Prefrontal control of familiarity versus recollection in working memory

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Introduction

Proactive interference (PI): deleterious effect of prior mental activity on current memory representations.

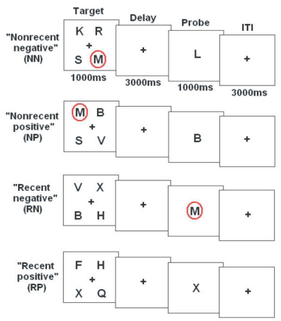
Left inferior frontal gyrus (IFG) is critical for the resolution of PI (Feredoes et al. *PNAS* 2006).

Question: What are the mechanisms underlying PI resolution?

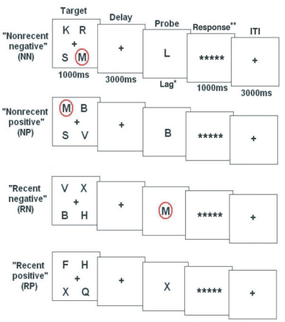
Hypothesis: Left IFG may resolve the conflict between recollection-based and familiarity-based signals.

PI manipulated using "Recent Probes" delayed-recognition task.

RN probes produce increase in RTs (vs. NN probes), because of conflict in processing probe recency (familiarity) vs. its absence from current trial's memory set.



Experiment 1: Methods

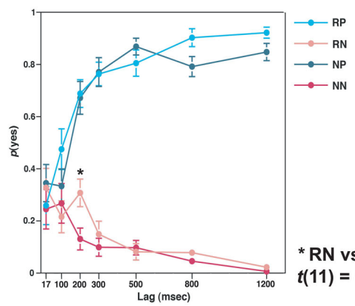


Response-deadline procedure used to determine the timecourse of information accrual triggered by probe onset.

Hypothesis: because familiarity = fast process, responses made early, before slower recollection can occur, will show an increase in false alarm rate for RN probes (probes with (misleading) familiarity signal) compared to NN probes.

Procedure: Recent probes task with responses triggered at seven different *lags: 17, 100, 200, 300, 500, 800 and 1200ms. **Subjects (N = 12) were trained to respond between 100-350ms.

Experiment 1: Results

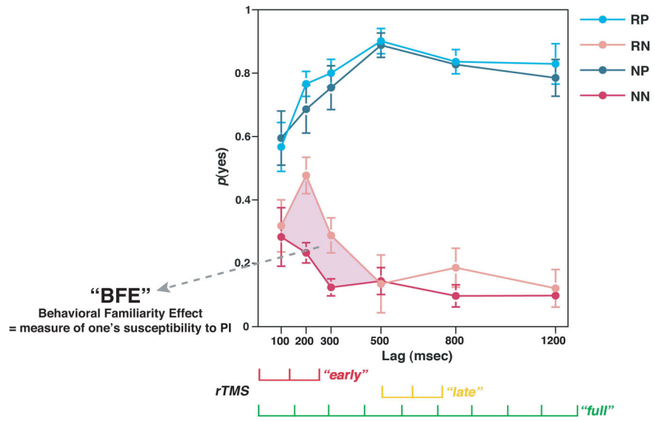


Hypothesis confirmed:
- 200ms lag = familiarity signal peaks.
- 300ms lag = influence of (slower) recollection-based signals begin to supercede familiarity-based signal.
- 500ms asymptote = accrual of all decision-related information.

* RN vs. NN
$t(11) = 4.64$; $p < .01$

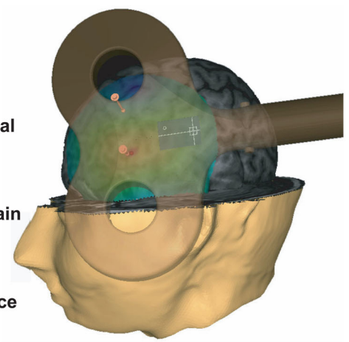
Experiment 2: Methods

Experimental Procedure:
- N = 10
- *Session 1*: Response-deadline behavioral task



Session 2: rTMS
Stimulation sites:
1. Left IFG (BA 45; identified as rostral to the ascending ramus and dorsal to horizontal ramus of the Sylvian fissure).
2. Left middle frontal gyrus (MFG), midway between frontal pole and precentral gyrus = control site for nonspecific effects of rTMS.

- Eight task blocks (24 trials each) performed for each brain region (counterbalanced across subjects).
- Each block contained equal number of probe types, in pseudo-randomized order.
- Orthogonal to factor of probe type was presence/absence of rTMS (also pseudo-randomized).



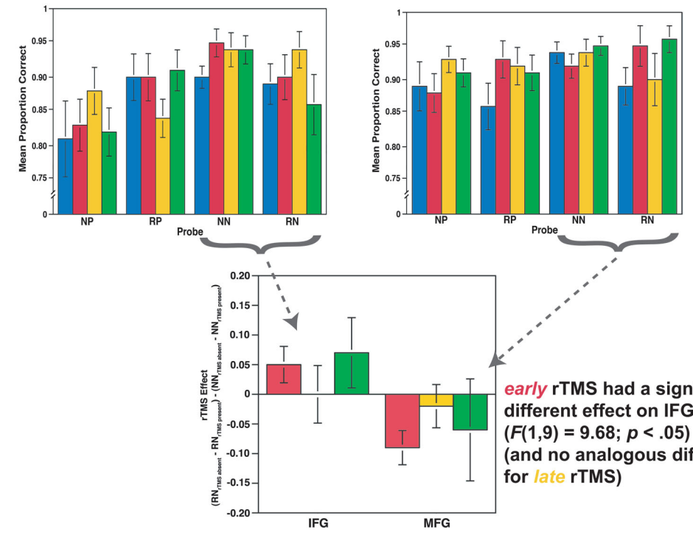
Predictions:
Familiarity tagging? If left IFG discriminates familiarity from recollection, *early* rTMS might obscure the source of the familiarity signal = selective effect of *early* rTMS.
Selection/conflict resolution? If left IFG is a selector from among competing decisions about the probe = selective effect of *late* rTMS.

Experiment 2: Results

Omnibus ANOVA:

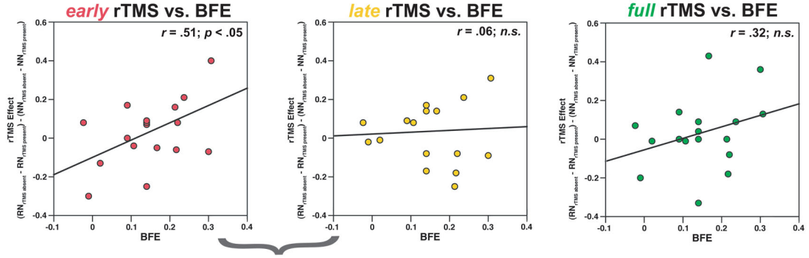
ROI (IFG, MFG) x Recency (recent, nonrecent) x Validity (valid, invalid) x rTMS Timing (absent, early, late, full)

- Main effect of Validity: $F(1,9) = 5.27$; $p < .05$
- No main effect of rTMS Timing
- Interaction between Recency and Validity: $F(1,9) = 6.56$; $p < .05$
- ROI x Recency x Validity x rTMS Timing: $F(3,27) = 2.18$; $p = 0.11$



early rTMS had a significantly different effect on IFG vs. MFG ($F(1,9) = 9.68$; $p < .05$) (and no analogous difference for *late* rTMS)

Individual differences in susceptibility to PI predict effect of rTMS to left IFG:



$t(17) = 2.16$; $p < .02$

The greater one's susceptibility to PI, the greater the left IFG *early* rTMS-induced false alarm rate to RN probes.

Conclusions

- Left IFG was selectively affected by *early* rTMS, implicating selective role for this region in familiarity processing.
- The PI-resolving mechanism of left IFG could be one of weighting of familiarity vs. recollection-based signals.

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