Real-time fMRI search for the visual components of object perception

**Cortical perception of complex visual properties**
- The visual features encoded by mid- and high-level cortical visual regions are not obvious.
- Very limited number of stimuli can be shown in neuroimaging study, compared to diversity of potentially cortically-relevant features
- We used realtime fMRI to explore cortical responses to specific features within restricted visual feature spaces for complex real-world or novel objects

**Methods**
- Participants shown photos of real-world or synthesized Fribble objects (Williams, 2000), drawn from 1 of 4 classes
- BOLD signals recorded with fast event-related design (2 sec TR, partial coverage) for 20 subjects

**Search for preferred visual properties**
- For each subject, select 4 brain regions associated with 4 stimulus classes
- Search in class-specific feature space for stimulus most activating brain region

**Example voxel regions studied**
- Example stimuli used in search for feature (center red circle) producing greatest activity

**Real-time stimulus selection**
- Stimuli selected based on BOLD response to past stimuli shown with simplex simulated annealing (Cardoso 1996)

**Visual feature space**
Feature spaces defined to capture visual similarities between stimuli, defined by SIFT (Lowe 2005) and defined by geometric morphs

**Behavior of search for preferred stimuli**
- Testing for desired performance
  - **Convergence**: focus on stimuli producing maximal response
  - **Consistency**: find similar features of interest regardless of where in space we start the search

**Selectivity in visual feature space**
- Invariance across subset of dimensions
- Multiple selectivities within brain region

**Objects highlighted by search**
- Stimuli sorted by S3 cortical response magnitude
- Surface and shape properties elicit marked cortical responses

**Discussion**
- Multiple feature-selective centers in the 125-voxel ROI within human ventral pathway
- ROI may be selective to variable sets of features (e.g., variable number of axes in feature space)
- Realtime searches converge on preferred stimuli with limited stimulus displays
- There is room for improvement in search performance

**References**

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