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Picture Preference Habituation

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Introduction

What is the behavior and neurobiology of an “Infovore”?

Is there a motivational system underlying visual information acquisition that maximizes the intake of *novel*, but *interpretable* information?

Phenomena we are trying to explain:

- In most circumstances, novelty is reinforcing
- Excessive exposure renders things “boring”
- Overly complex or “noisy” stimuli are aversive

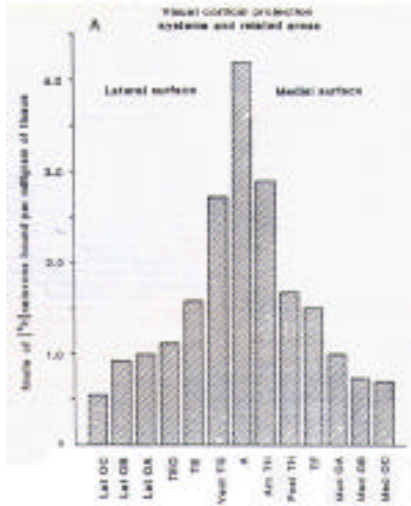
[However, novelty seeking behavior can be trumped by the demands of biological survival systems (e.g. hunger & thirst), directed search, and attention-grabbing signals such as sudden onsets or motion.]

Visual Preference

Our research is motivated by a Neurocomputational Theory of Perceptual and Cognitive Pleasure (Biederman, 2000). The theory posits a specific function for the gradient of endorphin receptors in the ventral pathway of the macaque discovered by Lewis et al. in 1981. These receptors (and by implication, endorphin activity) are sparsest in V1 and monotonically increase in density to V2, V4, IT and the amygdala. A similar gradient was found between primary and secondary auditory cortex. Why would endorphin activity be associated with a perceptual pathway? Our proposal is that novel but interpretable perceptual inputs would lead initially to the most neural activity--and hence endorphin activity--in the anterior stages of the ventral pathway (IT and the amygdala). However, with repetition of that perceptual input, competitive interactions would result in less activity (Li et al., 1993; Sobotka & Ringo, 1994). The magnitude of the endorphin activity would subserve perceptual and cognitive preference, resulting in a preference for patterns which are both novel (because they have yet to undergo competitive interactions) and richly interpretable (because such patterns would initially activate associated patterns in memory).

This information is then used by frontal lobe structures subserving visual working memory and response selection to guide visual attention (both covert and overt).

The result is a “win / shift” behavioral pattern in which parts of a scene with high probable information content are attended and processed for a period of time before a shift is executed to another part of the visual scene.



Lewis et al., 1981

μ-enkephalin receptors are present in the visual system in a gradient from lower cortical visual areas (V1) to higher areas (TE).

Research Questions:

- **How does visual preference for a scene or visual pattern change as a function of exposure?**
- **Do differences in initial preference affect the rate of change?**
- What factors contribute to a subject's initial preference for a scene?
- What is the neural basis for visual preference and its downstream effects? [future fMRI work]

Experiment 1 – Pretest

In order to study the effects of repetition on preference, we first collected baseline preference data on our stimuli.

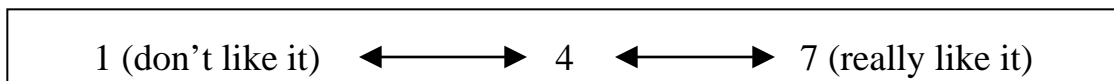
Stimuli

200 full color scenes (approx 15° in width) selected to vary widely on a number of dimensions:

- urban vs. natural
- close-up vs. scenic
- animate vs. inanimate
- cluttered vs. simple

Images were shown for 1 second each.

Preference Measure



Results

- Overall Preference: 4.03 ± 0.65
- How much do subjects differ?
Average subject correlation: 0.48 ± 0.3
- Stimulus Ordering
 - Theories of *a priori* picture preferences.

Kaplan(1992) : Preference for natural scenes which provide a vista yet offer refuge, or are suitable for human development (evolutionarily driven)

Do people prefer natural scenes?

4 subjects rated the scenes on a 7 point scale of “natural vs. urban/manmade.”
The correlation between these ratings and the preference ratings was **0.5877**.
Kaplan’s hypothesis generally supported.

Subjects showed a high degree of agreement in their ratings on this scale (0.91 ± 0.01 average subject correlation).

Experiment 2 - Repetition

Methods

- Monitor change in preference over repetition of scenes.
- 20 subjects
- Same scenes as Exp. 1, grouped into 20 sets of scenes evenly distributed over *a priori* preference.
- 1 second exposure duration

Experimental Design

GOAL: Control the local novelty environment so that scene novelty is not confounded with time (or trial number) in the experiment.

Each subject was shown 3 sets of 10 stimuli:

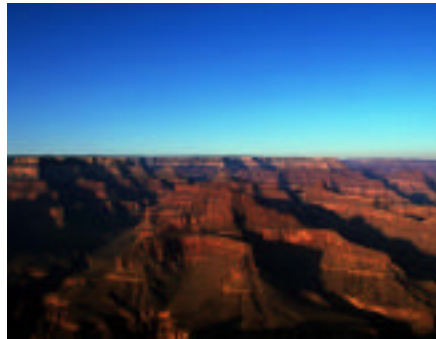
- **“Practice” stimuli for 1st 55 trials, used as spacers for test trials.**
- **“Block1” stimuli, spaced evenly throughout test trials. (BEST CONTROL)**
- **“Block2” images, used as spacers for 2nd half of test trials.**

Trial sequence controlled for:

- Average serial position of scenes
- Local novelty context (novelty was not confounded with trial number for the Block 1 images)
- Preference context (rough control, based on the results of the Pretest)

(Experiment 1 Results)

Highest Average Ratings

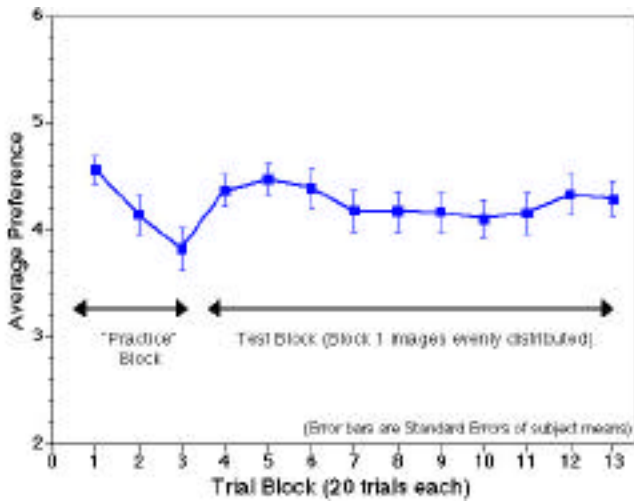


Lowest Average Ratings

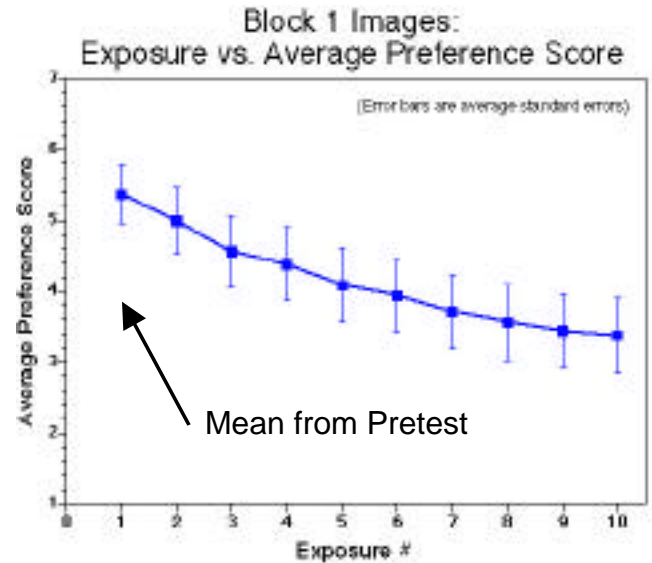


Results

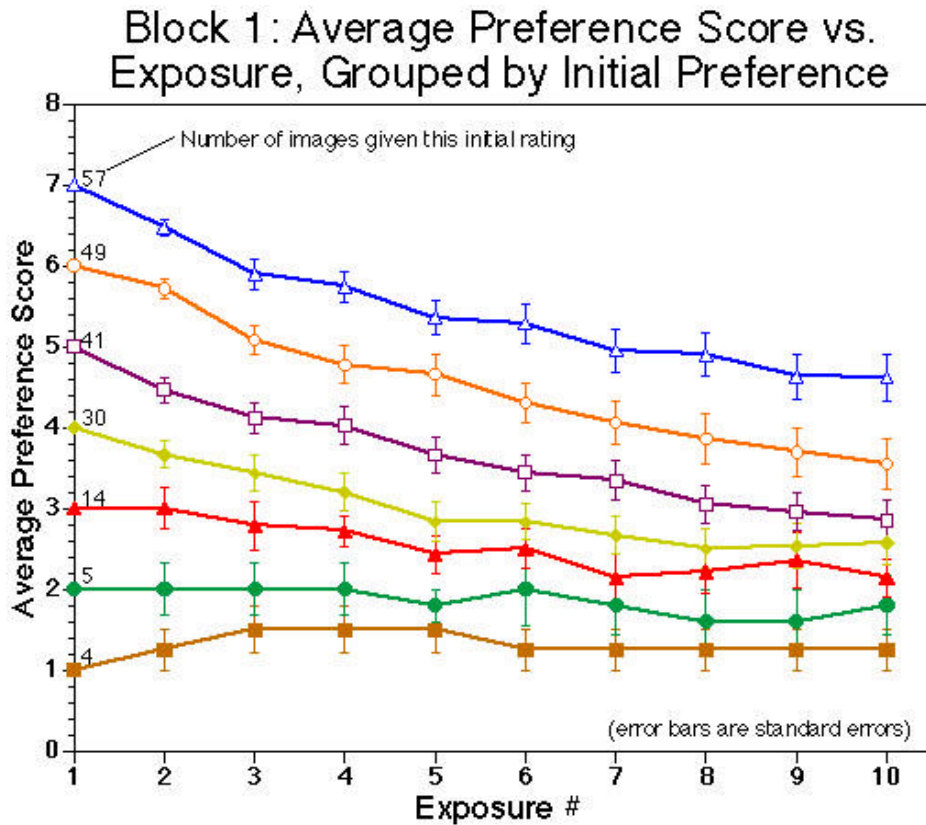
- Overall Preference: 4.23 ± 0.11
- Change in Preference over experiment:



Evidence for good control of novelty



- **Contrast Effect:** 5.37 vs. 4.03



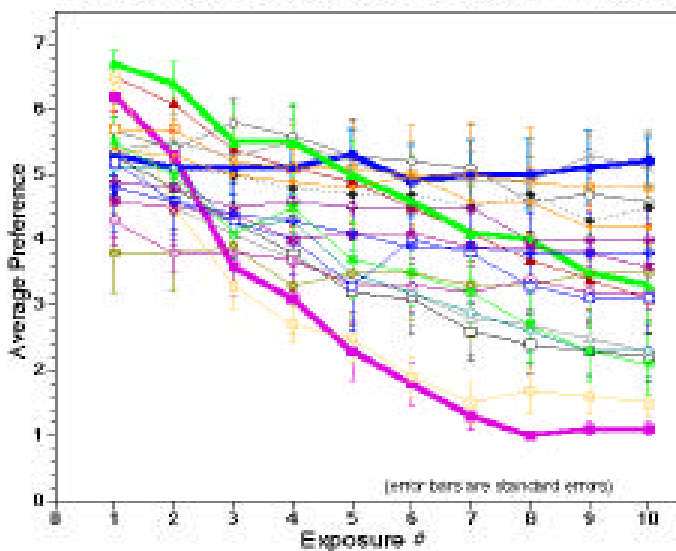
- With repeated exposure, preference habituates.
- This habituation is seen for all images, regardless of their initial preference (notwithstanding floor effects).

Results (cont.)

- Order relationships are preserved.
- “Cost” function:
e.g., A picture initially scored a 5 is equivalent to the 7th repetition of a picture initially scored a 7.
- What is the relationship of these ratings to those given during the pretest?
 $r = 0.396 \pm 0.025$

Subject Variability

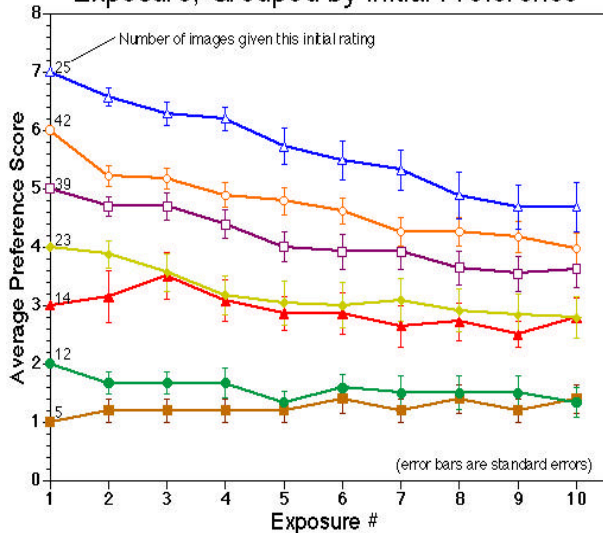
Individual Subject data for Block 1 Images



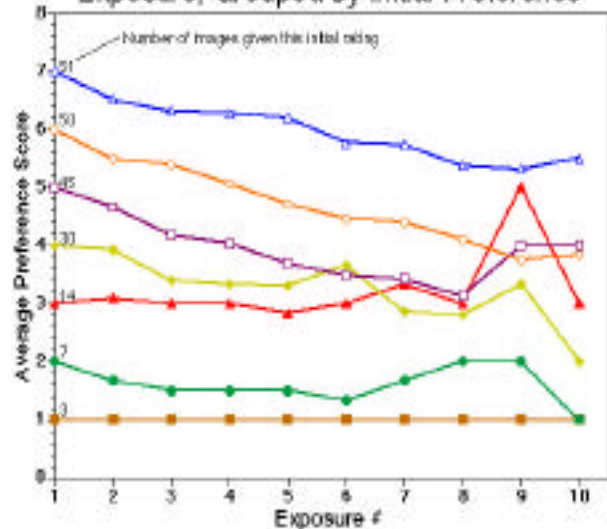
- Individual differences may be related to sensation seeking behavior (e.g. Zuckerman, 1994).

“Practice” & Block 2 Items

Practice: Average Preference Score vs. Exposure, Grouped by Initial Preference



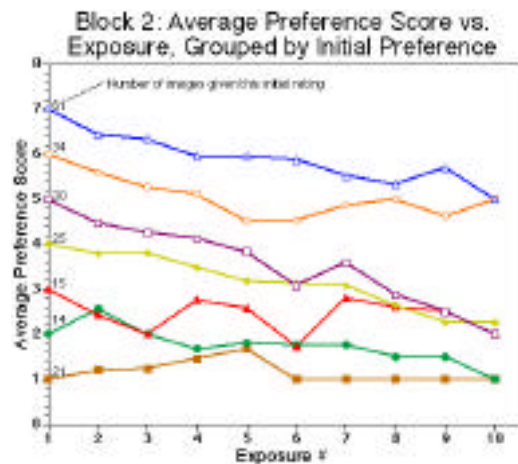
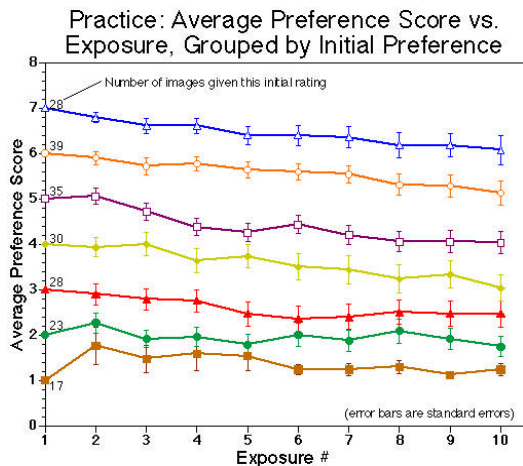
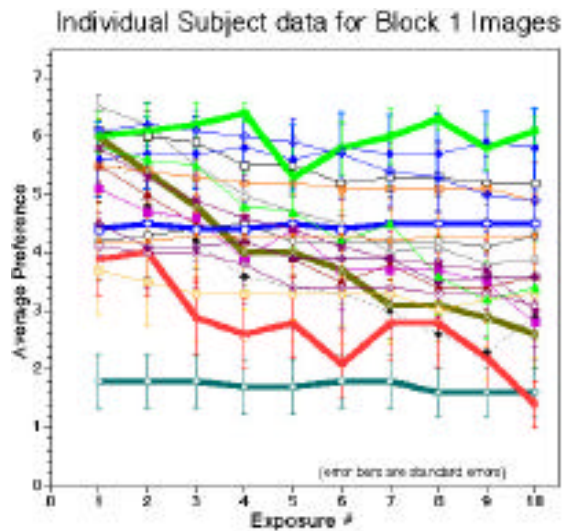
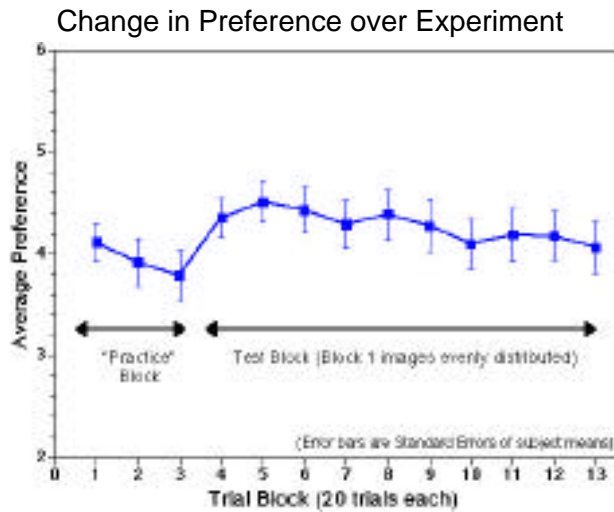
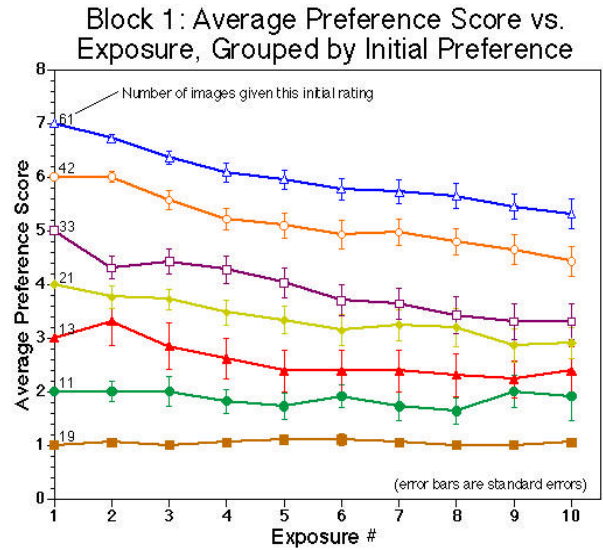
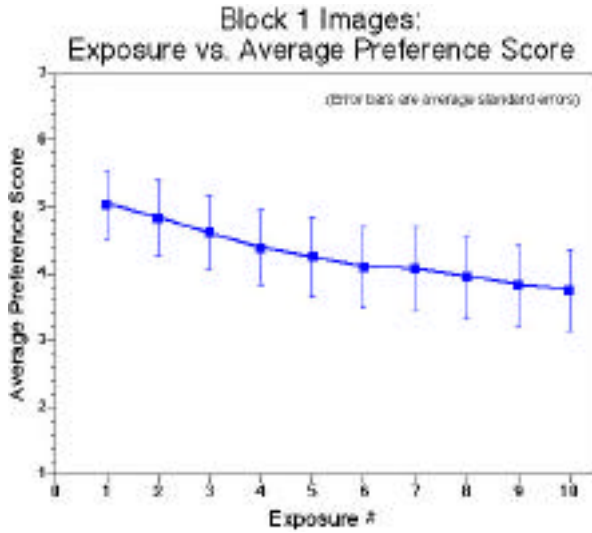
Block 2: Average Preference Score vs. Exposure, Grouped by Initial Preference



Reliability

- A second cohort of 20 subjects were run with the same stimulus orders to determine the reliability of preference scores.

Trial by trial correlation between subject pairs: 0.344 ± 0.190



Conclusions

- For relatively long exposures, preference declines with repeated presentation.
- This habituation occurs for images with a wide range of *a priori* preference.
- Preference is influenced by the local novelty context (contrast effect).
- Subjects tend to prefer natural scenes with a high degree of legibility, and dislike scenes which depict urban settings, clutter and man-made objects.

Future Work

- Psychophysical studies
 - **Eyetracking.** Given a choice among scenes, are fixations correlated with judged preference?
 - **Habituation.** Do scene preferences show a rebound after delay and extinction?

- **fMRI**

Event related design: (Buckner & Braver, *in press*)

Which brain areas show activity that correlates with a subject's preference for an image over repeated presentation?

Are scenes with a high initial preference, e.g., those that are high in Kaplan's "vista and refuge" and show resistance to habituation, represented in different areas than those scenes that are initially less preferred?

References

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