

Object Recognition in Pigeons: The Effects of Spatial Frequency Filtering

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Introduction

- Unlike humans, pigeons do not generalize from shaded images to line drawings in a recognition task (Young et al., 2001).
 - This species difference might be best explained as a difference in how spatial frequencies are used in recognition tasks.
 - Pigeons may have a stronger bias to preferentially attend to the low spatial frequencies in an image.
- Humans have a bias for coarse-to-fine processing of spatial frequency information in the early visual processing of images, but this information is used flexibly in recognition tasks (Morrison and Schyns, 2001).
- For pigeons, however, a coarse-to-fine bias may be evident in all recognition tasks, regardless of the diagnosticity of the high or low spatial frequency information.
- Questions:**
 - Do pigeons preferentially attend to low spatial frequencies when performing a recognition task in which the low spatial frequencies are diagnostic for the task?
 - Can pigeons attend to high spatial frequency information when they are forced to by the task demands?

Methods

- Stimuli:**
 - The original stimuli comprised line drawings and shaded images of four single-geon objects: the arch, barrel, brick, and wedge.
 - The total image size was 256 pixels in width and 256 pixels in height; the individual objects could fit into a rectangular window that was 68 pixels in width and 78 pixels in height.
 - The images were filtered in NIH Image Version 1.62 using a Gaussian filter.
- Apparatus:**
 - Specially constructed operant chambers fitted with a touchscreen.
- Procedure:**
 - Eight pigeons were trained in a four-alternative forced-choice task with unfiltered images of the different objects, four with the line drawings and four with the shaded images.
 - They remained in training until they reached a criterion of 85% accuracy overall and 80% for each object.
 - In Phase 1 Testing, pigeons received probe trials with three high-pass and three low-pass filtered images of each of the training objects (24 total test stimuli).
 - Low-pass images comprised spatial frequencies below 64, 90, or 115 cycles per picture (cpp).
 - High-pass images comprised spatial frequencies above 3, 6, or 13 cpp.
 - They were nondifferentially reinforced for responses to the test stimuli.
 - In Phase 2 Testing the pigeons received probe trials with three high-pass and three low-pass filtered images of each of the training objects (24 total test stimuli), with the filtering removing more of the content for the low-pass images and less of the content for the high pass images than in Phase 1 Testing.
 - Low-pass images comprised spatial frequencies below 45, 83, or 122 cpp.
 - High-pass images comprised spatial frequencies above 1, 4, or 6 cpp.
 - They were nondifferentially reinforced for responses to the test stimuli.

Stimuli

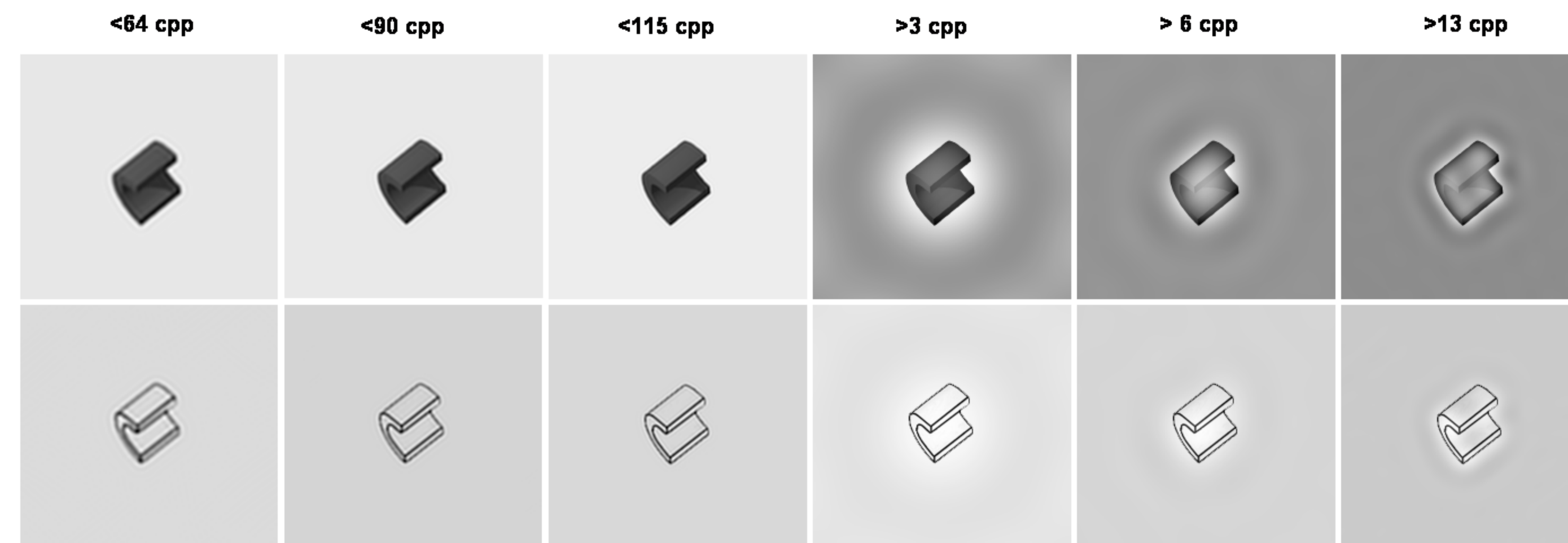
1

The Four Training Stimuli for Each Group



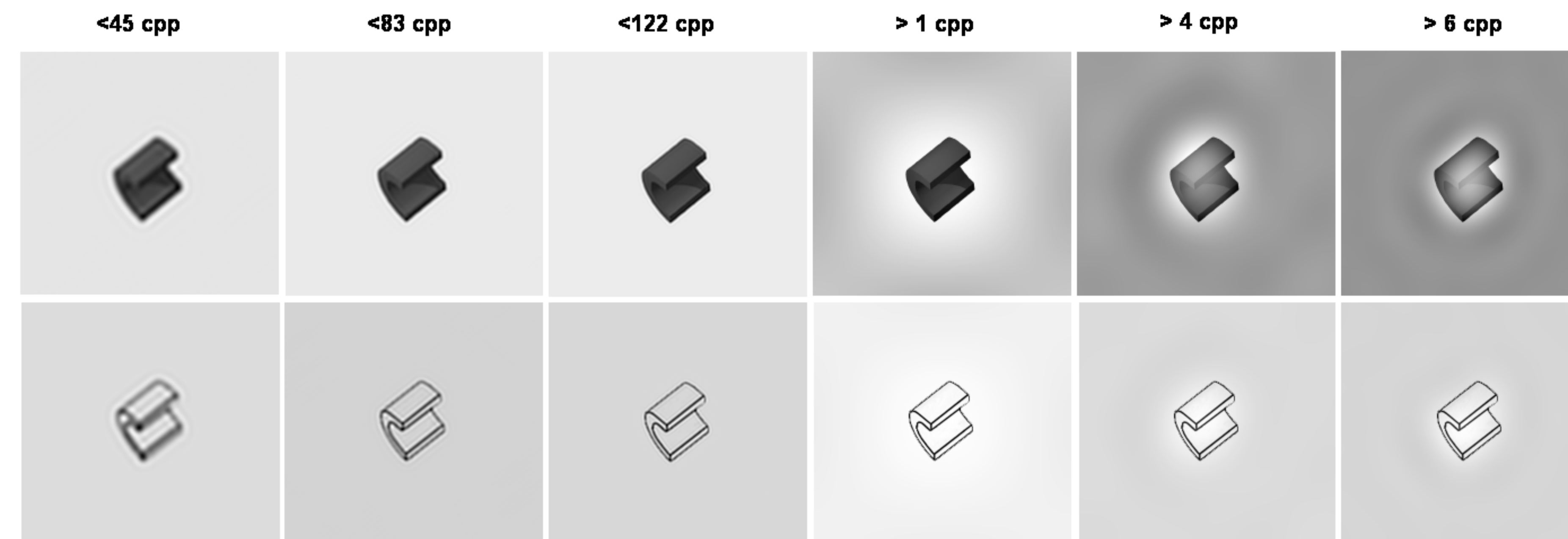
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Examples of the Phase 1 Testing Stimuli for Each Group

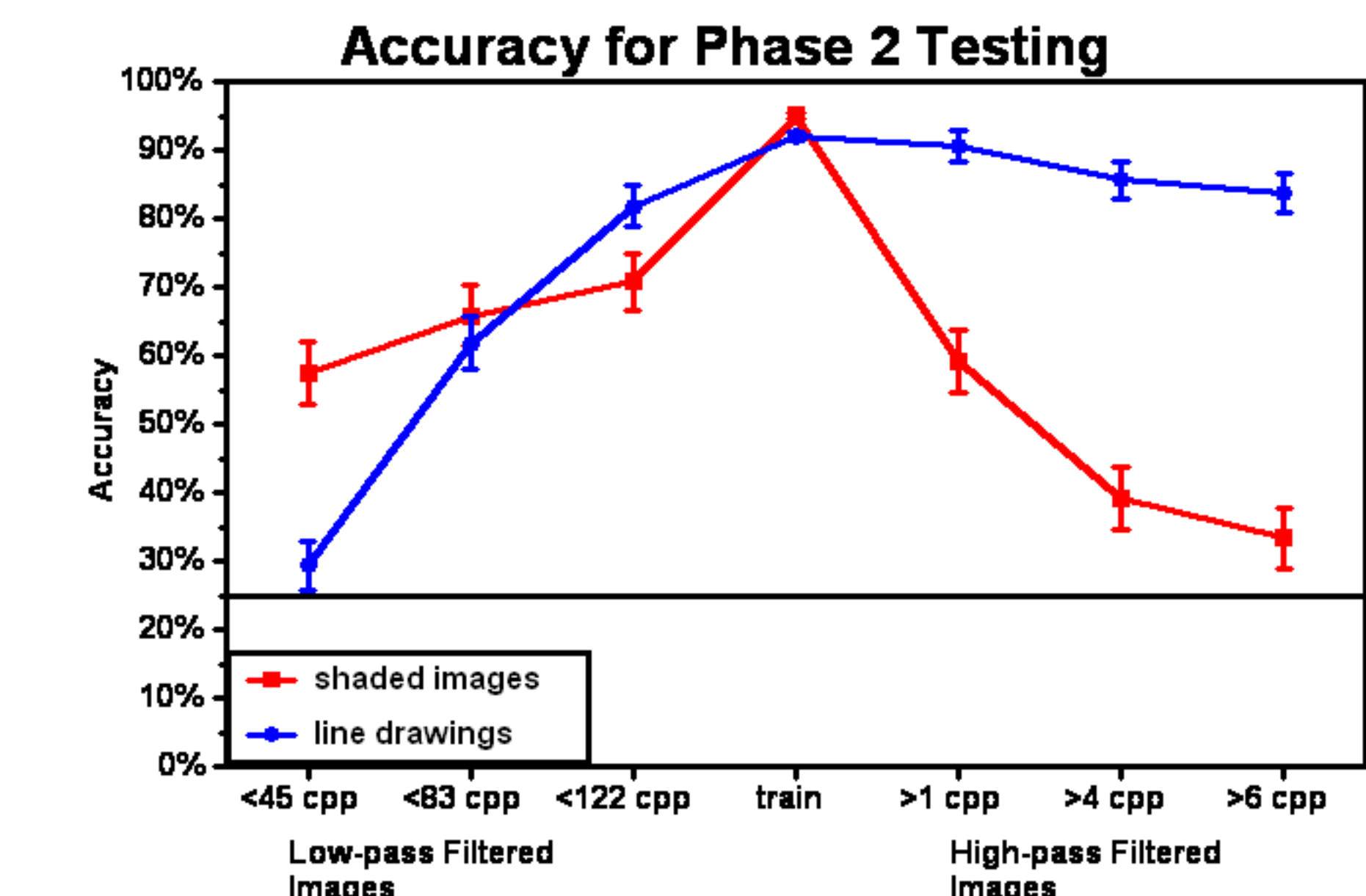
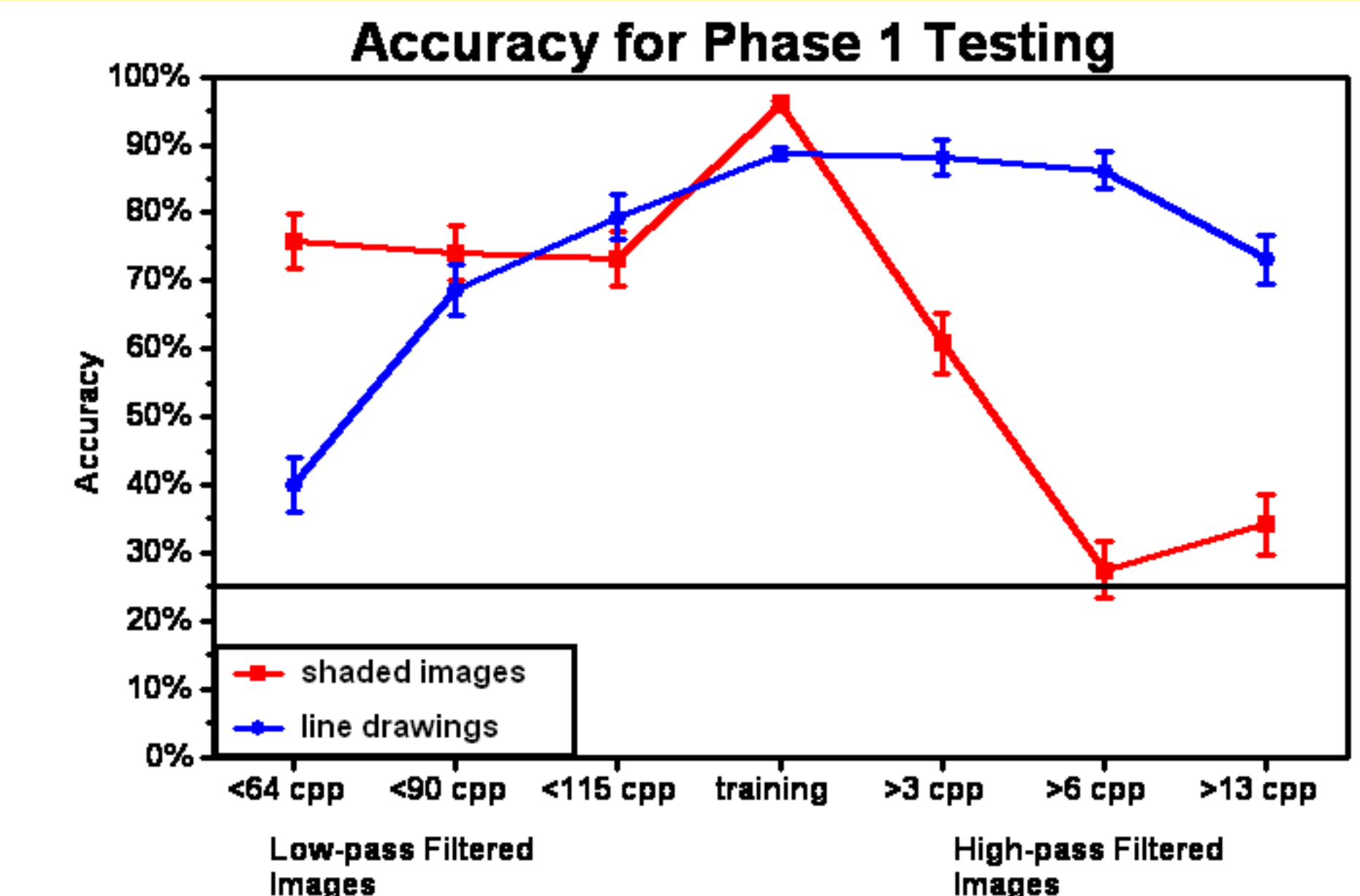


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Examples of the Phase 2 Testing Stimuli for Each Group



Results



Conclusions

- The performance of the pigeons trained and tested with shaded images was more disrupted when low spatial frequencies were filtered.
- The performance of the pigeons trained and tested with line drawings was more disrupted when the high spatial frequencies were filtered.
- Thus, given more naturalistic images pigeons preferentially attended to low spatial frequencies; however, they can be forced to attend to the high spatial frequencies.
- The pigeon's bias for low spatial frequency information may explain why pigeons do not generalize from shaded images to line drawings of the same objects.

References

- Morrison, D. J. & Schyns, P. G. (2001). Usage of spatial scales for the categorization of faces, objects and scenes. *Psychonomic Bulletin and Review*, 8, 454-469.
- Young, M. E., Peissig, J. J., Wasserman, E. A., & Biederman, I. (2001). Discrimination of geons by pigeons: The effects of variations in surface depiction. *Animal Learning and Behavior*, 29, 97-106.