Boundary Extension: Insights from Signal Detection Theory

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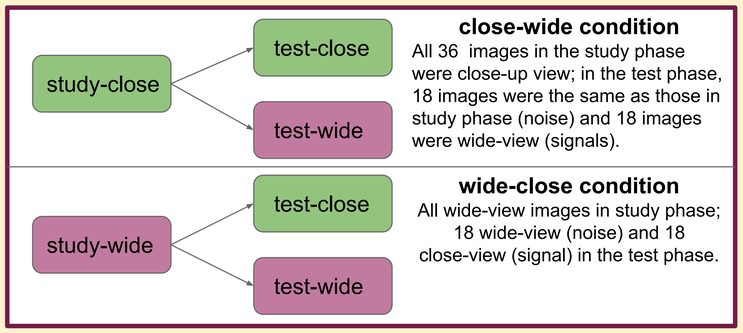
Introduction

- When recalling a scene, people often remember having seen more of the world than was originally visible. This phenomenon is referred to as boundary extension.
- Only recently has boundary extension been examined through the lens of signal detection theory (SDT).
- Yang et. al (2014) previously used SDT to examine this phenomenon. They found that the effect could be attributed to both discrimination sensitivity and criterion bias.
- However, given the similar criterion values they found for both close-wide and wide-close conditions, it is possible that their interleaved design meant participants used a single criterion for both close-wide and wide-close scenarios.
- Our current study is a direct extension of this research.

Figure 1. An example of boundary extension illusion. After studying the close-angle view image (left), people report that the wide-angle view image (right) is what they have studied. (From Figure 1 in Intraub and Richardson, 1989)

Current Study

- If a design using interleaved stimuli produces similar criterion values for both wide-close and close-wide conditions, will a blocked experimental design produce different criteria for each condition?
- To test this possibility, we grouped the wide-close and close-wide conditions into separate test blocks.
- Since each block presented only one of the two conditions, the resulting criteria were specific to a particular condition. Differences between criteria were then analyzed.



Methods

- The experiment consisted of 4 blocks, with 36 pairs of pictures in each block. 2 blocks were the wide-close condition and the other 2 blocks were the close-wide condition. The order of the 4 blocks were randomized.
- In each block, subjects studied either 36 close-view images or wide-view images. Each image appeared briefly on screen and was followed by a mask.
- In the test phase, subjects were presented either the same image or its wider/closer counterpart, and were asked to identify whether the new image was the same or the wider/closer counterpart.
- 6 ratings from -3 to +3 were used: -3 being "sure same" (same as the image in study phase), -1 guess same to +1 guess closer/wider, and +3 being sure closer/wider (different from the image in study phase).

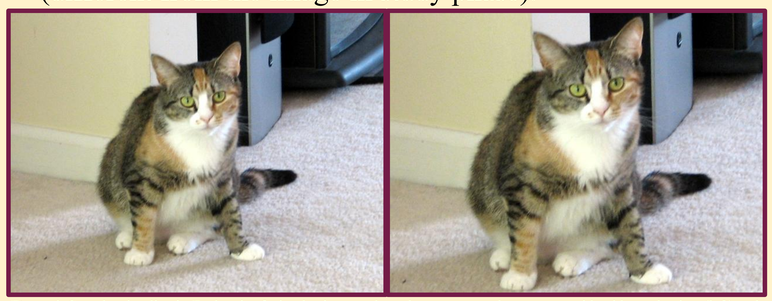
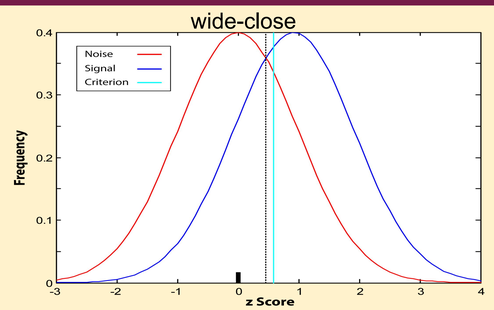
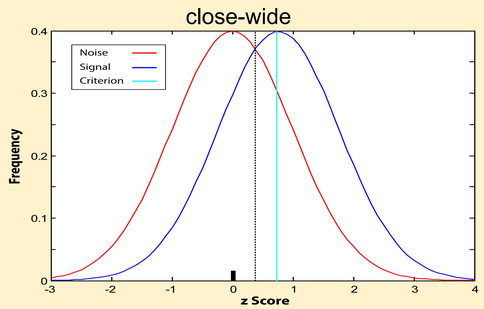


Figure 2. Sample stimuli pair. Each pair of stimulus images show the same natural scene, one with wide-angle view (left) and the other with close-up view (right).

Result(I)

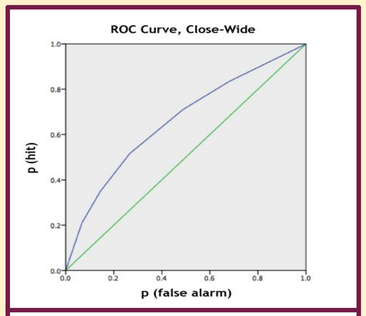


- Wide-Close condition sensitivity (d'), decision criterion and bias.
  d' = 0.92 ± 0.06
  criterion = 0.59
  bias = 0.13

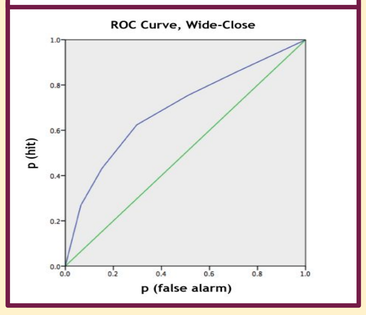


- Close-Wide condition sensitivity (d'), decision criterion and bias.
  d' = 0.76 ± 0.04
  criterion = 0.73
  bias = 0.35

Result(II)



- Area under ROC curve (blue): 0.659.
- Area under the ROC curve represents the discriminability between signal and noise under a given condition. An area of 0.5 (shown in green) describes a situation in which a participant could not distinguish between signal and noise better than chance.



- Area under ROC curve (blue): 0.693.
- Bigger area indicates better discrimination of signals from noises.

Conclusions

- Our study found that participants' decision criteria were significantly more conservative when they were tested on the close-wide condition, $t(164) = 3.26$, $p < 0.01$.
- Sensitivity was significantly greater in the wide-close condition (in which boundary extension would produce the greatest difference between the recalled image and the comparison image), $t(164) = 2.56$, $p < 0.01$. Since sensitivity is largely attributed to low-level cognitive processes, this suggests that boundary extension is an inherent facet of how visual information is stored and retrieved in the brain.
- Bias was significantly greater in the close-wide condition, $t(164) = 7.40$, $p < 0.01$, indicating that participants were more often relying on higher-level decisions, rather than actual perceived differences.

References

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Thanks to Yunzhong He for his contribution to this research.