Part/whole integration of 2D shapes in the hippocampus and the basal ganglia

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BACKGROUND

How do representations of shape differ across the visual processing hierarchy?

Human behavior (c.f. Singh et al. 1999) and ventral occipitotemporal primate single neurons (c.f. Pasupathy & Connor 2002) show sensitivity to distinct parts of shapes.

Ventral visual stream neurons are likely to represent successively more complex features at more anterior regions (c.f. Tanaka 1991), possibly culminating in intrinsically integrated object representations (c.f. Cate & Kohler 2006).

A difficulty in distinguishing part- and object-selectivity is that parts exist only in the context of a greater whole. Here we manipulated the probability of part occurrence within whole objects to investigate part/whole distinctions.

CONCLUSIONS

- Basal ganglia involved specifically when part of shape altered, rest of shape unchanged.
- BG patients (Parkinson’s, Huntington’s) have high rate of object, face and body-level complex hallucinations.
- Middleton & Strick (1996) discovery of inferior temporal BG feedback loops proposed as mechanism for hallucinations.
- Crude hypothesis: BG feedback loop required to selectively inhibit one set of shape features without inhibiting other features bound in same object context?
- (Hippocampus: need to rule out artifact first.)

STIMULI & TASK

2D objects created from sets of 4 top and 4 bottom parts. Convex middle region important for reducing perceptual independence of parts (c.f. Hoffman & Richards 1984, Liu et al. 1999)

Stimuli: 2°x3°

MAIN RESULT

Participants (N=14) maintained fixation and pressed a button when a lighter-colored shape appeared (3-5 times per block)

Although not task-relevant, successive stimuli could represent either 1-back part repetition or 1-back object (entire stimulus) repetition.

300 ms duration

200 ms ISI

32 stimulus blocks

32 stimulus blocks per run

GLM regressors

1 for each block type

Parametric modulations model number of 1-back repeats and target occurrences

Contrasts constructed from these uncorrelated regressors used to identify:

- Sensitivity to part/object variation
- Part/object-specific repetition suppression
- Sensitivity to the distinctiveness of the objects in a block

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GENERAL RESULTS

Effect of part-only repetition frequency: All conditions

Caudate nucleus body activated by one-part-only repetition

No whole-object-specific repetition effects in basal ganglia

Effect of part-only repetition frequency: 04p4 condition (greatest range of values)