

# Selection & Controlled Retrieval: Shared Neural Substrates, Differential Modulation by Anxiety and Depression

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## Background

### Role of Left VLPFC is Debated

- ▶ During language production, words must constantly be retrieved and selected for production in the face of many possible alternatives (e.g. multiple different words can express the same thought).
- ▶ Left ventrolateral prefrontal cortex (VLPFC) is involved but exact role is debated:
  - **Selection** between competing alternatives.<sup>1</sup>
  - Top-down **controlled retrieval** of semantic knowledge.<sup>2</sup>
  - **Two-processes account:** anterior-VLPFC subserves retrieval, mid-VLPFC subserves selection.<sup>3</sup>
- ▶ Each theory supported by some evidence but challenged by other findings.
- ▶ We propose discrepancies reflect problems in how these processes have been operationalized and measured: Correlated measures of selection and retrieval demands.

### Effects of Selection & Retrieval Demands

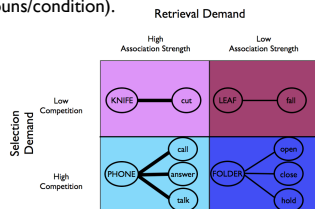
- ▶ Unconfounded measures reveal independent behavioral effects of selection and retrieval demands.<sup>4</sup>
- ▶ Current Study: Use improved, unconfounded, measures of selection and controlled retrieval demands based on LSA.<sup>5</sup>
- ▶ Possible neural implementations:
  1. Separate neural substrates support selection and controlled retrieval:
    - One process in VLPFC, one elsewhere?
    - Different subregions of VLPFC?
  2. Shared neural substrates support selection and controlled retrieval:
    - Different mechanisms in VLPFC?

### Selection & Retrieval May Be Differentiated by Anxiety & Depression

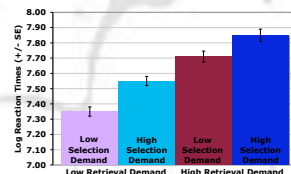
- ▶ Anxiety linked to selection deficits<sup>6</sup> and VLPFC dysfunction.<sup>7</sup>
  - Thus, predict anxiety will affect VLPFC during selection.
- ▶ Depression linked to retrieval monitoring deficits<sup>8</sup> and ACC dysfunction.<sup>9</sup>
  - Thus, predict depression will affect ACC during retrieval.

## Verb Generation Task

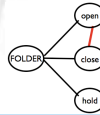
- ▶ For each noun, say the first verb that comes to mind.
- ▶ Independently manipulated selection demand (competition) and retrieval demand (association strength) (25 nouns/condition).



## Selection & Retrieval Demands Influence RT

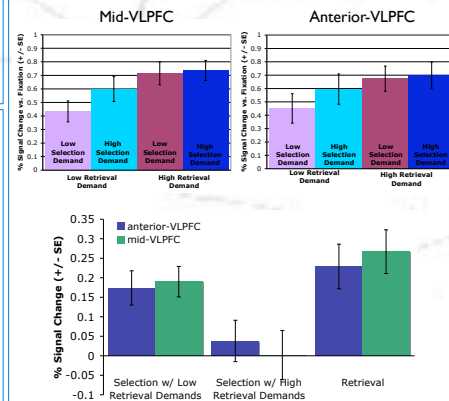


- ▶ Independent effects of selection demand ( $F(1,82)=215, p<.001$ ) and retrieval demand ( $F(1,82)=388, p<.001$ ).
- ▶ Significant interaction between selection and retrieval demands: effect of selection demand most apparent when retrieval demands are low ( $F(1,82)=12.1, p=.001$ ).
- When association strength is low, spreading activation between alternative responses may aid retrieval, counteracting selection cost.



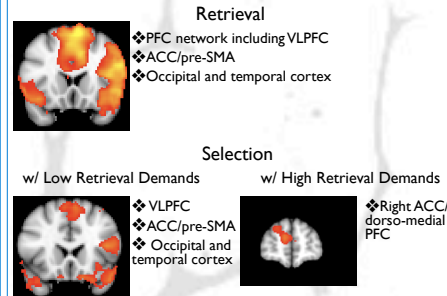
## Selection & Retrieval Demands Influence Left VLPFC

- ▶ Independent effects of selection demand ( $F(1,16)=15.32, p=.001$ ) and retrieval demand ( $F(1,16)=21.53, p<.001$ ).
- ▶ Significant interaction between selection and retrieval demands: effect of selection demand most apparent when retrieval demands are low ( $F(1,16)=4.68, p=.046$ ).
- ▶ No dissociation between mid and anterior VLPFC:
  - No interaction between region and selection demand ( $F(1,16)=0.72, p=.4$ ), retrieval demand ( $F(1,16)=0.95, p=.3$ ), or their interaction ( $F(1,16)=0.09, p=.8$ )



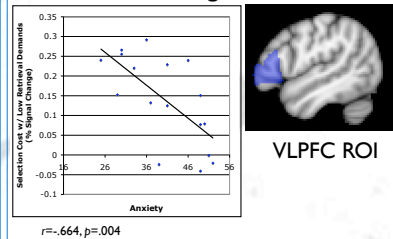
## Exploratory Whole-Brain Analysis

- ▶ Both selection and retrieval tap larger network, prominently including ACC/pre-SMA.



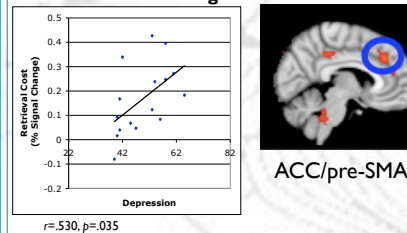
## Selection & Retrieval Differentially Modulated by Anxiety and Depression

### Anxiety Impairs Left VLPFC Activity During Selection



- ▶ Consistent with impaired selection and VLPFC dysfunction in high-anxiety participants.

### Depression Increases ACC/pre-SMA Activity During Retrieval



- ▶ May reflect monitoring retrieved items for task-relevance or compensation for poor top-down control.<sup>10</sup>

## Conclusions & Directions

### Shared Neural Substrates in VLPFC Support Selection and Controlled Retrieval

- ▶ Both selection and controlled retrieval demands elicit RT costs and activate left VLPFC, contrary to accounts positing a single role for left VLPFC.
- ▶ No dissociation between mid and anterior VLPFC, contrary to two-process account.
- ▶ Instead suggest that two properties of PFC support selection and retrieval within in the same cortical areas:
  - Competitive inhibition specifically critical for selection.<sup>4</sup>
  - Recurrent connectivity may support both retrieval and selection.

### Selection & Controlled Retrieval Interact in VLPFC

- ▶ Selection effects strongest when retrieval demands are low (both behaviorally and in VLPFC).
- Neural network model: When retrieval is difficult, spreading activation between alternative responses can boost their activation level.<sup>4</sup>

### Selection & Controlled Retrieval Differentiated by Relation to Psychopathology

- ▶ Anxiety specifically impairs VLPFC recruitment during selection. May be linked to decision-making problems and intolerance of uncertainty in anxiety.
- ▶ Depression increases pACC/pre-SMA recruitment during retrieval. Potentially linked to retrieval monitoring deficits in depression.

### Ongoing and Future Directions

- ▶ Study with selected high and low anxiety subjects.
- ▶ Comparing underdetermined to prepotent competition.
- ▶ Effects of depression on retrieval monitoring.

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