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An Investigation of the Effect of Prediction on Object Perception

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Background

Spatial attention alters appearance:
perceived contrast and spatial frequency higher for attended stimuli [1 2].

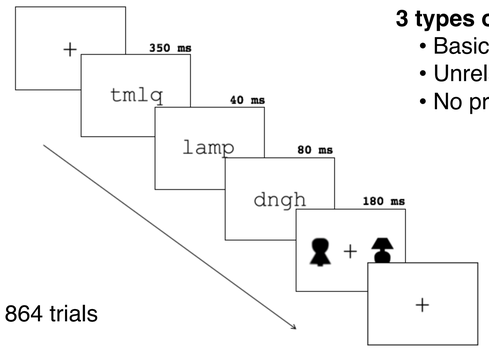
Predictive coding theories hold that perception involves testing predictions/expectations [3 4].

Question

Do expectations or predictions alter appearance?
Does an object appear sharper when expected?
Does a familiar obj appear sharper than a novel obj?

General Method

Induce expectations for upcoming stimuli via semantic priming



864 trials

3 types of Primes
- Basic Level (“lamp”)
- Unrelated (“hawk”)
- No prime (“xxxx”)

Task: Which of two stimuli is blurrier ?
Examine Point of Subjective Equality (PSE)

Two Stimuli Per Trial matched on low level features
-Lamp
-Novel Object made by rearranging lamp parts into a novel configuration: Part-Rearranged (PR) Novel

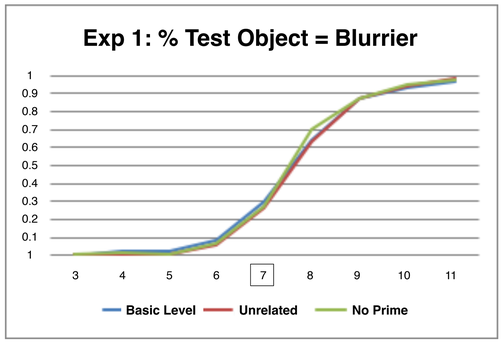
Standard and Test on every trial
-Lamp & PR = *Test* and *Standard* equally often
-*Standard* blur level = 7, *Test* blur level range = 3 – 11
-Blurred using Gaussian smoothing kernel (imgaussfilt)
-*Test* is target for primes
PR primes match Lamp prime in length and frequency

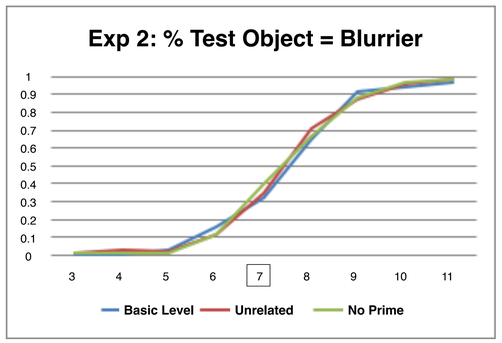
Hypothesized Results

Prime-induced expectations will cause Lamp to appear sharper than it is
Lamp will appear sharper than PR Novel Object
Blurry objects will violate predictions for appearance, producing error signal.
Modulation of this error signal will result in a sharpening of the final percept.

Experiments 1, 2

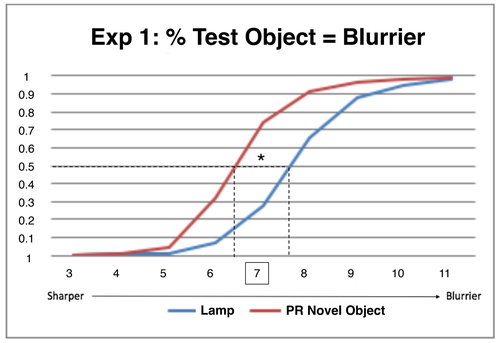
No effect of priming

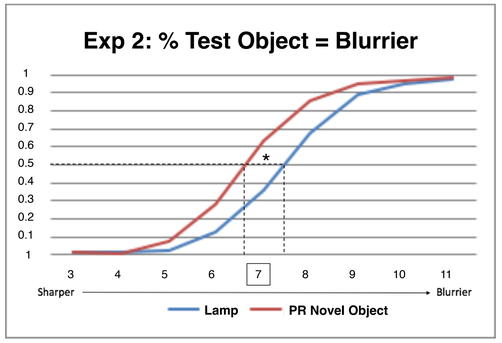




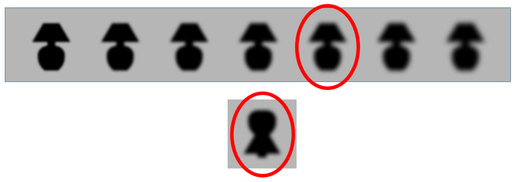
Data obtained when Lamp = *Test*

A familiarity effect was observed, however.
Lamp perceived as sharper than PR Novel Object in all conditions
Exp. 1, $p < 0.001$, n=14; Exp. 2, $p < 0.001$, n=15





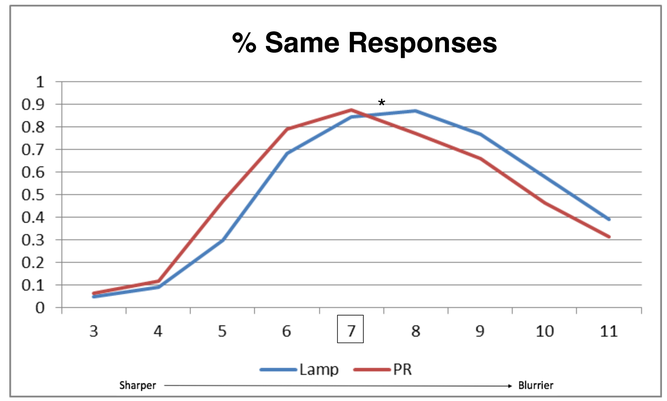
Data from both Lamp = *Test* and PR = *Test* trials



These results could reflect a bias to choose PR Novel Object as blurrier

Experiment 3

Same as Exps 1 & 2, except Response Bias Free Task
Judge Whether 2 stimuli are Same or Different Blur Levels



Data when Lamp and PR were test objects (hence, varied in blur)

Lamp perceived sharper than PR stimulus, $p < .001$, n = 21
*** Results are response bias free

No effect of Prime Condition

Summary

No effect of prime-mediated expectations
- Perhaps stimulus wasn’t good match to memory activated by primes
- Perhaps primes weren’t sufficiently predictive (16.6% match)

Familiarity effect
- Predictions from object memories activated by lamp interact w/ input
- Memories represent norm of previously seen lamps
- Norm tends to be sharper than experimental stimuli

Is Familiarity effect mediated by attention?
No evidence that familiar objects automatically attract attention [5]
Strategy effect?

Conclusion

Object memory-based predictions affect appearance
object memories accessed by input, not a priori
No evidence of effect of word prime-based prediction

References
1) Carrasco M, et al. (2004). *Nature Neuroscience*, 7, 308-313.
2) Gobell J., and Carrasco M. (2005). *Psychological Science*, 16, 644-651.
3) Summerfield & Egner (2009). *Trends in Cognitive Science*, 13, 403-409.
4) Caddigan, E., et al. (2017). *Journal of Vision*, *17*(1), 21-21.
5) Peterson, M. A., et al (2017). *Attention, Perception, & Psychophysics*, 79(1), 180-199.

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