Weakening perceptual representations through moderate excitation

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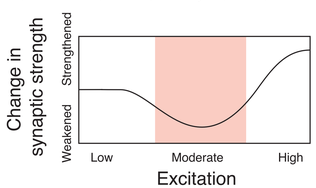
Introduction

Losing competitors are subsequently harder to access
- E.g., Negative priming - Tipper (1985)

Two stimuli simultaneously presented
- Subject asked to name one & ignore the other
  - e.g. "Name the red tinted image in the center"
- Later: the image to be named could be:
  - novel -or- previously ignored -or- previously named

Baseline RT | Slow | Fast

Models of learning suggest this happens because the competitor receives a moderate level of excitation when it competes
- E.g., Bienenstock, Cooper, & Munro (1982)
- E.g., Norman, Newman, Detre, & Polyn (2006)

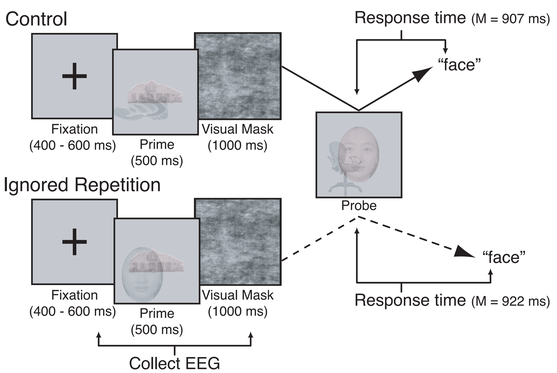


Same pattern has been found in vitro
- For example:
  - Post synaptic potential - Artola, Brocher, & Singer (1990)
  - Post synaptic Ca2+ concentration - Hansel, Artola, & Singer (1996)

Hypothesis:
Negative priming results from moderate excitation

Our approach:
1. Record EEG as subjects perform a negative priming task
2. Use pattern classifiers to measure distractor processing
3. Relate behavioral effect size to measured level of processing

Task Design: Delayed-match-to-sample with distractors



Subjects instructed to:
- Attend to centered tinted TARGET image
- Ignore offset grayscale DISTRACTOR image
- Say `match' if probe target is identical to prime target
- Name probe target if targets are not identical

Trial types:
- Control trials:
  - Categories of probe stimuli unique from prime stimuli categories
- Ignored-repetition trials:
  - Probe target identical to prime distractor

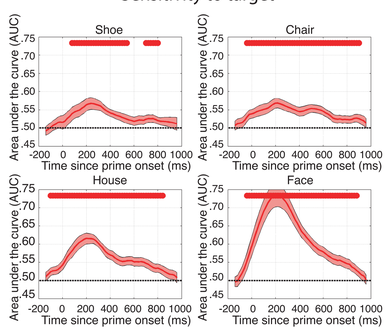
Results

Behavioral results:
- Time to name novel image (**907ms**)
- Time to name ignored image (**922ms**)
- Priming effect (**-15ms**) (t(15) = 2.71, p < .05)

- Task generates standard weak negative priming effect

Classifier sensitivity analysis:

Sensitivity to target

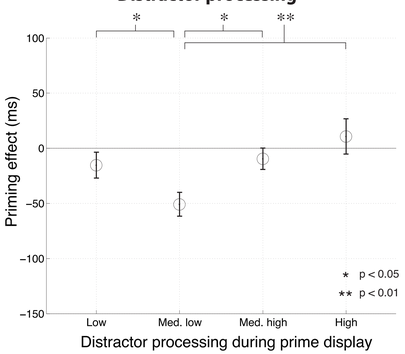


Sensitivity to distractor (area under ROC)
- Shoes, M = .52, t(15) = 4.26, p < .001
- Chairs, M = .52, t(15) = 3.35, p < .01
- Houses, M = .53, t(15) = 2.44, p < .05
- Faces, M = .58, t(15) = 4.38, p < .001

- Classification analysis sensitive to processing of all four categories of distractor stimuli

Priming effect as function of:

Distractor processing

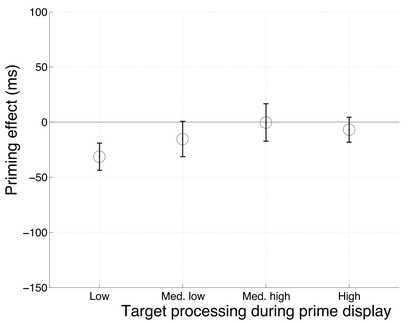


- Priming effect varies nonmonotonically as function of level of distractor processing

- Moderate processing predicts significantly larger priming effect than either less or more processing

Priming effect as function of:

Target processing



- Priming effect does not vary across levels of target processing

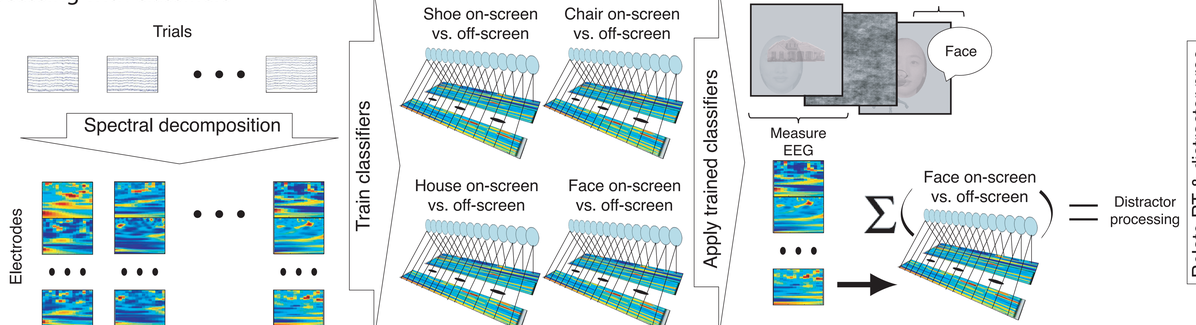
Conclusions & Discussion

Moderate processing of a perceptual representation reduces the subsequent accessibility of that representation

This result links the conditions known to induce synaptic weakening in rodents to diminished accessibility of perceptual representations in humans

Analysis Design: Detecting distractor processing with classifiers

1. Perform spectral decomposition
   - Wavelets (49 bands from 2-128 Hz)
   - Spectral components concatenated to make feature vectors
2. Train classifiers to detect each category
   - One classifier per category per time bin
   - On-screen-as-target vs. off-screen
   - Trained with ridge regression
3. Apply trained classifiers
   - Classifier trained to detect the category of the distractor image used for each trial
   - Sum output over time bin classifiers
4. Relate RT and distractor processing
   - Split trials into quartiles using classifier output
   - Compute priming effect per quartile



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