



Tasks of Inhibition and Short-term Memory: Comparison of Patients with Phonological and Semantic Short-Term Memory Deficits

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INTRODUCTION

Martin, Shelton and Yaffee (1994) demonstrated dissociable phonological and semantic components of short-term memory. Brain damage affecting these separable capacities yields distinct patterns of performance on short-term memory tasks as well as on sentence comprehension and language production. Lesion data suggest that semantic short-term memory deficits are associated with damage to middle and inferior frontal areas, whereas phonological deficits are associated with more posterior damage. Recent neuroimaging data (Martin et al., in press) provide converging evidence for frontal involvement in semantic retention and posterior involvement in phonological retention. Consistent with damage to frontal areas, patients with impairment of semantic short-term memory appear to have particular difficulty with tasks requiring inhibition. Here we compare patients with semantic short-term memory deficits and phonological short-term memory deficits on several tasks of executive function that are commonly assumed to require inhibition - the Stroop task, a nonverbal Stroop-like task, a task of proactive interference, and the antisaccade task. Data from a semantic short-term memory patient revealed impaired performance on tasks that required inhibition of irrelevant verbal information (e.g., Stroop Task, proactive interference) but no impairment on tasks not requiring manipulation of verbal material (nonverbal Stroop and antisaccade task). Given that inhibition is thought to be a component of executive function (Miyake et al., 2000), the current findings raise questions about the organization of executive function and verbal short-term memory. Further, the findings suggest that inhibition is not represented globally in frontal areas but rather that different regions may be involved in domain-specific inhibition.

PATIENTS

SEMANTIC STM DEFICIT

Patient ML

- 62 year-old male
- Education: two years of university course work
- CVA - 1990
- Lesion -left frontal and parietal operculum
- Production: halting with reduced phrase length
- semantic working memory deficit (Freedman and Martin, 2001)
- serial recall span = 3 items

PHONOLOGICAL STM DEFICIT

Patient EA

- 73 year-old female
- Education: Baccalaureate
- CVA - 1975
- Lesion -left temporal & parietal
- Production: good production w/ occasional difficulty producing multi-syllable words
- phonological working memory deficit (Martin, Shelton and Yaffee, 1994)
- serial recall span = 2 items

Patient JM

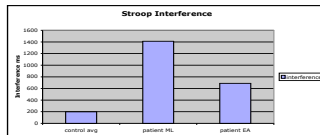
- 57 year-old male
- Education: High School
- Aneurysm - 1999
- Lesion - left fronto-parietal-temporal
- Production: nonfluent
- serial recall span = 1-2 items

STROOP TASK

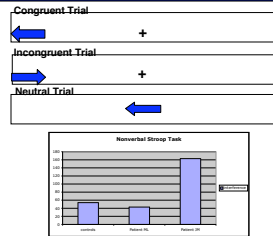
STROOP TASK

- Stroop Task commonly thought to require inhibition
- Patient ML (semantic STM deficit) demonstrates exaggerated interference effects for incongruent trials in Stroop Task
- Patient EA (phonological STM deficit) shows greater interference relative to controls, but less than Patient ML.

STROOP TASK



NONVERBAL STROOP



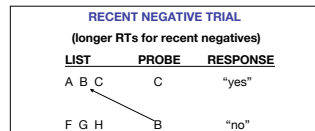
- Patient ML (semantic STM deficit), who demonstrates greatly exaggerated interference effects on verbal Stroop task, shows interference effects within range of controls on a presumably analogous nonverbal task
- NOT a deficit of inhibiting ALL types of conflicting responses

PROACTIVE INTERFERENCE

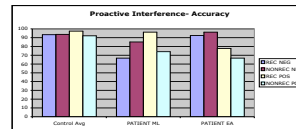
LETTER PROBE RECOGNITION TASK

- Three item memory list followed by a probe
- Subject indicates whether probe item appeared in list
- Measure accuracy and reaction time
- Manipulate recency - a probe may not appear in present list, but DID appear in previous list

Critical Condition: Recent Negatives - probes that appeared in previous list have longer RTs - inhibition presumably necessary to resolve proactive interference (Jonides et al., 1998)

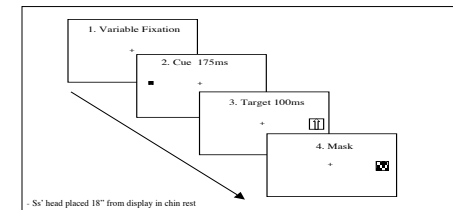


- Patient ML (semantic STM deficit), demonstrates exaggerated effects for recent negatives in a modified letter probe recognition task manipulating recency of items
- Patient JM, a patient with a similar STM span, but NOT specifically attributable to a deficit of either semantic or phonological STM, shows very little effect of PI

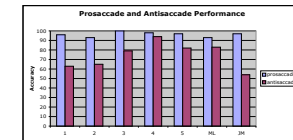


- On a similar PI paradigm (using one-syllable words), Patient ML (a semantic STM deficit) shows considerable effects of PI in both RT and accuracy, while Patient EA (a phonological STM patient) shows no such PI as measured by RT or accuracy

ANTISACCADE TASK



- Antisaccade task is thought to measure inhibitory functions important in working memory (WM)
- WM/ STM related to the ability to inhibit prepotent responses (Roberts et al. 1994)
- WM/ STM capacity reflects general capability to maintain information in highly active state and suppress irrelevant stimuli via controlled attention (Kane et al., 2001)



- Patient ML (semantic STM deficit) is within range of age- and education-matched controls in both accuracy and RT - No impairment in inhibiting prepotent responses and reflexive saccades
- Patient EA (phonological STM deficit) is unable to perform this task
- Patient JM also performs poorly on this task

CONCLUSIONS

- Patient studies may assist in elucidating the relationship among executive function, WM/STM and inhibitory mechanisms
- Patient ML's impaired performance on Stroop task and normal performance on the antisaccade task represent a dissociation of tasks previously reported to load on a single "Inhibition" factor (Miyake et al., 2001, Friedman and Miyake, 2002)
- Semantic STM deficit is associated with impaired performance on Stroop and Proactive Interference Task (both are verbal tasks)
- Although impaired on verbal tasks of inhibition, patient ML demonstrates no impairment on nonverbal tasks (non-verbal Stroop and antisaccade tasks)
- While semantic STM deficit associated with exaggerated PI, no PI observed in phonological STM deficit
- Patient ML not impaired on ALL inhibition tasks - in fact, normal performance on antisaccade task and a nonverbal Stroop task

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