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# A Critical Role of Temporoparietal Junction in the Integration of Top-Down and Bottom-Up Attentional Control

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**Abstract:**

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**Key words:**

## INTRODUCTION

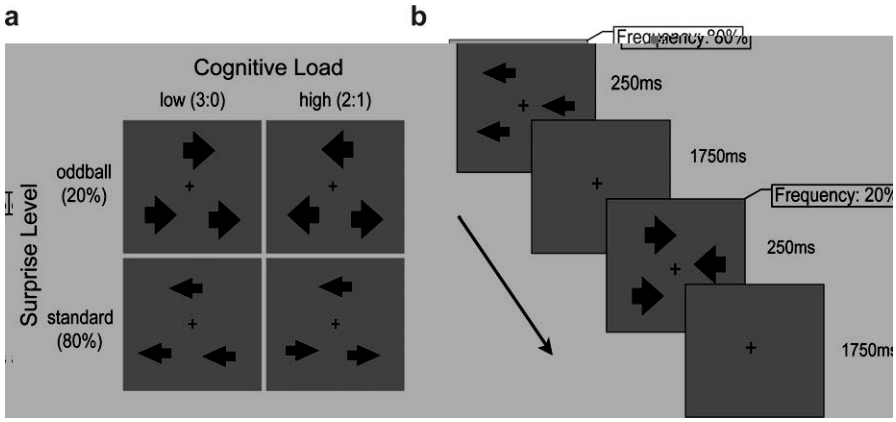


**Figure 1.**

Stimuli and procedure. (**a**) Stimuli used in the experiment and conditions in a 2 × 2 factorial design. Cognitive load (low load vs. high load) was manipulated by varying the ratio of arrows pointing to the same direction (3:0 vs. 2:1). Surprise level (standard vs. oddball) was manipulated by varying probabilities of two types of arrows (smaller and larger) that were irrelevant to the task (80% standard trials vs. 20% oddball trials). The size of the oddball arrows were counterbalanced across runs and participants. (**b**) A schematic description of a standard and an oddball trial. Each trial began with the presentation of three arrows for a fixed duration of 250 ms, followed by 1750 ms blank screen, during which participants indicated the direction of the majority of the arrows.

### fMRI Data Acquisition

### tDCS Protocol

### Behavioral Data Analysis

### fMRI Data Analysis

***Image preprocessing and statistical parametric mapping***

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### *Psychophysiological interaction (PPI) analysis*

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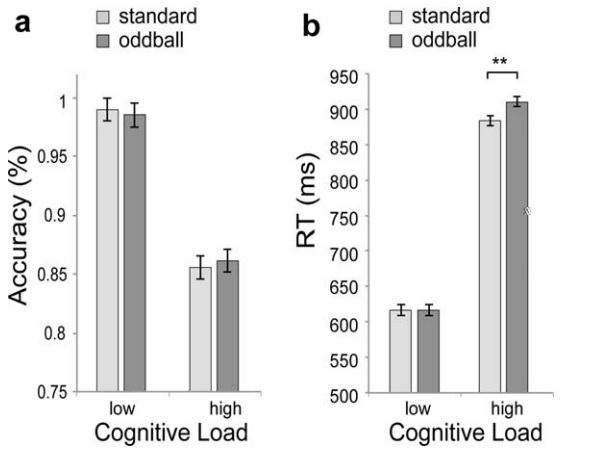


**Figure 2.**
Behavioral results. (**a**) The accuracy result: performance decreased in the high cognitive load condition compared with the low load condition. (**b**) The reaction time (RT) result: high cognitive load as well as the oddball condition was associated with prolonged RT, with a super additive surprise effect. ** $P < 0.01$; Error bars: ±SEM.

### *ROI and correlation analyses*

### *Dynamic causal modeling (DCM)*


**Figure 3.**

Main effects of top-down and bottom-up processes. (**a**) Regions associated with the recruitment of top-down attentional process (main effect of cognitive load, high load - low load). (**b**) Regions associated with the recruitment of bottom-up attentional process (main effect of stimulus surprise level, oddball - standard). Red color indicates voxels with increase in activation. Blue color indicates voxels with decrease in activation. SPL, superior parietal lobule; IPS, intraparietal sulcus; AG, angular gyrus; TPJ, temporo-parietal junction; lFEF, left frontal eye field; rFEF, right frontal eye field; lAI, left anterior insula; rAI, right anterior insula; vmPFC, ventral medial prefrontal cortex; PCC, posterior cingulate cortex; FG, fusiform gyrus; Tha, thalamus; MOG, middle occipital gyrus.

**TABLE I. Activation and deactivation of brain regions involved in top-down attentional processes**

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## RESULTS

### Behavioral Results of the fMRI Experiment

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### Statistic Parametric Mapping Results

#### *Main effects of top-down and bottom-up control processes*

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**TABLE II. Activation and deactivation of brain regions involved in bottom-up attentional processes**

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## PPI Results

### *Interaction between top-down and bottom-up processes*

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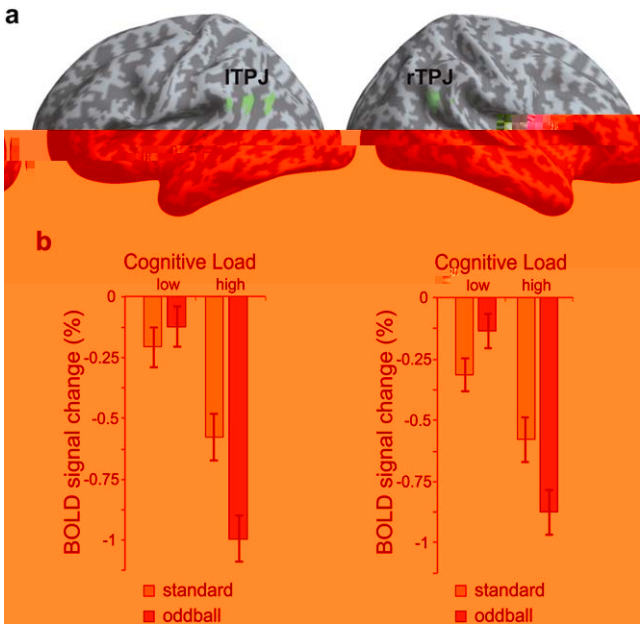


**Figure 4.**
Interaction between top-down and bottom-up processes. (**a**) Regions identified by interaction contrast ([oddball − standard]$_{high}$ − [oddball − standard]$_{low}$). Deactivation was seen bilaterally in the region of the TPJ. (**b**) BOLD signal change (% in beta value) extracted from bilateral TPJ clusters in each condition. Error bars: ±SEM.

## DCM Results

## tDCS Results

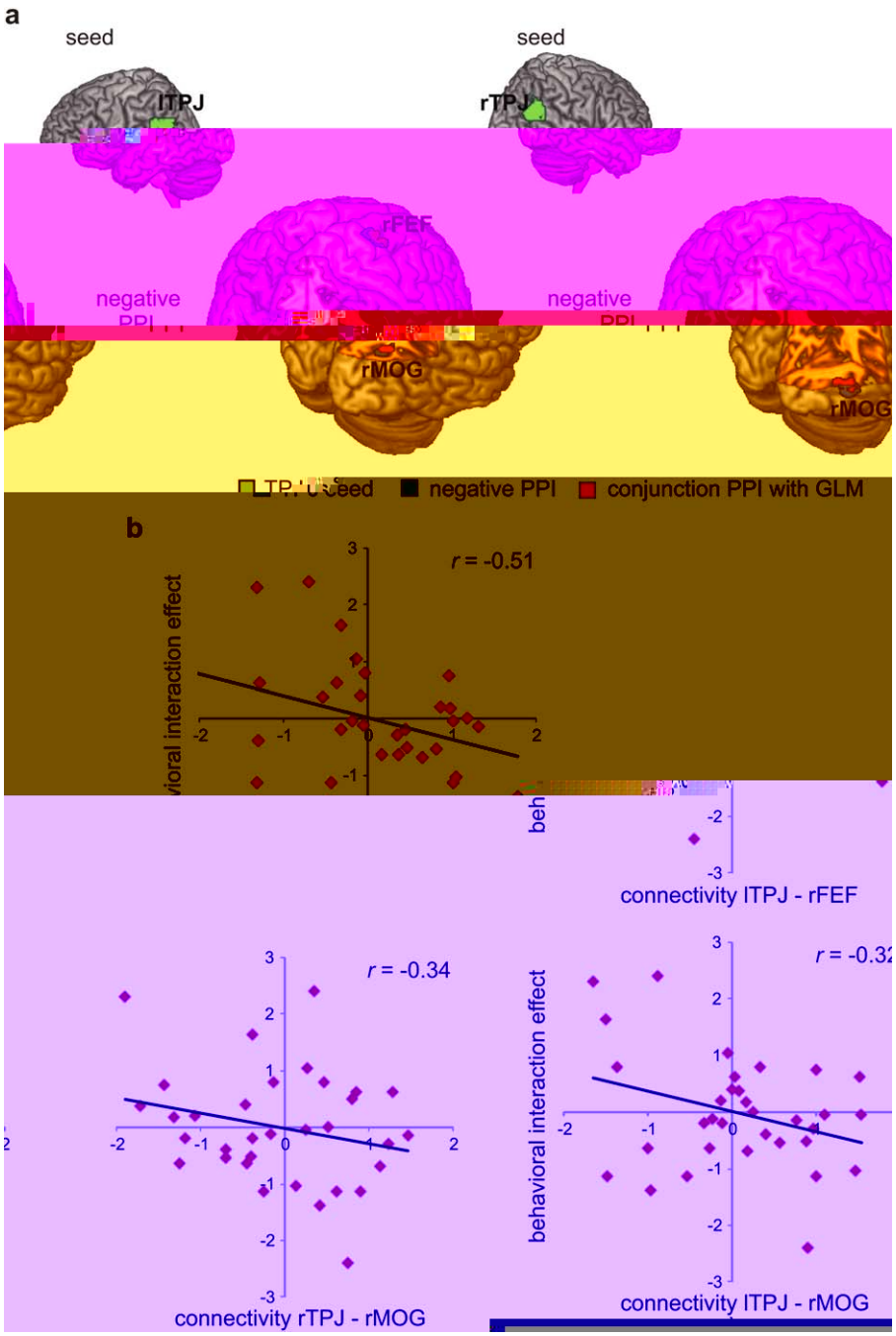


**Figure 5.**

PPI and ROI results. (**a**) PPI results. Top row: seed regions of left and right TPJ for PPI analysis. Bottom row: regions showed negative associations with left or right TPJ modulated by the interaction between experimental manipulations. Decreased activity in the left TPJ was associated with increased activity in the rFEF and rMOG, while decreased activity in the right TPJ was associated with increased activity only in the rMOG. Green color indicates the seed regions of the bilateral TPJ. Blue color indicates regions showing negative PPIs with the TPJ. Red color indicates conjunction regions of bottom-up contrast image of the GLM (oddball > standard) and the PPI image, and the conjunction of top-down (high cognitive load − low cognitive load) contrast image and the PPI. (**b**) ROI and correlation results. The PPI between the lTPJ and rFEF was negatively correlated with behavioral interaction effect. The PPI between the bilateral TPJ and rMOG was marginally correlated with behavioral interaction effect.

**TABLE III. Negative PPI**

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## DISCUSSION

### A Filter Model of the TPJ

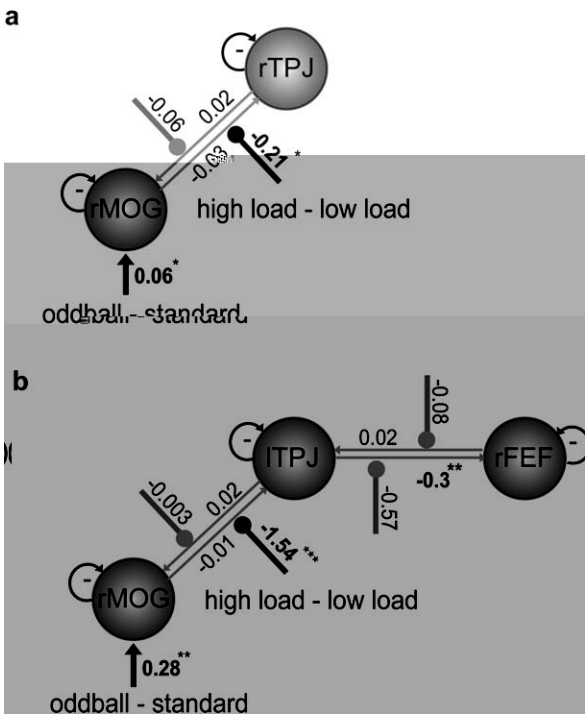


**Figure 6.**
DCM models and results. (**a**) DCM model of the rTPJ and rMOG. (**b**) DCM model of the lTPJ, rMOG, and rFEF. Bold arrows indicate the driving input (oddball − standard). Arrows with circle in the end indicate the modulatory effect (high load − low load), with significant modulation in black and nonsignificant modulation in gray. Significant parameters are indicated by the asterisk (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$).

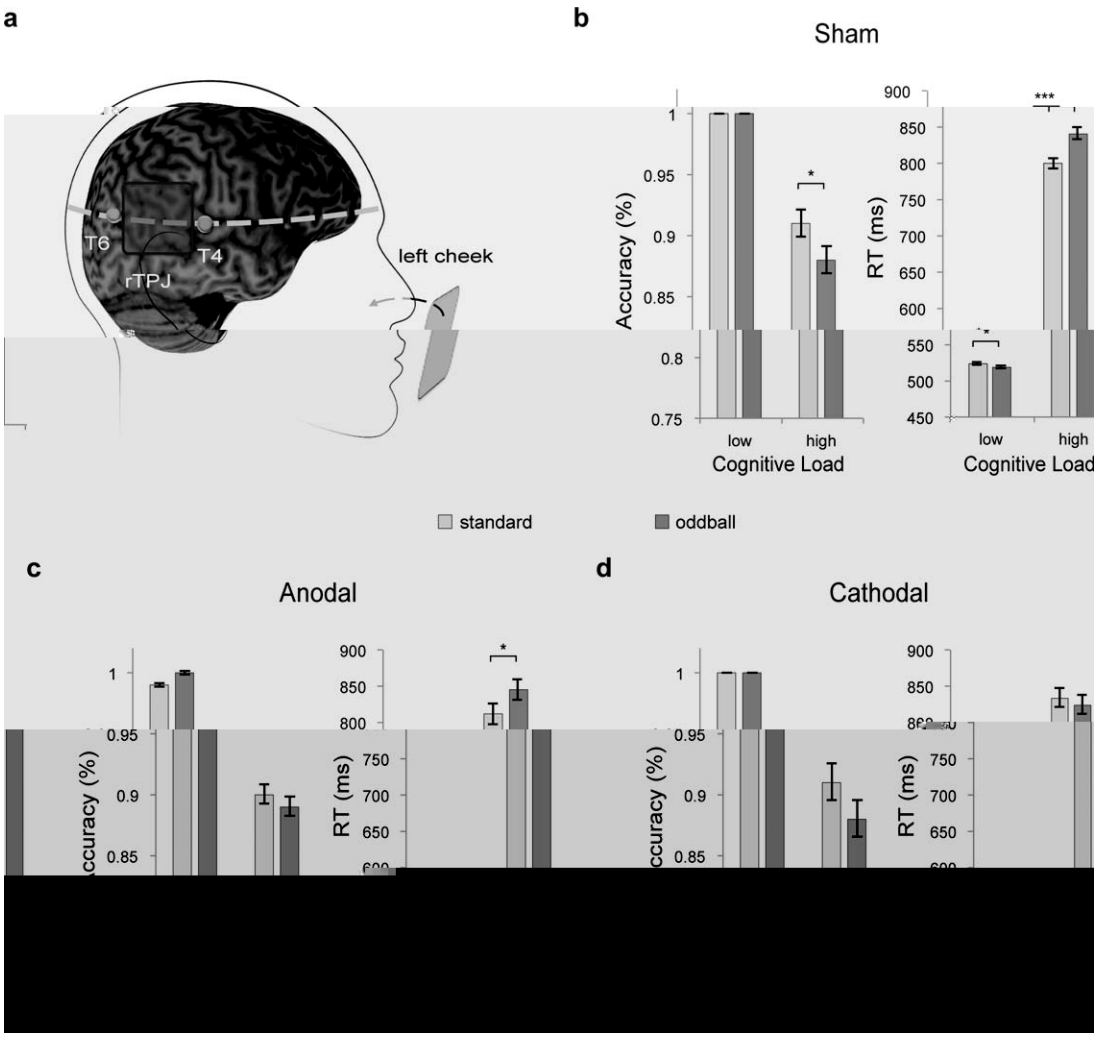


**Figure 7.**
tDCS results. (**a**) schematic representation of the locations of the tDCS. (**b**−**d**) results of Sham, anodal, and cathodal tDCS. Significance is indicated by the asterisk (* $P < 0.05$; *** $P < 0.001$).

## REFERENCES

## ACKNOWLEDGMENTS