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Competition-Based Ground Suppression in Extrastriate Cortex and the Role of Attention

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Background

How are objects represented in visual cortex?

For multiple objects: Competition for representation [1,2]

For a single object (when 2 regions share a border):

- 1 side perceived as figure, other as shapeless ground
- Potential mechanism: inhibitory competition
  - Edge/feature units on opposite sides of border compete [3,4]
  - Losing units & features suppressed

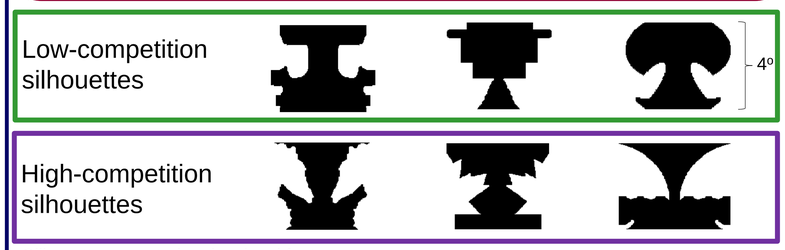
Behavioral evidence for inhibitory competition at the higher level of object shape [5,6]

- Ground suppression observed at low levels -- due to feedback? [6,7]

Goal of Experiment 1:

Search for neural evidence of ground suppression arising from object-level inhibitory competition

Experiment 1: fMRI



Silhouettes equated on low-level features

Prediction: if competition at object level:

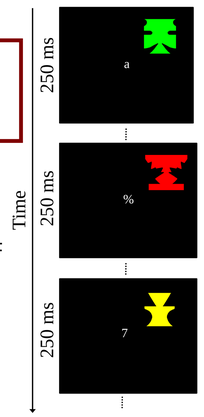
- Greater competition in high vs. low-competition
- More ground suppression in high vs. low-competition

Difficult RSVP task at fixation: [2]

- Detect lowercase letter in 4 Hz stream of digits/symbols
- Task-irrelevant silhouettes appeared in upper LVF or RVF

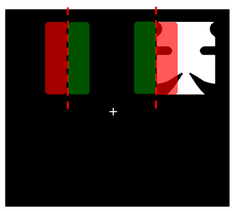
Block design:

- 10 stim (high- or low-comp, RVF or LVF) per block
- Jittered ISI: 750-1750 ms



Defining & localizing the ground:

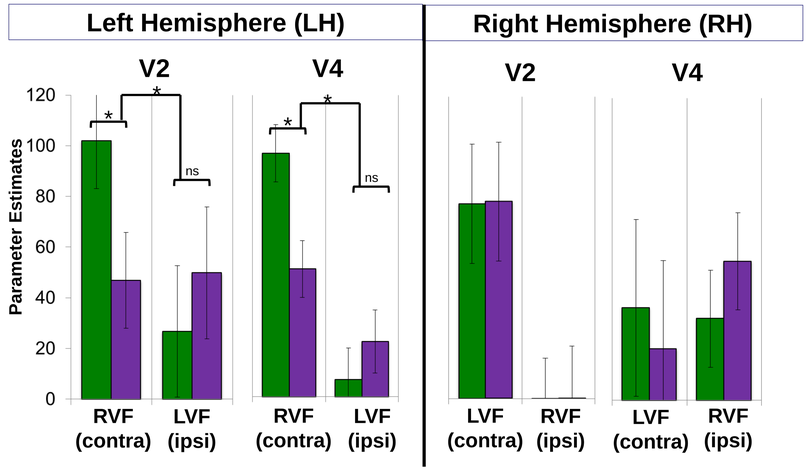
- Localized using 2º-wide dynamic Gabors
- On groundside of an imaginary vertical line drawn on the edge of silhouette border closest to fixation
  - No portions of figure included as ground
  - No regions that responded to Gabors on figure side
  - Conservative localization method



Localizing visual cortex: V1-V4

- Standard retinotopic mapping procedures [2,8]

Experiment 1: Results



* $p < .05$

In LH:

- Reduced activation in ground of high- vs. low-competition silhouettes
- Larger ground suppression in high- vs. low-competition
- Evidence of object-level inhibitory competition
  - In V4 and V2
  - V2: consequence of feedback?

Why LH only?

- Conflict detection system is LH lateralized [9,10, 11]
  - High-competition silhouettes are high in conflict
- Attention is drawn to conflict [12]
- Maybe attention only drawn to RVF high-competition silhouettes

Experiment 2 Question:

Can laterality effect be explained by conflict-driven attention?

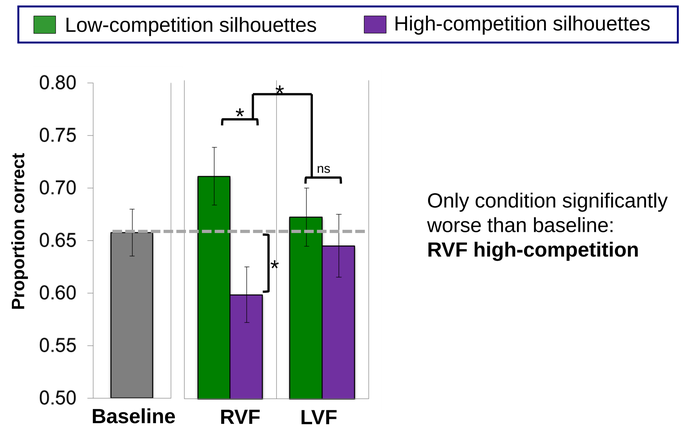
Experiment 2: Behavioral Study

Task similar to Exp. 1:

- Identify lowercase letter in 15-item RSVP stream at fixation
  - 42 ms exposure, 42 ms ISI
- Baseline trials: No silhouette in periphery
- Test trials: 1 task-irrelevant silhouette appeared 2 items before target letter
  - RVF or LVF, High- or low-competition
- Assess RSVP task performance as a function of silhouette type & location

If high-competition silhouettes in RVF draw attention, then RSVP performance should be impaired

Experiment 2: Results



Only condition significantly worse than baseline:
RVF high-competition

- Impaired performance only for RVF high-competition
  - Drew attention away from task at fixation

- LH-only suppression effect in Exp. 1 might have been due to attention
  - Conflict in RVF high-competition detected by LH & drew attention
  - Allocation of attention to RVF allowed competition to be resolved

Conclusions

Neural evidence of ground suppression arising from object-level inhibitory competition

- Greater competition from high-competition ground in V4 where RFs are large (~4º)
  - Greater ground suppression in V4 for High-C than Low-C
- Same pattern in V2 where RFs are small (~2º)
  - But no differential competition in V2 (stimulus features matched)
  - Feedback from high levels were RF can encompass object

Data support a dynamical visual system architecture

Attention necessary for high competition to be resolved

- Attention to visual quadrant?
- No evidence that attention drawn to inside of silhouette
  - Here or previous experiments [6]

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