Working Memory (Goal Maintenance and Interference Control)

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Outline

- Goal Maintenance
- Interference resolution: distraction, proactive interference, and directed forgetting

Working Memory

• Goal Maintenance: The processes involved in activating task related goals or rules based on endogenous or exogenous cues, actively representing them in a highly accessible form, and maintaining this information over an interval during which that information is needed to bias and constrain attention and response selection.

Goal Maintenance

- Not a major factor in simple working memory (WM) task (e.g., item recognition)
- Major factor in WM tasks that require control processes, complex span tasks (Engle, 1989)
- Complex span tasks require shifting of goals Ex: Operations Span



Recall Words

Working Memory

• Interference Control: The processes involved in protecting the contents of working memory from interference from either other competing internal representations or external stimuli.

Meta-Analysis of Some Control Processes (Wager & Smith, 2003)

- Meta-Analysis distinguished between three kinds of control process
 - Continuous updating of WM (e.g., n-back)
 - Attending to order information (e.g., alpha span, n-back)
 - Dual tasking (e.g., Operation span) and/or transformation (e.g., mental arithmetic)
 - Focus: Activation in each Brodmann Area (BA) for control process vs. maintenance only



Frequencies for each executive function in comparison with storage-only tasks for each Brodmann's area



Interference Control

- Controlling distraction: Retroactive Interference
- Proactive interference
- Directed forgetting

Control During Distraction: Behavioral Findings

- Distractors vs. no-distractors: minimal memory vs. good memory
- More similar distractors cause more interference
- Usurping attention vs. creating interfering representations (cross-talk) vs. dual-tasking

Neural Evidence that Offsetting Distraction Requires Control Processing

- Patient studies: Frontal patients impaired in WM mainly when distracters presented
 - Frontal patients not impaired on memory span (D'Esposito & Postle, 2000)
 - Frontal patients impaired in auditory item recognition only when distracters present (Chao & Knight, 1995)
 - Dorsolateral PFC may be inhibiting posterior areas that represent distracters (Chao & Knight, 1998)

Imaging Evidence for Role of PFC in Offsetting Distraction

- Focus on PFC activity when just seeing distractors: minimize dualtasking (Jha et al., 2004)
- Two different regions:
 - Ventral PFC selection among alternatives (Thompson-Schill et al., 2005)
 - Dorsolateral PFC executive attention/inhibition
- Results for delay period (15000 msec)
 - Both Left ventral and dorsal PFC activated by distractors
 - Only Left ventral PFC affected by similarity of distractors: more selection needed
 - Face area more activated when maintaining face than non-face



Schematic of Jha et al. (2004) behavioral paradigm and task design

Left Ventrolateral PFC



Left Ventrolateral PFC activity by working memory domain (Jha et al., 2004)

Connections to Schizophrenia Research

- Interference tasks
 - Schizophrenics impaired when distracters present (Fleming et al., 1995)
 - Impairment associated with less activation than normals in dorsolateral PFC
 - Impaired components: selection and attention/inhibition?

Proactive Interference in WM

- Interference from prior trial: Recent negatives in item recognition
- Behavioral finding: Longer RTs to recent negative probes (Monsell, 1978)
- Effect due to conflict about probe: Familiarity vs. set membership
- Imaging finding: Recent vs. nonrecent probes: Left, ventrolateral PFC selection (Jonides, Smith et al., 1998)



A schematic of the Recent-Probes task



Activation for recent vs. non-recent negatives (Jonides, Smith et al., 1998)



Activation for recent vs. non-recent negatives in left ventrolateral PFC (D'Esposito et al., 1999)

Two Kinds of Proactive Inhibition

- Familiarity of probe competes with memory of set-membership (at time of retrieval)
- Probe associated with another response, and competition occurs among responses (at time of retrieval)

Nelson et al. (2003) Trial structure and examples of trial conditions



Nelson et al. (2003) Mean reaction times for the various probe types



Nelson et al. (2003)

(A) Identified clusters of activation that overlap with ROIs in the response-conflict contrast (yellow) and the familiarity-conflict contrast (blue). Indicated Z-coordinates refer to MNI space. (B) The average *t* values of voxels within the identified clusters of activation in the key contrasts of interest. mPFC, medial prefrontal cortex.



Directed Forgetting in WM

- Directed forgetting similar to offsetting distraction -- inhibition of to-be-forgotten/attention to to-be-remembered
- Different attentional/inhibitory mechanisms involved than in offsetting perceptual distraction

Nee & Jonides (2008) *Psychological Science* A schematic of the tasks



Nee & Jonides (2008) Results

	Ignore			Forget		
	Lure	Control	Valid	Lure	Control	Valid
Mean RT (SD)	642.89 (31.14)	619.82 (23.65)	619.88 (25.5)	698.89 (32.59)	619.43 (29.87)	614.18 (33.29)
Mean ER (SD)	1.8 (2.5)	3.3 (5.3)	3.5 (3.4)	9.8 (7.0)	5.2 (6.5)	14.8 (10.9)

Nee & Jonides (2008). Occipital cortex demonstrated unique Ignore activation whereas left dorsolateral prefrontal cortex demonstrated unique Suppress activation





Nee & Jonides (2008). Regions demonstrating common interference-related activity for Ignore and Suppress



Summary

- Goal Maintenance
 - More of a factor in complex WM-span tasks
 - Also a factor in many cognitive-control tasks (e.g., Stroop)
- Interference Resolution
 - Three kinds: distracters, PI, directed forgetting
 - All involve conflict
 - All activate ventral or dorsal PFC