Object state-change predicts neural similarity of visual representations before and after a described event

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INTRODUCTION

Intuition Pump: Recall a pumpkin that you purchased, carved, displayed for Halloween, and eventually discarded.

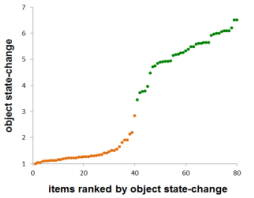
Prior Work: Tracking multiple representations of the same object as it undergoes state-change engenders conflict due to having to distinguish the 'before' and 'after' states of the object (Altmann & Kamide 2009; Hindy et al 2012).

Question: Do objects compete or do object features compete?

Experiment: We varied whether an object was minimally changed by a described action (e.g., "weigh the pumpkin") or substantially changed by the action (e.g., "carve the pumpkin"). In early and late visual cortex, we measured the neural similarity between imagined visual representations of that object before and after the action.

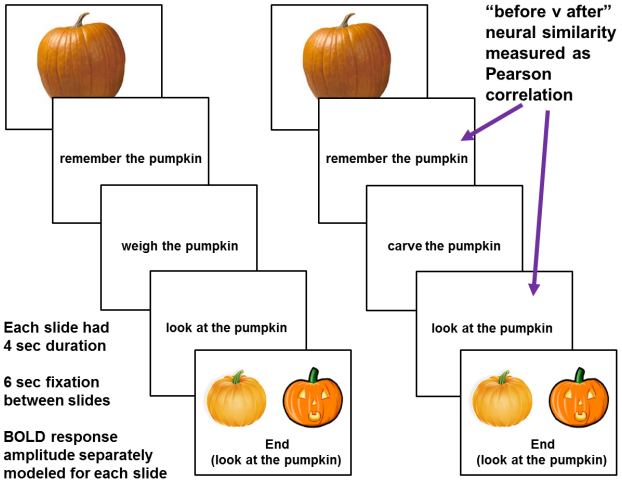
METHODS

Stimulus Norming (N = 106):
Stimuli (40 objects, 80 actions) were rated on the extent to which a depicted object would be changed by a described action. Depending on action, each object was **minimally changed** in one condition, and **substantially changed** in another.

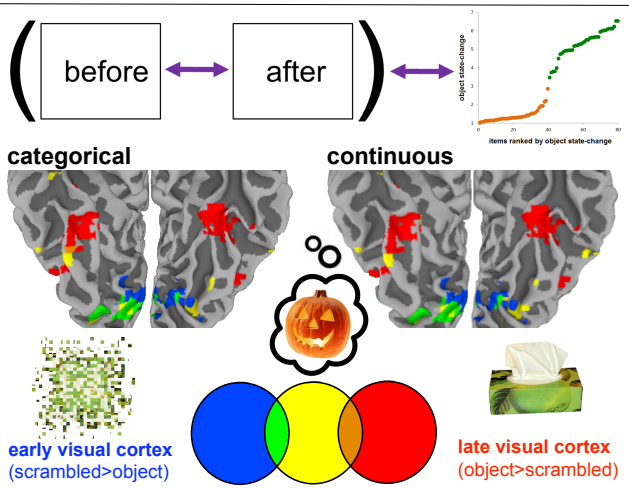


fMRI Experiment (N = 14):
The primary task included 40 state-change trials (20 of each condition), distributed across five 7-minute runs. A 5-minute functional localizer included alternating blocks of intact and scrambled objects.

minimal state-change **substantial state-change**

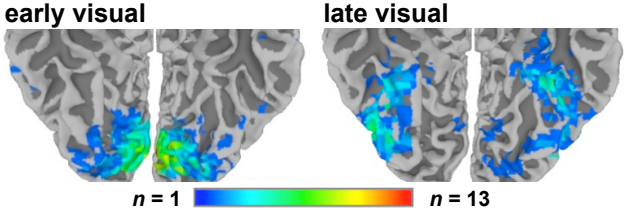


SEARCHLIGHT

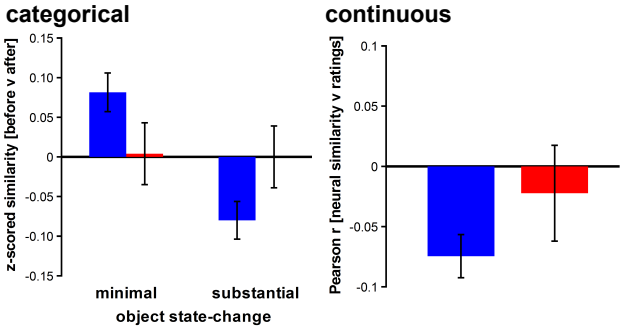


Overlap of visual cortex functional localizers and the 200 visual cortex searchlights (3-voxel radius; Kriegeskorte, 2006) in which similarity across time points depended on category or degree of object state-change.

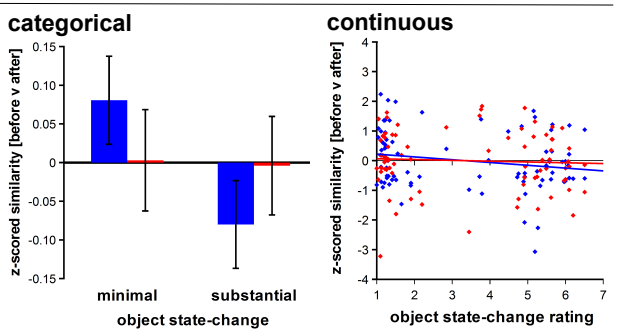
FUNCTIONAL ROI



Probabilistic overlap map of 200-voxel subject-specific functional ROIs.



ITEM ANALYSIS



Within each functional ROI, before/after similarity scores for each stimulus item were averaged across subjects. 7/14 subjects contributed a similarity score for each item.

DISCUSSION

Early visual cortex is dynamic while late visual cortex is static: In early visual cortex, pattern similarity across time points before and after a described action was reliably reduced when the object was substantially changed, compared to when the object was minimally changed. In late visual cortex, pattern similarity across time points was invariant to object state-change.

Features change while objects stay the same: When representing object state-change, visual representations of object features vary across object states, while the same high-level object representation is maintained across object states.

Potential follow-up experiment: "remember the pumpkin" → "carve the pumpkin" → "look at the basketball." If the "before" and "after" are distinct objects (and not just distinct states of the same object), patterns of neural activation in late visual cortex may appear more dynamic.

Simon & Garfunkel: "No it isn't strange, after changes upon changes, we are more or less the same."

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