

# Selection for position: The role of left inferior frontal gyrus (LIFG) in sequencing nouns



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## Background

The study of patients with brain damage is key to determining the causal relations between brain areas and cognitive components. Neuropsychological studies of syntax have often focused on the grammatical impairments in Broca's aphasia (e.g., reduced grammatical complexity, omission of function words) while presuming a link with underlying damage to Broca's area (Brodmann 44/45). But, the syndrome itself is a cluster of *dissociable* impairments, and damage to Broca's area is neither necessary nor sufficient to produce these deficits (see e.g., Dick, et al., 2001).

## Biasing hypothesis

Our approach is to isolate a key component of syntax (sequencing) and delineate the mechanism by which LIFG could influence this process. LIFG is consistently implicated in the selection of a task-relevant representation from amongst competitors (e.g., Jonides & Nee, 2006). Damage to LIFG results in syntactic impairments as well as exaggerated interference in non-syntactic cognitive control tasks (Hamilton & Martin, 2007). We hypothesized that inadequate biasing of competitive interactions may underlie both types of deficits.

## Selection for position

Previous studies have explored the role of LIFG in resolving semantic interference during language production (Schnur, et al., 2009). Here we explore *positional* interference. Does the ability to flexibly position nouns in appropriate phrasal positions depend on LIFG-mediated cognitive control processes?

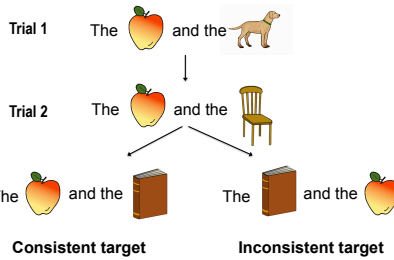
## Patient selection

- Substantial damage to frontal (BA 44/45/47) and minimal damage to posterior areas.
- Highly proficient in single-picture naming.

Table 1: Background Information

	WAB Fluency	WAB Comp	Naming (PNT)	STM Span	Reversible Comp	Closed Class	Well-formed Verbs	
CBD	8	9.75	95	3.2	73	0.48	0.42	0.73
MD	9	9.6	88	3.4	97	0.56	0.43	0.95
TB	9	8.85	91	4.6	63	0.5	0.48	0.62
UT	9	9.8	90	5	100			
Control						0.54 (0.04)	0.48 (0.06)	0.95 (0.08)

## Multword priming task



Interference effect = latency on inconsistent minus consistent

## Interference effects on latency

Patients CBD and TB show exaggerated interference relative to controls

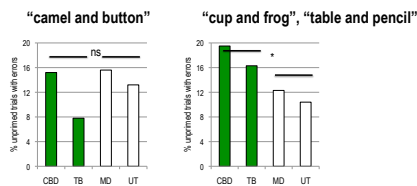
Table 2: Interference Scores

Participant(s)	Session 1	Session 2
	interference score (ms)	interference score (ms)
Controls (N=8)	69.74 (SD=97.28)	N/A
CBD	790.86*	1084.53*
MD	-416.60*	-83.90
TB	406.57*	317.03*
UT	198.90	120.41

\* denotes a significant effect at p<.05 (Crawford test)

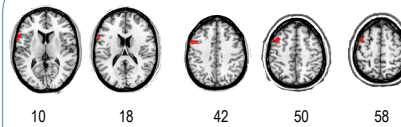
Table 3: Errors

Patient	# errors	% unprimed errors
CBD	90	33.33
MD	61	9.84
TB	78	42.31
UT	53	1.89



The same two patients (CBD and TB) also made more errors, including omissions, on unprimed trials. They differed from the other two patients particularly on trials where an inanimate noun was placed first.

## Anatomical correlates



Areas where CBD and TB have damage and MD does not: BA 44/6 extending dorsally to BA 44/6/9.

Locus is consistent with fMRI studies of sequencing (Gelfand & Bookheimer, 2003; Grewe, et al., 2006)

## Conclusions

- A subset of LIFG patients showed impairment in "selection for position". They had difficulty overriding prepotent positions for nouns (short-term priming or long-term animacy biases).

- Correlation with comprehension of non-canonical sentences and production of well-formed sentences is suggestive and needs to be explored (Table 1: Reversible Comp & Well-formed).

- Suggested anatomical locus is BA 44/6. Domain-generality of the impaired mechanism needs to be explored.

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