

Emergence of perceptual Gestalts in the human visual cortex

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How do Gestalt phenomena emerge in the brain?

The percept of the whole often qualitatively different from the sum of its parts. How?

Feedforward: super-additive grouping effects emerge only in higher visual areas

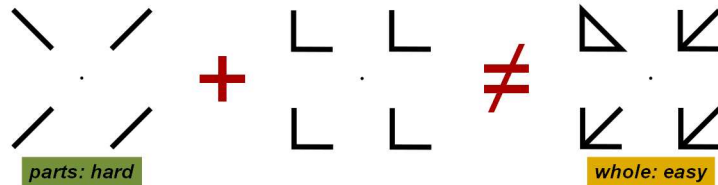
– full shape selectivity is observed in IT/LOC only

Feedback: early visual areas are crucially involved in producing the percept

– computational models require feedback/lateral connections
 – some Gestalt effects reported in early visual areas
 – early regions have the capacity to contain high-level shape representations

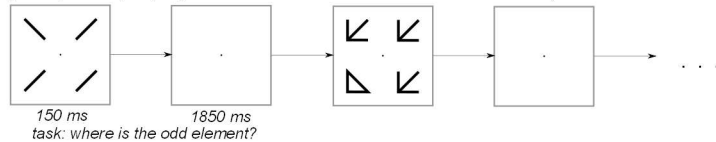
Case study: The configural superiority effect

detect the odd element



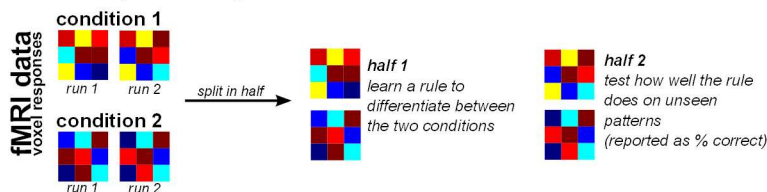
Method

1. Localization of retinotopic (V1, V2, V3) and shape-selective regions (LO, pFs)
2. Event-related paradigm to obtain neural responses to 8 conditions: (parts, whole) × (4 quadrants where the odd element could be)



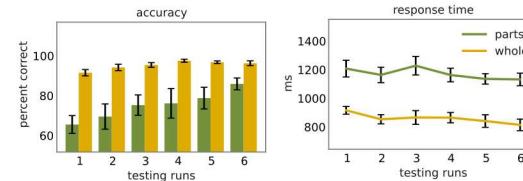
3. Multi-voxel pattern analysis (MVPA) using a support vector machine (SVM) to look for the neural configural superiority effect: a better discrimination between those conditions that are behaviorally easier

Multi-voxel pattern analysis in a nutshell



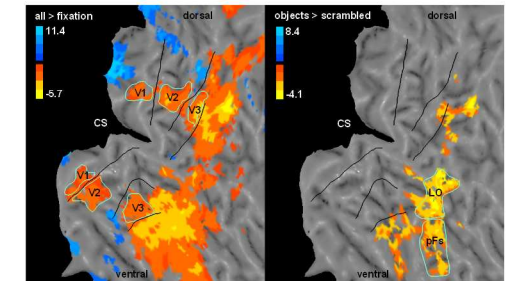
Results

Behavioral configural superiority effect



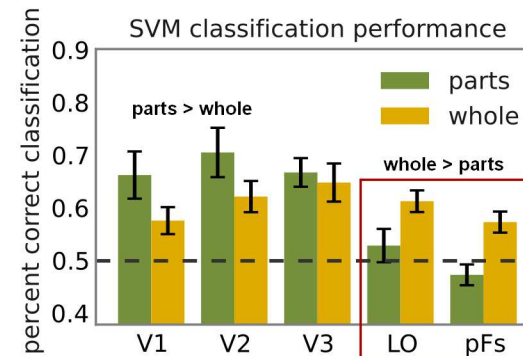
Behavioral configural superiority effect as observed in the fMRI scans (n = 8). These results demonstrate that the effect in reaction time and accuracy persists throughout all testing blocks.

Regions of interest



Flattened image of the right hemisphere of one participant with the ROIs (cyan outlines) used for SVM. Black lines indicate borders between V1 and V2, V2 and V3, and V3 and higher regions, as identified using meridian maps. Cyan regions mark the identified ROIs using the contrast all stimuli > fixation (V1, V2, V3; threshold .01 uncorrected) and objects > scrambled (LO, pFs; threshold .0001 uncorrected) in the localizer task. Calcarine sulcus is abbreviated as CS.

Where is the neural effect? (whole > parts)



Configural superiority effect emerges throughout the cortex

Earlier regions contain more information about the parts, with better neural detection of parts than of wholes. Higher regions represent the whole shape, with better neural detection of the whole.

Consistent with bottom-up processing, no feedback detected

If early regions were employed by higher regions via feedback in order to facilitate whole shape processing (that lead to the behavioral effect), then we should also have observed an advantage for the whole shape decoding in these early regions.

Conclusion

Configural superiority effect is consistent with the feedforward nature of visual processing

We propose that this method allows developing a taxonomy of Gestalt phenomena:

bottom-up – e.g., configural superiority effect

top-down – e.g., size-constancy illusion (Murray et al., 2006)