IDENTIFYING THE ROLE OF THE INTERFERENCE-ELICITED MEDIAL FRONTAL NEGATIVITY:

Effects of Working Memory Load revealed by Independent Component Analysis

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Background

- Interference manipulations in Stroop and Sternberg tasks produce a unique **medial frontal negativity** 400-500 ms after stimulus presentation (**MFN** or N450).[1,2]
- **Question**: What is the functional nature of the MFN?
- **Design:** Vary working memory (WM) load to see whether reduced attentional capacity would affect the neural response to interference as indexed by MFN.

Hypotheses:

If the MFN is a correlate of reflexive responses proportional to the extent of interference, then as WM load increases the amplitude of conflict-related responses should also increase (i.e. *larger* MFN)

OR

If the MFN is a correlate of an adaptive process, increased WM load will decrease resources available for interference resolution and, therefore, decrease the amplitude of resolution-related responses (i.e. *smaller* MFN)

Method

Sternberg Task

Memory Load:	Low	Medium	High
-Serial exposure -800 ms/item	hill tack	hill tack fly save	hill tack fly save arm bowl
Delay:	(1800-2200 ms)		
Probe:	hill	barn	bowl
Response:	"positive"	"negative"	"positive"

(Time)

Interference Manipulations

Trial	Memory Set		Probe	Condition
n-1	jail trip pine art		pine	
n	hill tack fly save	IF	tack	→ *Positive*
		IF	barn	→ *Negative*
		IF	art	→ *Neg/Familiar**
		IF	pine	→ *Neg/Response Conflict**

* The two interference conditions produced similar MFNs (in timing and topography) and have been collapsed in the present analysis

- Trials: 188 Pos, 48 Neg, 48 Fam, 48 RC X 3 WM loads
- Presented in randomized runs of 15 trials per load

Participants

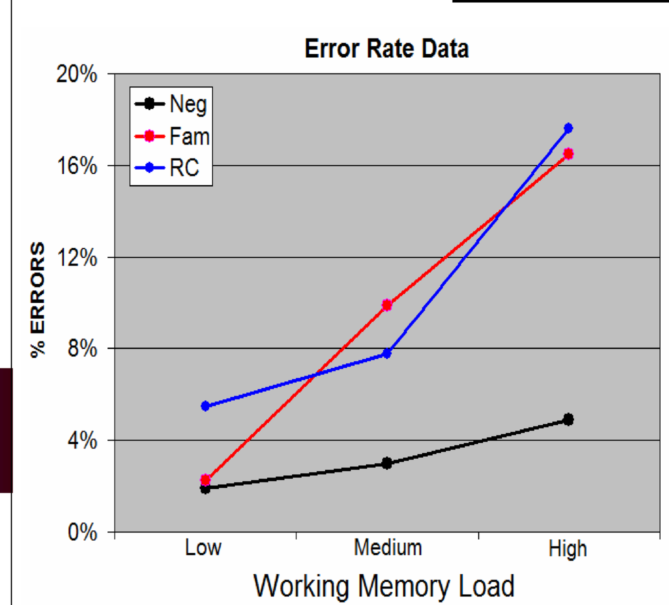
- 16 right-handed Brock Univ. undergrads (12 female)
- Mean age = 20.4 years (range: 18-26; SD = 1.8)
- Screened for neuropsych problems, vision, etc.

Electrophysiological Recordings

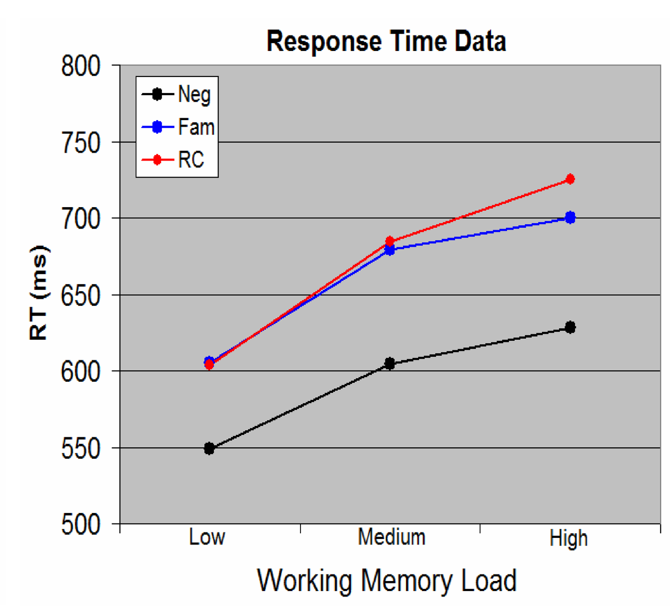
- Recorded using 128-Channel EGI system at 500 Hz with a vertex reference and impedances < 50 kΩ
- Data were filtered offline at 1-30 Hz
- Correct trials were extracted and blinks were corrected with a bipolar regression algorithm in MATLAB. Remaining artefacts were rejected.
- ERP grand averages are shown with an average reference in all figures
- MFN scored at peak frontal site of negativity between 410-470 ms following the probe

Results

Behavioural Results



Cond x Load $F(60,4)=10.69$, $p<.001$

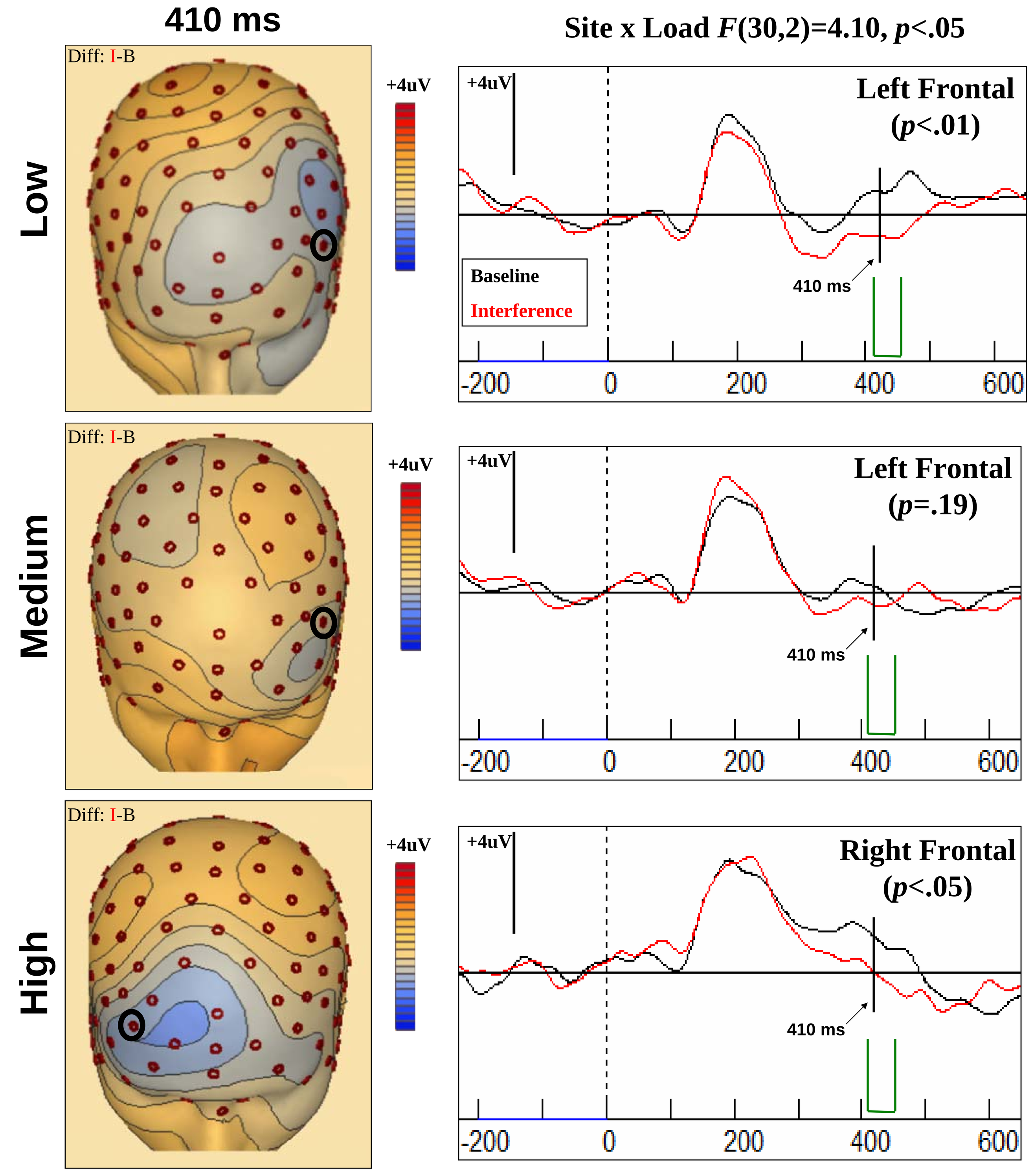


Condition $F(30,2)=32.06$, $p<.001$
Load $F(30,2)=21.89$, $p<.001$

Preliminary ERP Results

410 ms

Site x Load $F(30,2)=4.10$, $p<.05$



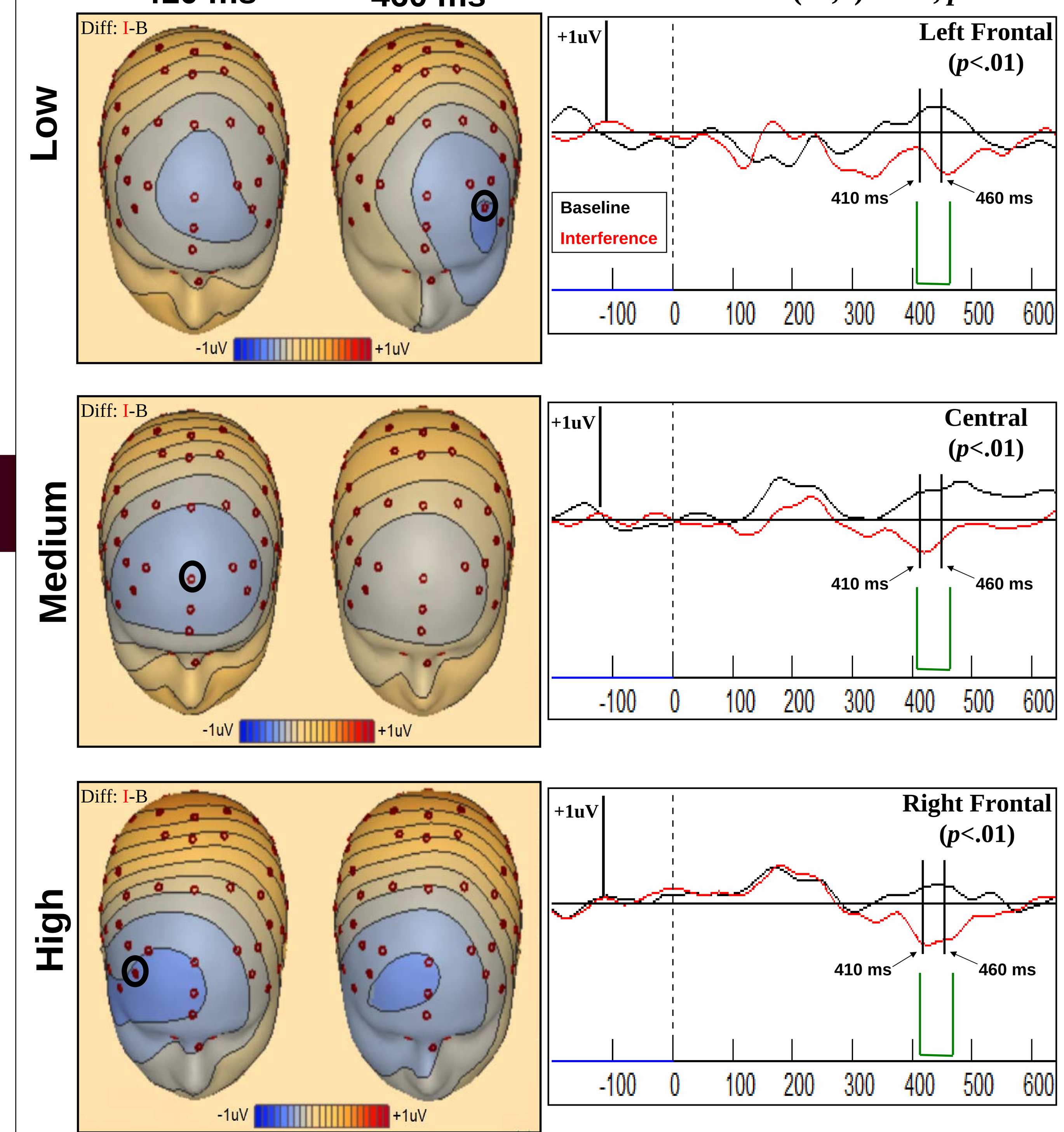
Independent Component Analysis (ICA)

- We used the Infomax ICA algorithm to produce a blind separation of temporally independent signals that reflect coherent activity from specific brain areas/networks
- Identification of MFN components was based on both latency and topography (400-500 ms, negativity peaking at frontal sites) from a 64 channel montage

ICA ERP Results

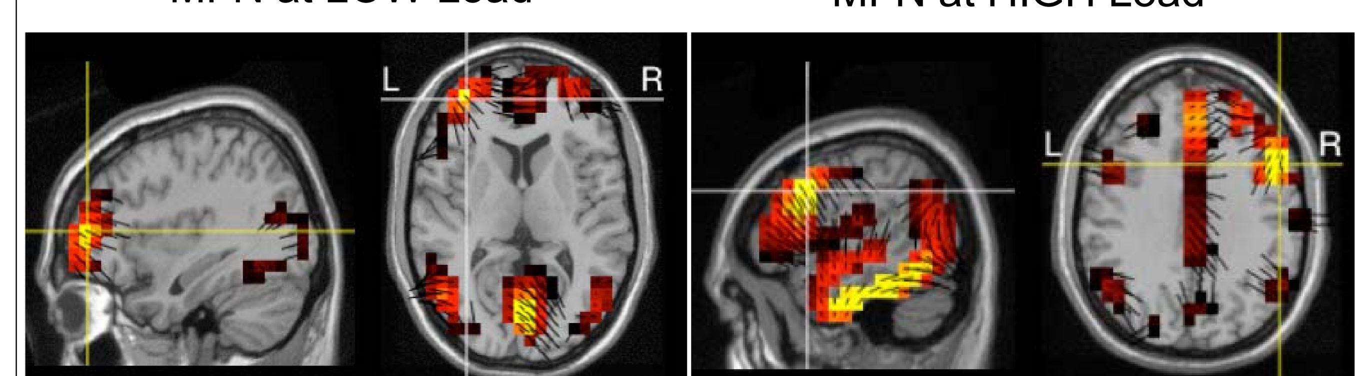
410 ms 460 ms

Site x Load: $F(60,4)=3.40$, $p<.05$



Source Analysis (LORETA)

MFN at LOW Load MFN at HIGH Load



Peak activity in LEFT frontal lobe | Peak activity in RIGHT frontal lobe

Summary

Varying WM load effectively altered the extent of interference (i.e. increasing errors/longer RTs at higher loads). Load manipulations reveal that the typically observed MFN is the sum of multiple frontal negatives that are differentially sensitive to varying attentional demands.

1) At low load, we observed a relatively *late* and *left* lateralized negativity. This response may reflect the adaptive process engaged to withstand interference, possibly through refreshing the contents of WM or the context information that guides memory judgments.[4]

2) At high load, we observed a relatively *early* and *right* lateralized negativity. This response may reflect a reflexive conflict/uncertainty response to the presence of interference that results in a general "break" mechanism suppressing any prepotent motor response.[5]

References

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