



# The Role of Inhibition in Lexical Selection: Evidence from Nonfluent Aphasia

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## INTRODUCTION

Several case studies of aphasic patients with left frontal damage have reported preserved single picture naming but impaired naming with various contextual manipulations. McCarthy and Kartsounis (2000) reported that their patient FAS was impaired naming pictures blocked by semantic category, particularly at a fast presentation rate. McCarthy and Kartsounis hypothesized "refractory" lemma access that disrupted access to the same and related items. According to this account, lexical representations undergo a period of inhibition after being highly activated, and the inhibition is deeper or longer lasting for the case of the left frontal patients. A different argument was made by Schnur, Schwartz, Brecher, & Hodgson (2006). They had frontal and posterior aphasic patients name pictures in repeated sets that were semantically blocked or not, and found that left frontal patients had exaggerated semantic interference in naming. Based on the pattern of errors that the frontal patient made, they argued that the patients were having difficulty in selecting lexical representations due to a deficit in selecting among several highly activated items, which they attributed to a deficit in an executive mechanism involved in inserting lexical items into syntactic frames.

Our lab has reported an aphasic patient, ML, who is similar in that he has left frontal damage and excellent single picture naming, but shows impaired onset latencies for producing conjoined noun phrases from semantically related picture pairs (Freedman, Martin, & Biegler, 2004). We have attributed his difficulties to a semantic short-term memory (STM) deficit (Martin & He, 2004). Recently, we have also found that ML is impaired in tasks involving inhibition abilities (Hamilton & Martin, 2005), and have hypothesized that a deficit in a post-lexical selection inhibitory mechanism may be the cause of his nonfluent speech, STM deficit (Martin & Biegler, 2006), and exaggerated semantic interference. If it is the case that ML has a deficit to a post-selection inhibitory mechanism, then we would expect for him to show exaggerated semantic blocking effects only when spoken responses must be made. We assessed this in the current study through several semantic blocking tasks involving production or comprehension. We also tested another nonfluent patient, AR, who shows some similarities to ML, and a fluent patient LW, who has a phonological processing deficit, for comparative purposes.

### Patient Information

ML is a 63 year-old right-handed male who suffered a CVA in 1990, resulting in lesion affecting the left inferior and mid-frontal gyri and the left parietal lobe. His speech is slow and halting, but he performs at a high level on single picture naming tasks, scoring 98% correct on the Philadelphia Naming Task.

AR is a 70 year-old right-handed male who suffered a CVA in 1999, resulting in a substantial left hemisphere lesion including frontal, parietal, and temporal regions. His speech is very effortful, but he performs at a high level on single picture naming tasks, scoring 95% correct on the Philadelphia Naming Task. AR shows a deficit in inhibition on some tasks, including picture-word interference, though his pattern is less consistent than that of ML.

LW is a 71 year-old right-handed male who suffered a CVA in 2003. Lesion information has not been collected from him. His speech is fluent, and his performance on various tasks is consistent with a phonological STM or phonological deficit. He performs also performs at a high level on single picture naming tasks, scoring a 96% correct on the Philadelphia Naming Task.

## EXPERIMENT 1

### Cyclic Naming with Single and Multiple Picture Presentations

Given ML's documented deficit in inhibition, he would be unlikely to show an exaggerated blocking effect if the effect in nonfluent patients is due to refractory access - that is, an excess of inhibition. On the other hand, if the deficit is due to over-activation and difficulty in suppressing competitors, he would be expected to show a greatly exaggerated effect. A similar prediction can be made for AR. In contrast, LW does not show an inhibition deficit and would be predicted to show a normal pattern.

#### Method

Materials consisted of 72 pictures, 6 from each of 12 semantic categories. Items were presented in blocks of 6 pictures. Each picture was presented 4 times in a block. Subjects saw each picture in both a semantically blocked and unblocked context. In the single-picture condition, pictures were individually presented. In the multiple-picture condition, subjects were presented with an array of 6 items that remained on the screen and were probed by highlighting the picture for the subject to name.

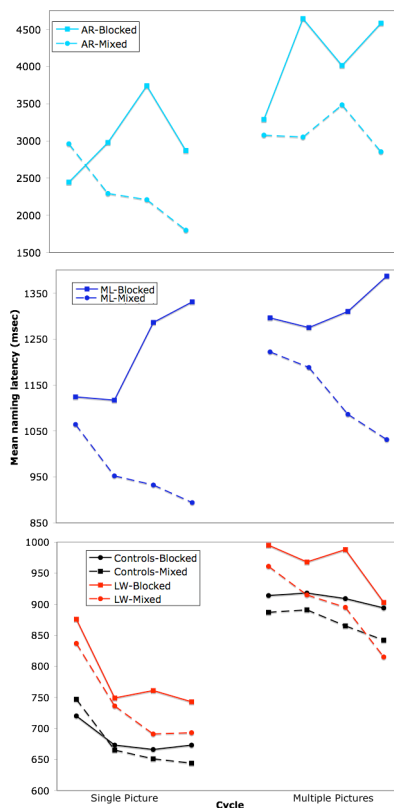
#### Results

All subjects were highly accurate on these tasks. All subjects were significantly slower in responding to items that were semantically blocked, but the controls and LW showed different patterns from ML and AR. The controls and LW showed decreasing onset latencies for both the semantically blocked and mixed conditions across cycles with the semantic interference effect increasing across cycles. ML and AR also showed decreasing onset latencies across cycles for the semantically mixed condition, but showed increasing onset latencies in the semantically blocked condition.

#### Discussion

The two nonfluent frontal patients showed a divergent pattern from the other subjects in the related condition. This would seem to indicate that they were having difficulty in resolving competition. We hypothesized that the patients were having difficulty to a deficit in an inhibitory post-selection mechanism acting on lexical representations. If this were the case, then we would not expect to see the pattern of an increasing blocking effect in a similar comprehension test.

Naming Latencies for Blocked Cyclic Naming Task



## EXPERIMENT 2

### Cyclic Word-Picture Matching with Single and Multiple Picture Presentations

#### Method

Materials were the same as in Experiment 1, and blocking and cycle were manipulated as well. In the single-picture condition, subjects were presented with a picture and an auditory word and responded whether the picture and word matched. In the multiple-pictures condition, subjects were presented with an array of pictures and an auditory word, and pressed a key corresponding to the picture that matched the word.

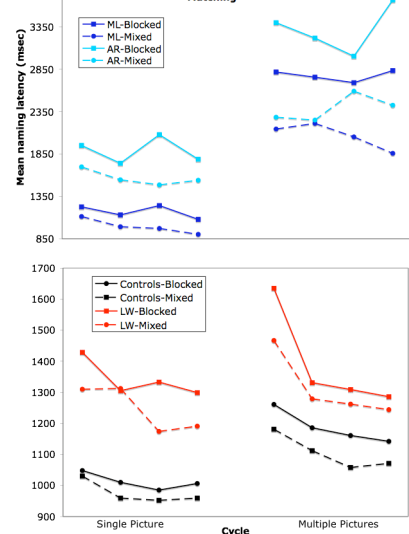
#### Results

Accuracy was again high for all subjects. All subjects showed a main effect of semantic blocking effect, but the controls did not show an increasing blocking effect with cycle. The controls and LW again showed significantly decreasing response times across presentations for both conditions. ML and AR again showed somewhat larger semantic blocking effects, but there was inconsistent evidence for an increasing semantic blocking effect, with ML's blocking effect being within the range of controls for the single-picture presentation. ML and AR also did not show a significant trend for increasing response times for the semantically blocked condition, which was very robust in Experiment 1.

#### Discussion

All subjects again showed a main effect of semantic blocking effect, but the exaggerated and growing effect was not seen for the nonfluent frontal patients in this case.

Response Latencies for Blocked Cyclic Picture-Word Matching



## CONCLUSIONS

The nonfluent frontal patients' difficulty in repeatedly naming items from the same category suggests a deficit in inhibiting highly active competitors. Less evidence was found for an exaggerated difficulty in the comprehension task, suggesting that the deficit giving rise to the semantic blocking effect for the patients is only involved in production. Other recent evidence converges in showing that ML has a deficit in inhibiting irrelevant verbal representations (Hamilton & Martin, 2005) - and the inhibition deficit may be the source of his STM deficit. The results across patients suggest that the left frontal lobe participates in the control of lexical retrieval, but it is still uncertain what the exact nature of the role it plays. The results from ML across studies point to a deficit in a post-selection inhibitory mechanism in his case.

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