

# Assessing the transience assumption for high-frequency rTMS during a cognitive task

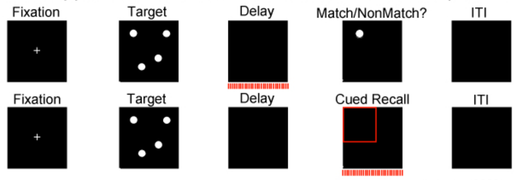

**Jeffrey S. Johnson[1], Massihulla Hamidi[2], Eva Feredoes[3], Bradley R. Postle[1]**

[1]Departments of Psychology and Psychiatry, University of Wisconsin - Madison; [2]Medical Sciences Training Program, University of Wisconsin, Madison,
[3]Institute for Cognitive Neuroscience, University College London, UK


## Introduction

- Concurrent rTMS approach allows isolation of discrete task components

30 TMS pulses during delay- versus response-periods




Hamidi, Tononi, & Postle (2009), *Neuropsychologia*

- But are effects *isolated* to the targeted component?

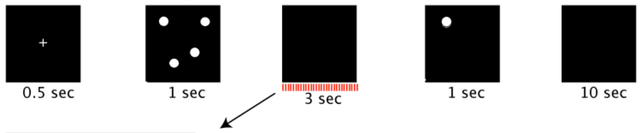
**Table 1** TMS parameters, aftereffect-size and aftereffect-duration broken down according to TMS protocols

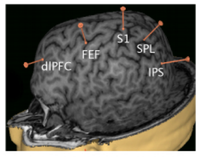
| Protocol | Total N subjects | Mean total N of pulse | Mean N of pulses per train | Mean train-duration | Mean N of trains | Mean intertrain interval | Mean intensity | Mean effect-size | Mean effect-duration (time until recovery) |
|---|---|---|---|---|---|---|---|---|---|
| Conventional Low-F: 0.9–1 Hz | $N = 177$ | $n = 882$ (200–1500) | $n = 882$ (200–1500) | 15 min (3.3–25 min) | $n = 1$ | – | 101%MT (80–130%MT) | 31% ($n = 11$: 10–82%) | 31 min ($n = 8$: 15–70 min) |
| Conventional High-F: 5–25 Hz | $N = 251$ | $n = 704$ (24–2000) | $n = 60$ (20–300) | 9 s (2–60 s) | $n = 17$ (1–100) | 102 s (5–300 s) | 96%MT (80–110%MT) | 30% ($n = 11$: 10–60%) | 28 min ($n = 3$: 25–30 min) |
| cTBS | $N = 55$ | $n = 600$ (600–600) | $n = 600$ (600–600) | 39 s (33–40 s) | $n = 1$ | – | 80%MT (80–80%MT) | 35% ($n = 5$: 15–50%) | 70 min ($n = 3$: 60–90 min) |
| iTBS | $N = 35$ | $n = 600$ (600–600) | $n = 30.3$ (30–31) | 2 s (2–2 s) | $n = 19.5$ (19–20) | 8 s (8–8 s) | 80%MT (80–80%MT) | 17.5% ($n = 2$: 15–20%) | no data |
| PAS | $N = 92$ | $n = 150$ (90–180) | – | – | – | – | 128%MT (105–150%MT) | 22.5% ($n = 3$: 10–50%) | 40 min ($n = 2$: 20–60 min) |

reproduced from Thut & Pascual-Leone (2010), *Brain Topography*

## Methods

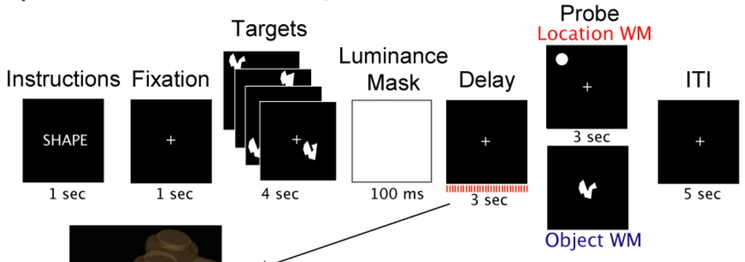
**Experiment 1: rTMS-only** (Hamidi, Tononi, & Postle (2008), *Brain Research*)

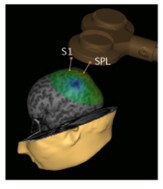



- 48 memory trials/brain area (4 runs of 12 trials)
- 10-Hz rTMS delivered unpredictably throughout delay period on half of trials
- rTMS blocked by brain area
  - Group 1: 10 Hz rTMS applied to dlPFC, SPL, and S1
  - Group 2: 10 Hz rTMS applied to FEF, IPS, and S1

**Experiment 2: rTMS-EEG** (Hamidi, Slagter, Tononi, & Postle (2009), *Frontiers in Integrative Neuroscience*)



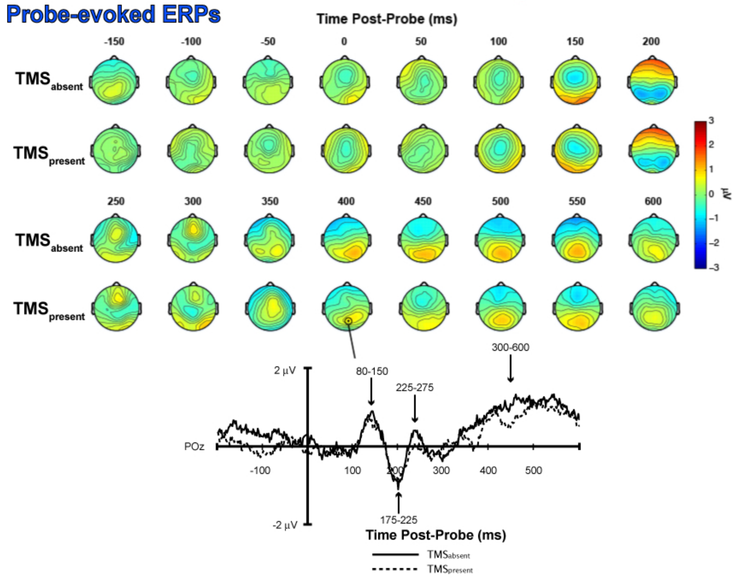

- 192 trials/brain area (8 runs of 24 trials)
  - 96 location memory, 96 object memory
- 10-Hz rTMS delivered unpredictably throughout delay period on half of trials
- rTMS blocked by brain area (S1,SPL)

- ***Do the Immediate Effects of delay-period rTMS spill over into other task epochs?***
  - Strategy: Compare probe-evoked ERPs in $TMS_{absent}$ versus $TMS_{present}$ trials
- ***Does delay-period rTMS have Cumulative Effects that build up over task blocks?***
  - Strategy 1: Assess whether ***behavioral*** effects of rTMS accumulate over trials in $TMS_{absent}$ blocks.
  - Strategy 2: Assess whether ***physiological*** effects of rTMS accumulate over trials in $TMS_{absent}$ blocks.

## Results

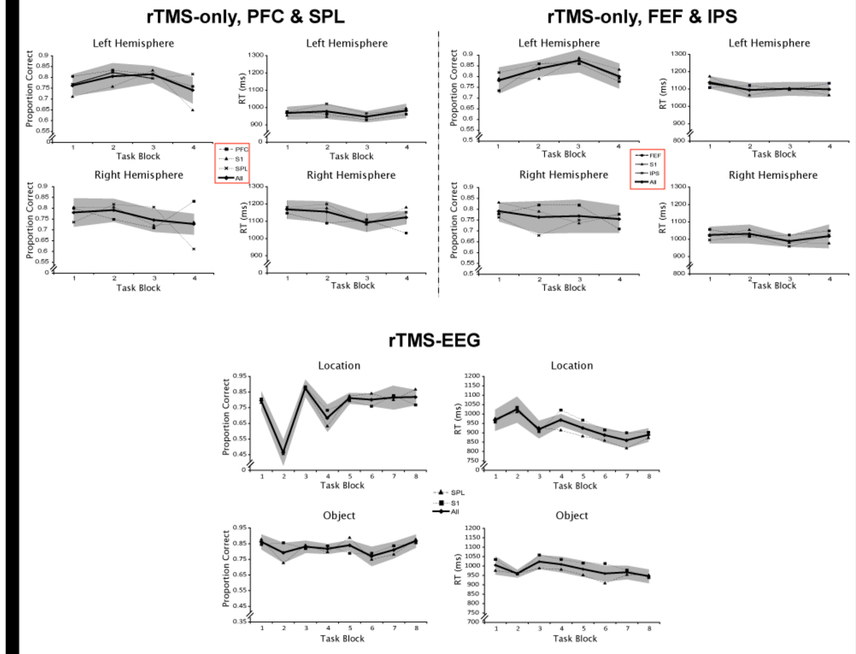
### Immediate Effects Analysis

**Probe-evoked ERPs**




**No effect of delay-period rTMS on probe-evoked ERP, suggesting that immediate effects of TMS did not spill over into the probe period**

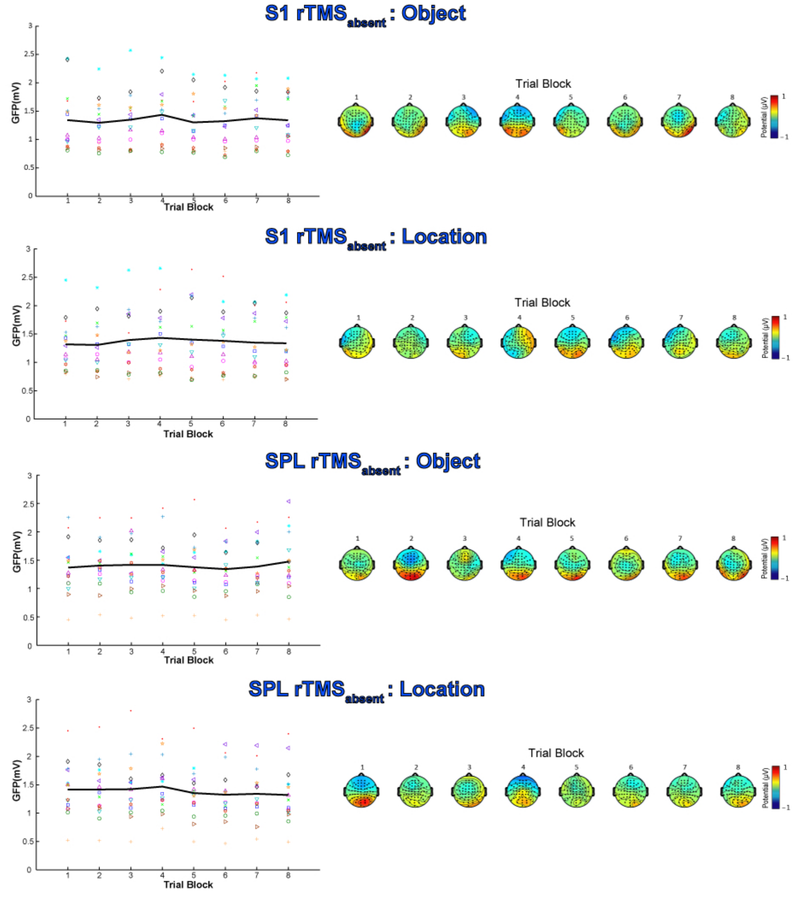
### Cumulative Effects Analysis: Behavior



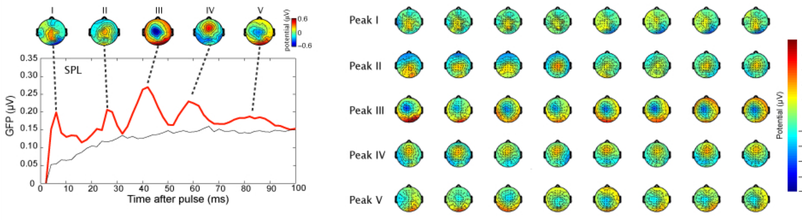

**The effects of delay-period rTMS on behavior do not accumulate across trial blocks**

## Cumulative Effects Analysis: EEG

Mean delay-period GFP across blocks | Scalp topography of delay-period potentionals across blocks




### Topography of each peak of the TMS-related ERP across blocks




**The effects of delay-period rTMS on neural activity do not accumulate across trial blocks**

## Conclusions

- The behavioral and physiological effects of delay-period rTMS observed in two previous experiments had little effect on the subsequent task epoch (i.e., on the probe-evoked ERP), and were not found to accumulate over trial blocks within the experiment.
- These findings support the transience assumption, thereby validating the use of rTMS to "dissect out" discrete components of complex cognitive tasks *(for full report, see Hamidi et al. (in press), Brain Topography)*.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