



Evaluating the role of prefrontal and parietal cortices in memory-guided response with repetitive transcranial magnetic stimulation

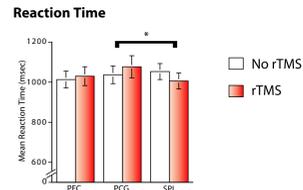


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Introduction

- Previous data have shown that SPL is more sensitive to delay-period rTMS than is PFC (Hamidi, et al., 2006):



- What about memory-guided response?
- Patients with frontal lobe damage are relatively unimpaired on simple tasks of working memory, such as forward digit span. However, with tasks involving memory-guided decision-making performance suffers (D'Esposito & Postle, 1999).

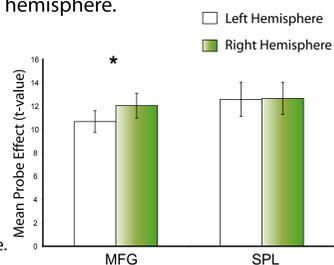
- Although probe evaluation/response activity is bilateral (e.g., D'Esposito, et al., 2006), an analysis of spatial delayed recognition data (Postle, 2006) indicates that probe-evoked response amplitude is greater in right hemisphere vs. left hemisphere.

- Both PFC and SPL shows significant bilateral activity.

- PFC has differential activity by hemisphere

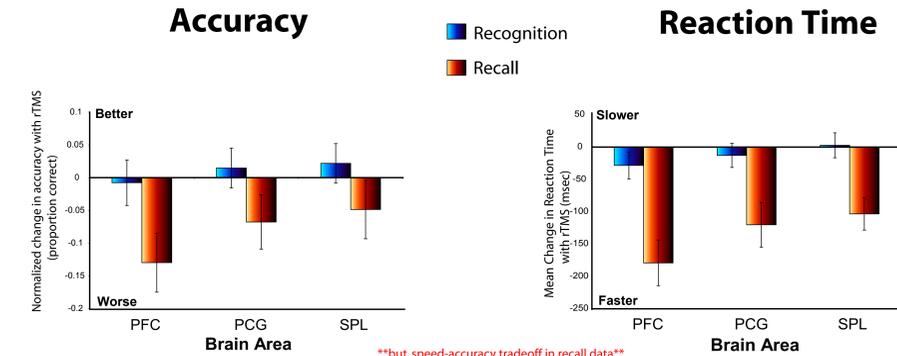
- Right PFC shows greater probe-evoked response compared to left PFC [$t(11) = 3.02; p < 0.05$].

- SPL activity does not differ by hemisphere.



Results

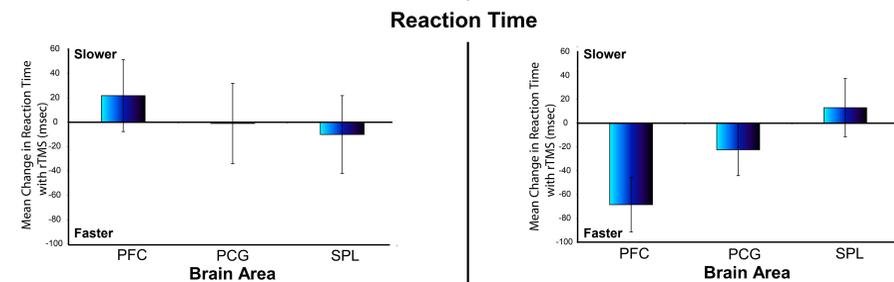
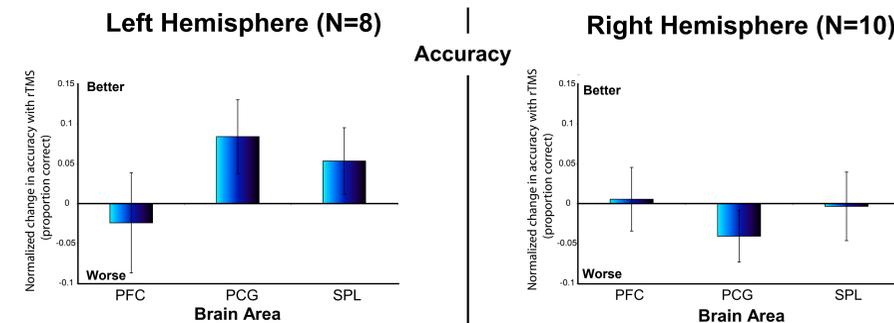
All Subjects (N=18)



- Main effect of task type [$F(1,18)=8.54; p < 0.01$].
- Effect of rTMS is greater on recall trials.
- No effect of Brain Area or Brain Area x Task type interaction ($F_s < 0.94$).
- Main effect of task type [$F(1,17)=40.41; p < 0.0001$].
- Effect of rTMS is greater in recall trials.
- No effect of Brain Area or Brain Area x Task type interaction ($F_s < 1.63$).

but, speed-accuracy tradeoff in recall data

Recognition by Hemisphere



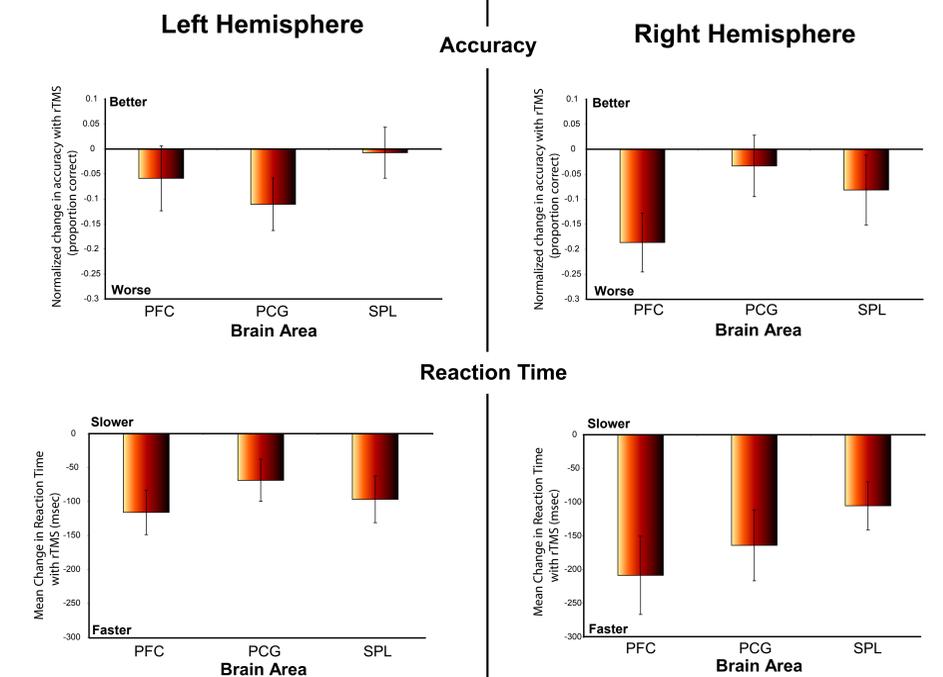
- Accuracy (L Hem only):
 - No significant effect of Brain Area [$F(2,14)=1.41; n.s.$].
- Accuracy (R Hem only):
 - No significant effect Brain Area [$F(2,14)=10.36; n.s.$].
- Reaction Time (L Hem only):
 - No significant effect of Brain Area [$F(2,14)=0.13; n.s.$].
- Reaction Time (R Hem only):
 - Marginally significant effect of Brain Area [$F(2,14)=3.40; p=0.056$].

Effects of Hemisphere

- Accuracy:
 - No significant effects or interactions with Hemisphere (all $F_s < 1.86$).

- Reaction Time:
 - No significant effect of Hemisphere [$F(1,16)=1.95; n.s.$].
 - Trend toward a Brain Area x Hemisphere interaction [$F(2,32)=2.15; p=0.133$], reflecting opposing effects of rTMS on PFC [$t(16)=2.45; p < 0.05$].

Recall by Hemisphere



- Accuracy:
 - No significant effect of Brain Area [$F(2,18)=0.80; n.s.$].
- Reaction Time:
 - No significant effect of Brain Area [$F(2,18)=0.21; n.s.$].

Effects of Hemisphere

- Accuracy:
 - No significant effects or interactions with Hemisphere (all $F_s < 1.69$).
- Reaction Time:
 - Trend toward a main effect of Hemisphere [$F(1,16)=2.15; p=0.162$].
 - Effect of rTMS on right hemisphere is greater in magnitude than rTMS of the left hemisphere.
 - No Brain Area x Hemisphere interaction [$F(2,32)=0.82; n.s.$].

Conclusions

- Susceptibility to rTMS depends on task
 - rTMS has effects of greater magnitude on delayed-recall, but produces a speed-accuracy tradeoff.

Laterality in memory-guided response:

- Recognition
 - fMRI evidence reveals greater recognition response-related activity in right PFC vs. left PFC.
 - RT: rTMS of right PFC results in a speeding of response, whereas rTMS of left PFC results in a slowing of response.

Recall

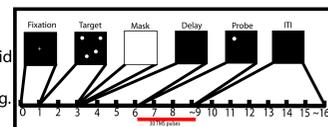
- RT: rTMS of right hemisphere may produce a greater effect than rTMS of left hemisphere
 - No region-specific effects.

Methods

- 18 right-handed healthy subjects (9 male) participated.

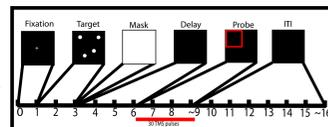
Recognition

- Probe: required Y/N recognition decision; matched a target location with $p=0.5$; invalid probes were offset from the nearest target location by an average of 3.08 (SD=0.4) deg. along one of the 8 cardinal or ordinal axes.



Recall

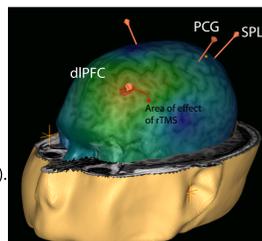
- Upon presentation of the probe, subjects were required to move a joystick to the remembered location of the circle that appeared within the highlighted quadrant.
- For both tasks, accuracy and reaction time were recorded.



- Presentation of the probe lasted until a response was made.
- Recall and recognition trials were randomly distributed within a task block
- Subjects performed 8 task blocks of 24 trials each over a 2 day period
 - 48 trials of each task type per brain area per subject.
- Order of stimulation and hand used for response was counterbalanced across subjects.

rTMS

- Each subject's head was coregistered with his/her MRI using eXimia Navigated Brain Stimulation (NBS) frameless stereotaxy navigation system (Nexstim, Helsinki).
- rTMS (10 Hz, 110% MT, 3 sec. - Magstim Standard Rapid, Whitland, UK) coincided with the onset of the probe on half the trials (randomly determined order).



- Stimulation intensity was corrected for scalp-to-cortex distance (Stokes, et al., 2005).
- Location of targets determined by individual anatomy.
- Postcentral gyrus (PCG) served as a stimulation control area

Hamidi, M., Tononi, G., & Postle, B.R. (2006) Presented at the 2006 Society for Neuroscience conference.
 D'Esposito, M., Cooney, J.W., Gazzaley, A., Gibbs, S.E.B., & Postle, B.R. (2006) *J. Int'l Neuropsychol. Soc.* 12: 248-260.
 D'Esposito, M., & Postle, B.R. (1999) *NeuroImage* 37: 1303-1315.
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 Stokes, M.G., Chambers, C.D., Gould, I.C., et al. (2005) *J. Neurophys.* 94: 4520-4527