Shared and distinct representations of visual regularities across levels of abstraction

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Introduction

The visual system is deftly attuned to spatial and temporal regularities[1], including abstract (category-level) regularities[2]

Evidence for statistical learning can be detected using EEG frequency tagging methods[3,4], including preliminary evidence that visual regions represent category-level regularities[5]

How does the brain represent temporal regularities at different levels of abstraction (exemplar vs. category)?

Experimental Design

Category-level Structured

Image presentation: 250 ms, followed by 250 ms ISI
Each run: 40 repetitions of each exemplar/category
Task: passive viewing

Exemplar-level Structured

Random

N = 7 (6 w/ electrode recons)

Approach: Frequency Tagging

Sensory Input

Image Frequency

Pair Frequency

Representations of regularities in visual cortex

Inter–Trial Coherence (R^2)

Frequency (Hz)

Pair Freq. / Image Freq.

Category

Exemplar

Random

Visual cortex represents regularities at multiple levels of abstraction

Distributed representations of structure

How many contacts tag to the pair frequency?

Exemplar 135 | 46 | 128 Category

count / Permuted overlap: Pair Frequency

Reliable overlap in electrode contacts representing exemplar and category regularities

Where are the contacts tagging to the pair frequency?

- Pair – Overlap
- Pair – Category
- Pair – Exemplar
- Image Only
- None

Proportion of Significant Contacts

ROI: V1, LO, ITG, PHG, ATL, SPL, Hipp, IFG

Evidence for distinct representations throughout the visual hierarchy

Summary

Evidence for entrainment to abstract, category-level regularities, suggesting that the brain abstracts over trial-level variance online to represent higher-order regularities

Earlier visual areas (V1, LO) represent both levels of structure, later visual areas (ITG, PHG, ATL) represent exemplar pairs, and higher-order regions (Hipp, IFG) represent category pairs

Fits with role of higher-order regions in abstraction/generalization, but raises questions about where and how categorical regularities get represented in visual cortex to co-exist with exemplar regularities

References

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