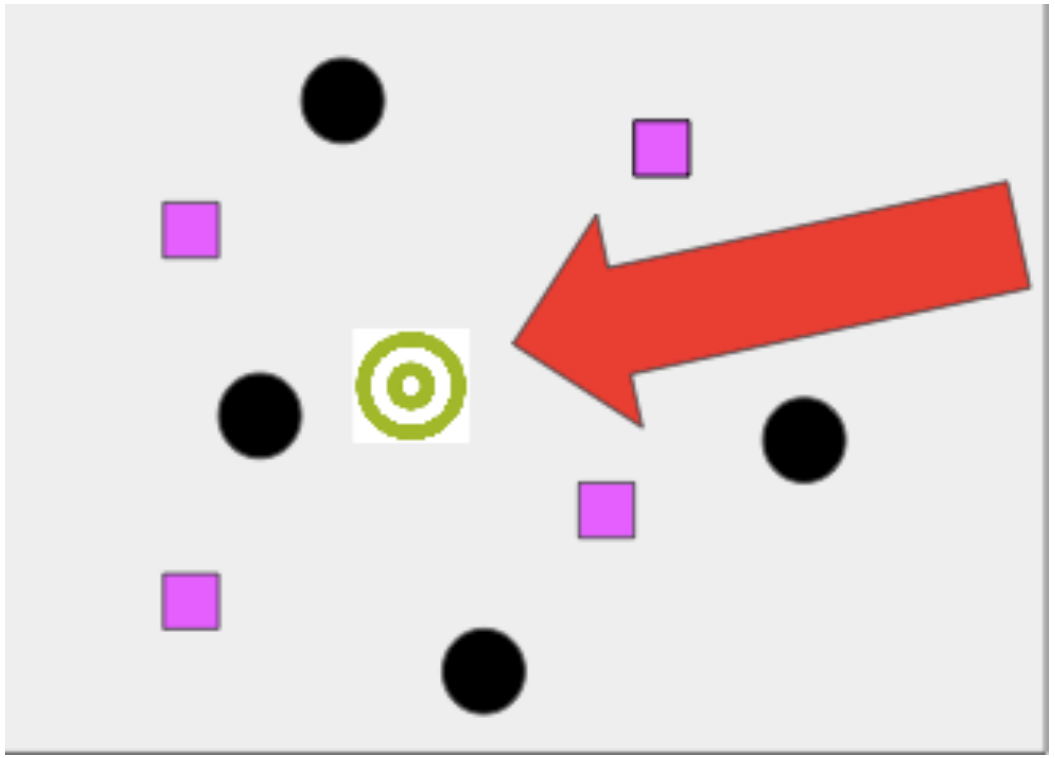
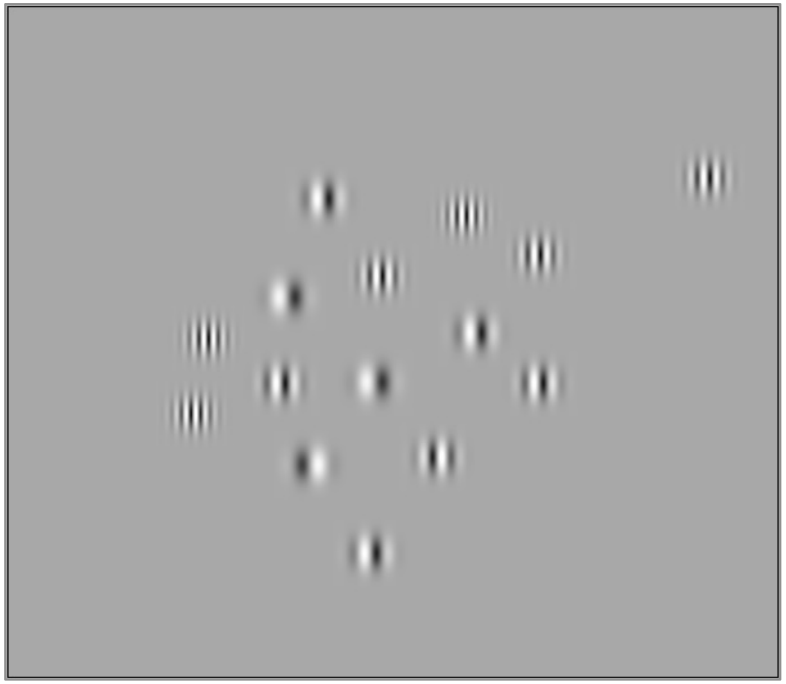


Centroid

Gabor Pattern

Gabor patterns were used to study the selective attention for different frequencies.



Research Question

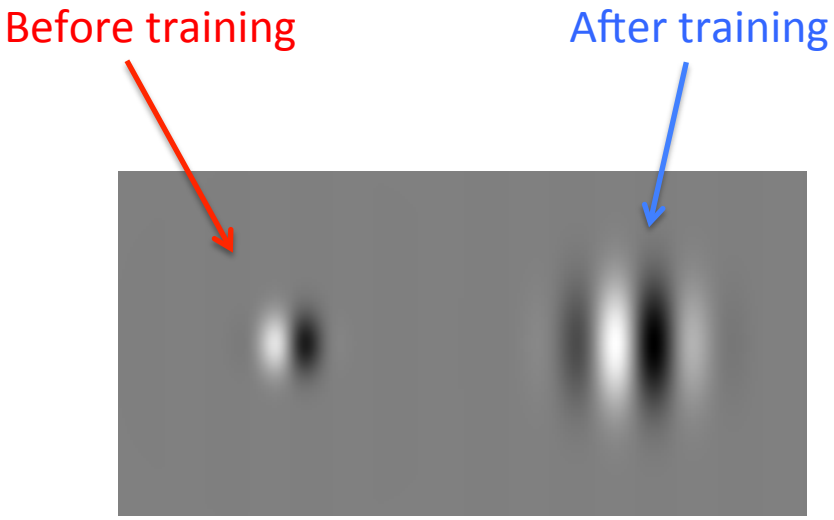
- When people use feature-based attention to try to pick out Gabor patterns of a particular target spatial frequency, can training help to sharpen attention filters?

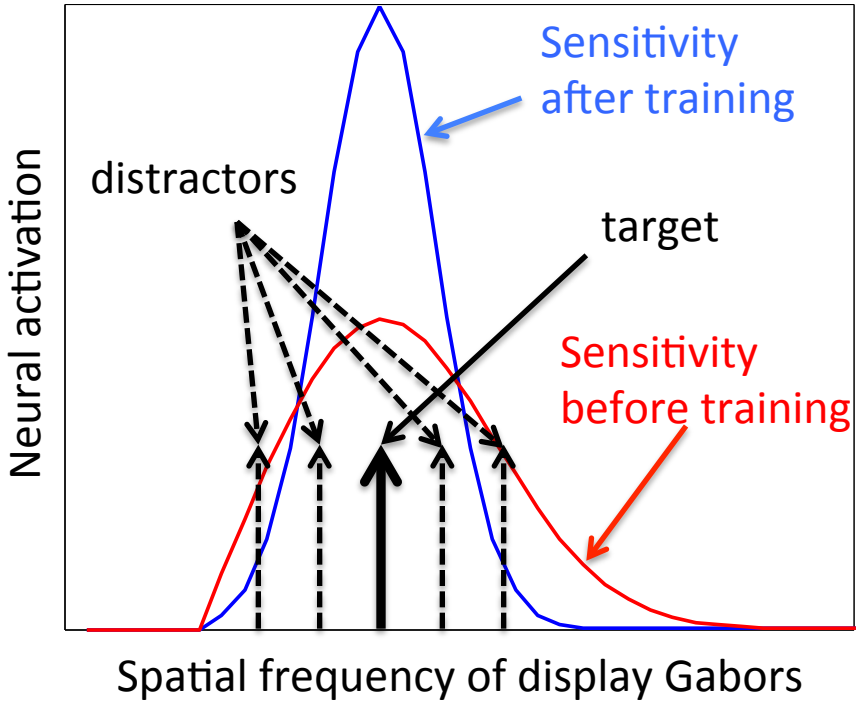
Hypothesis

- We hypothesized that training will help to sharpen the filter.
- Prediction: If the filter is shaper, then people will perform better in the centroid task.

How Might Attention Filters Be Sharpened?

If the receptive field of the neurons used to perform the task can be changed by training as shown here, then the tuning curve will be shaper after training.





Measuring Performance

- Participant's performance was measured by the spread among stimuli.
- Spread = Distance of the spatial frequency of distractors from the target spatial frequency
- The smaller the spread = the more difficult the centroid task is = better performance

Level of Difficulty of the Centroid Task

- A 3-up-1-down staircase was used in this experiment.
  - 3 correct responses = Going up to the next level of difficulty in the next trial (spread decreased)
  - 1 incorrect response = Going back the easier level (spread increased)

E.g. For the first trial (easiest level), the spread is the biggest spread, which means that the distances of the distractors with the target frequency are the longest.

Measuring Performance

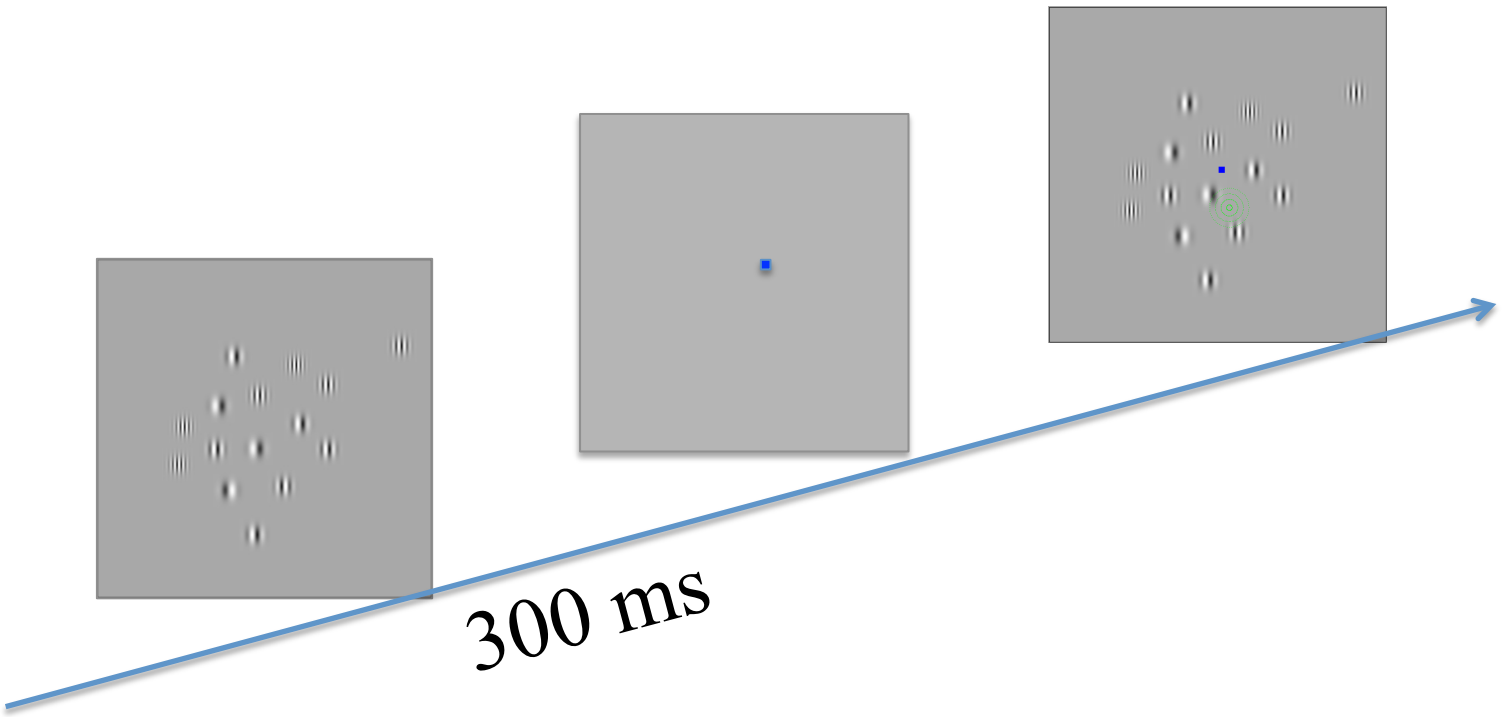
By the end of the training, if participant's performance to the centroid task is better, they should be at a high level of difficulty (small spread).

Experiment Design

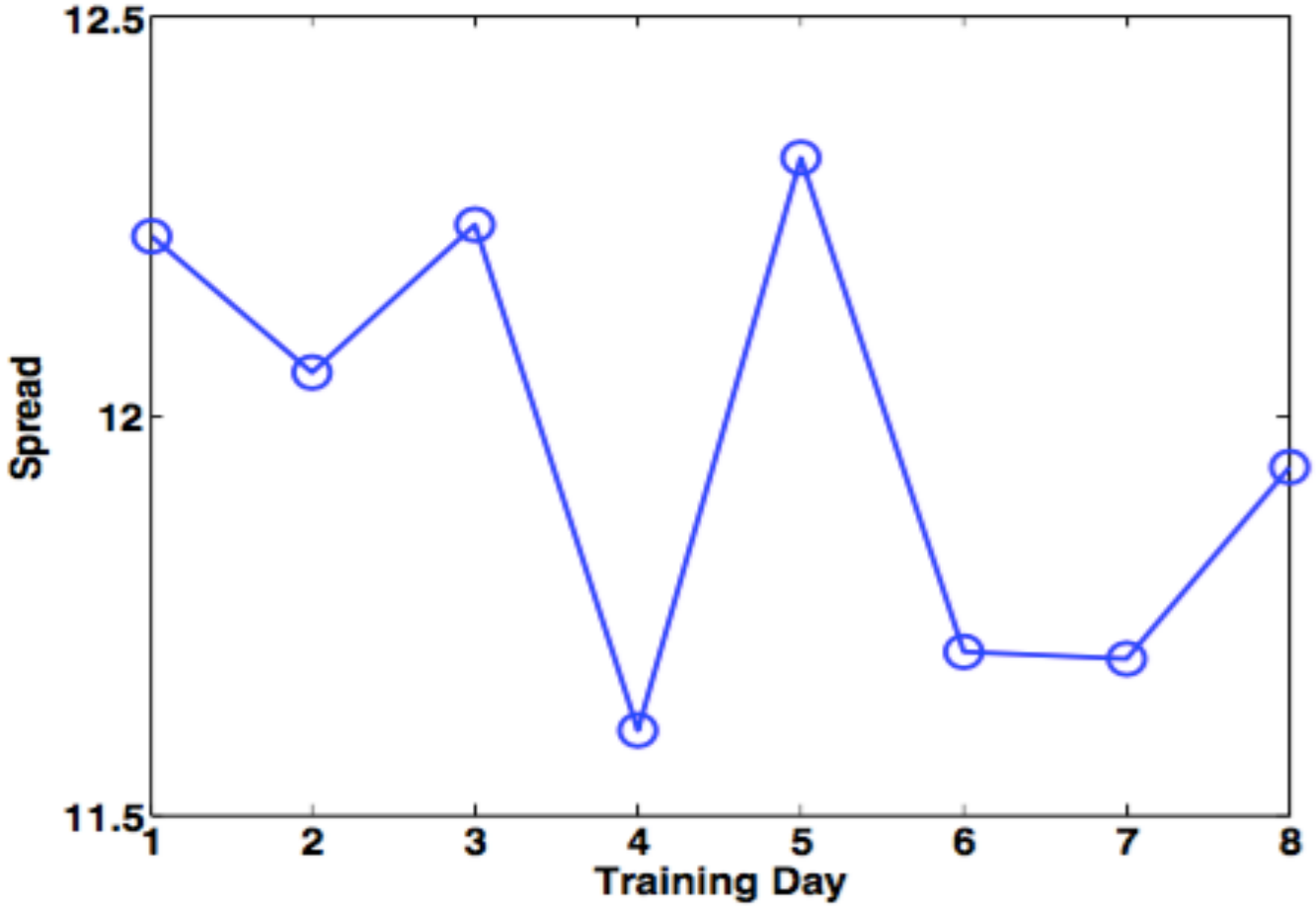
- 8 days
  - 7 days for training: 2 phases each day
    - Testing phase: maximum of 100 trials or six reversals (same stimuli as in training session)
    - Training phase: 4 blocks, 100 trials/block

- Purpose of testing phase: to investigate whether or not the subject learned from previous session(s) to do better on the centroid task.

Example of a Trial



Results



Discussion

- Hypothesis was falsified.
- There is no learning occurred during 8 days of experiment.
- The participant did not learn to perform the centroid task better.

→ Training does not help to sharpen attention filters.

Implication

Maybe the spatial frequency tuning of visual neurons is fixed and innate.

Acknowledgement

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References

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