

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

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◆ Abstract: ◆

Key words:

INTRODUCTION

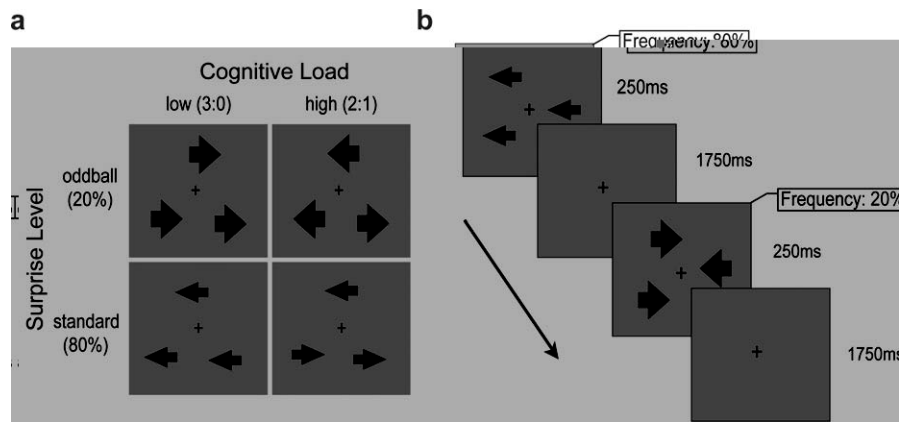


Figure 1.

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

The fMRI data were acquired using a Siemens 3T scanner with a standard 12-channel head coil. The subjects were scanned in the supine position. The scanning protocol included T1-weighted structural scans, T2-weighted structural scans, and a series of fMRI scans. The fMRI scans were performed using a blood-oxygen-level dependent (BOLD) contrast sequence with a 2000 ms repetition time (TR), 40 ms echo time (TE), and a 3 × 3 × 4 mm voxel size. The scanning protocol was approved by the Institutional Review Board at the University of California, San Diego.

tDCS Protocol

The tDCS protocol consisted of three sessions. The first session was a baseline session where the subjects received a 20-minute tDCS treatment over the left DLPFC. The second session was a 20-minute tDCS treatment over the left DLPFC. The third session was a 20-minute tDCS treatment over the left DLPFC. The tDCS treatment was delivered using a 4 × 4 cm saline-soaked sponge electrode. The current intensity was set at 2 mA. The subjects were blind to the treatment condition. The tDCS protocol was approved by the Institutional Review Board at the University of California, San Diego.

The fMRI data were analyzed using SPM8. The first step in the analysis was the removal of the first five volumes of each scan to account for scanner drift. The remaining volumes were then spatially normalized to a standard MNI152 template. The normalized data were then segmented into gray matter, white matter, and cerebrospinal fluid. The gray matter data were then smoothed using a Gaussian kernel with a full width at half maximum of 6 mm.

Behavioral Data Analysis

The behavioral data were analyzed using a linear mixed-effects model. The model included the following fixed effects: tDCS condition (sham vs. real), task condition (block vs. random), and their interaction. The model also included the following random effects: subject and trial. The results were then compared using a t-test.

fMRI Data Analysis

Image preprocessing and statistical parametric mapping

The fMRI data were analyzed using SPM8. The first step in the analysis was the removal of the first five volumes of each scan to account for scanner drift. The remaining volumes were then spatially normalized to a standard MNI152 template. The normalized data were then segmented into gray matter, white matter, and cerebrospinal fluid. The gray matter data were then smoothed using a Gaussian kernel with a full width at half maximum of 6 mm. The resulting data were then analyzed using a linear mixed-effects model. The model included the following fixed effects: tDCS condition (sham vs. real), task condition (block vs. random), and their interaction. The model also included the following random effects: subject and trial. The results were then compared using a t-test.



Psychophysiological interaction (PPI) analysis

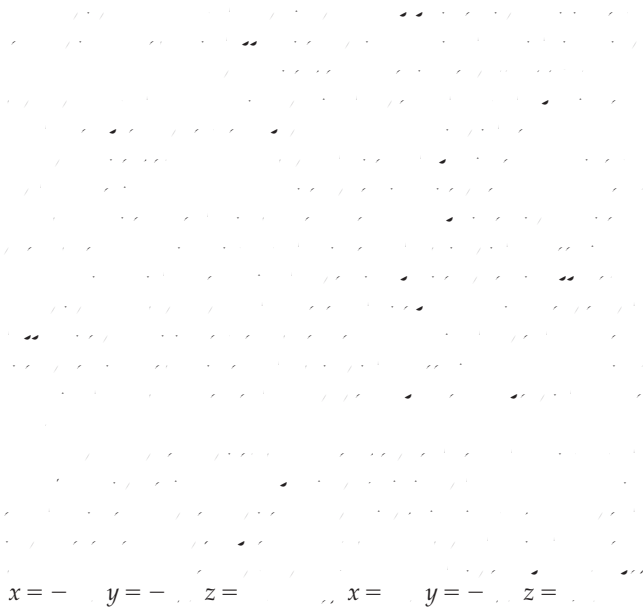
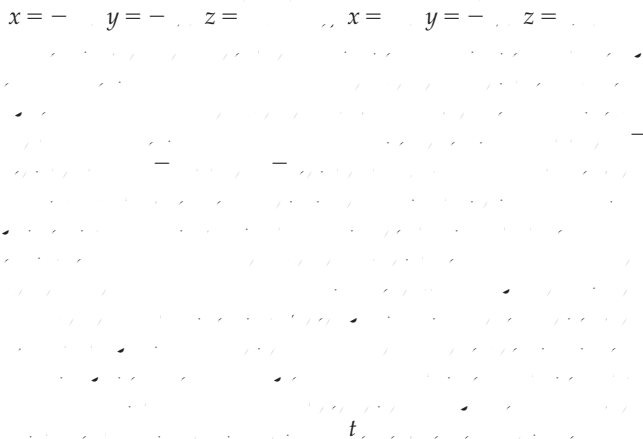


Figure 2.

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: \pm 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; IFEF, left frontal eye field; rFEF, right frontal eye field; IAI, 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.

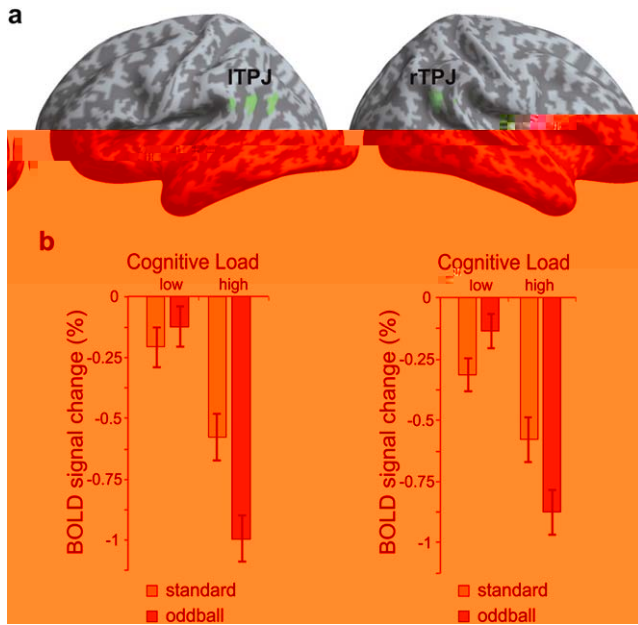


Figure 4.

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.

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DCM Results

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tDCS Results

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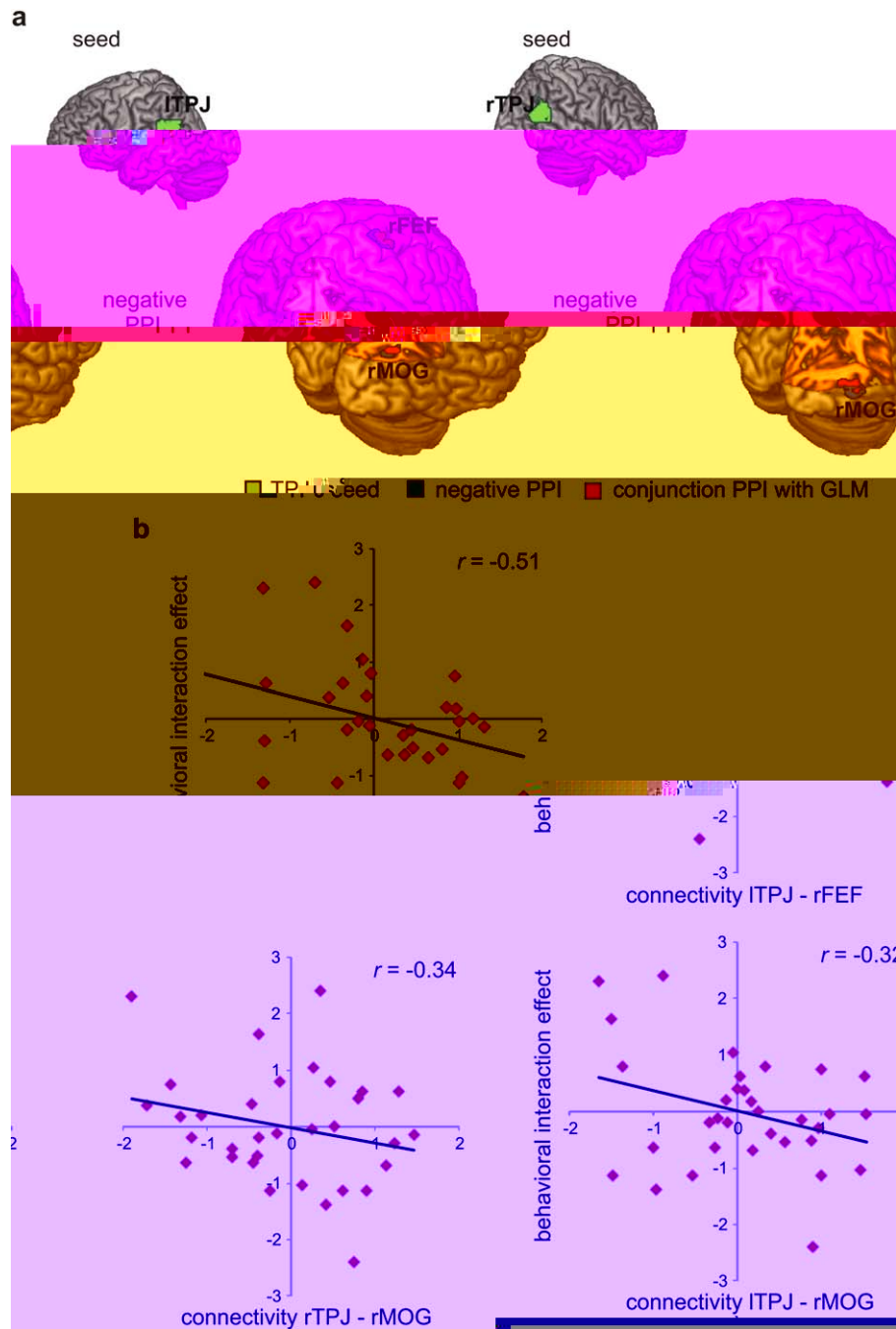


Figure 5.

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 ITPJ 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

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A Filter Model of the TPJ

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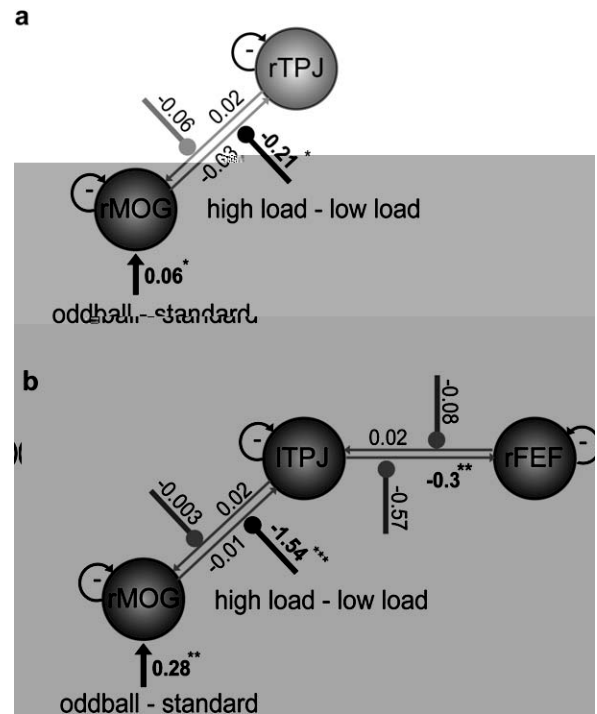


Figure 6. DCM models and results. (a) DCM model of the rTPJ and rMOG. (b) DCM model of the ITPJ, rMOG, and rFEF. Bold arrows indicate the driving input (oddball – standard). Arrows with circle in the end indicate the modulatory effect (high load – low load), with significant modulation in black and nonsignificant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

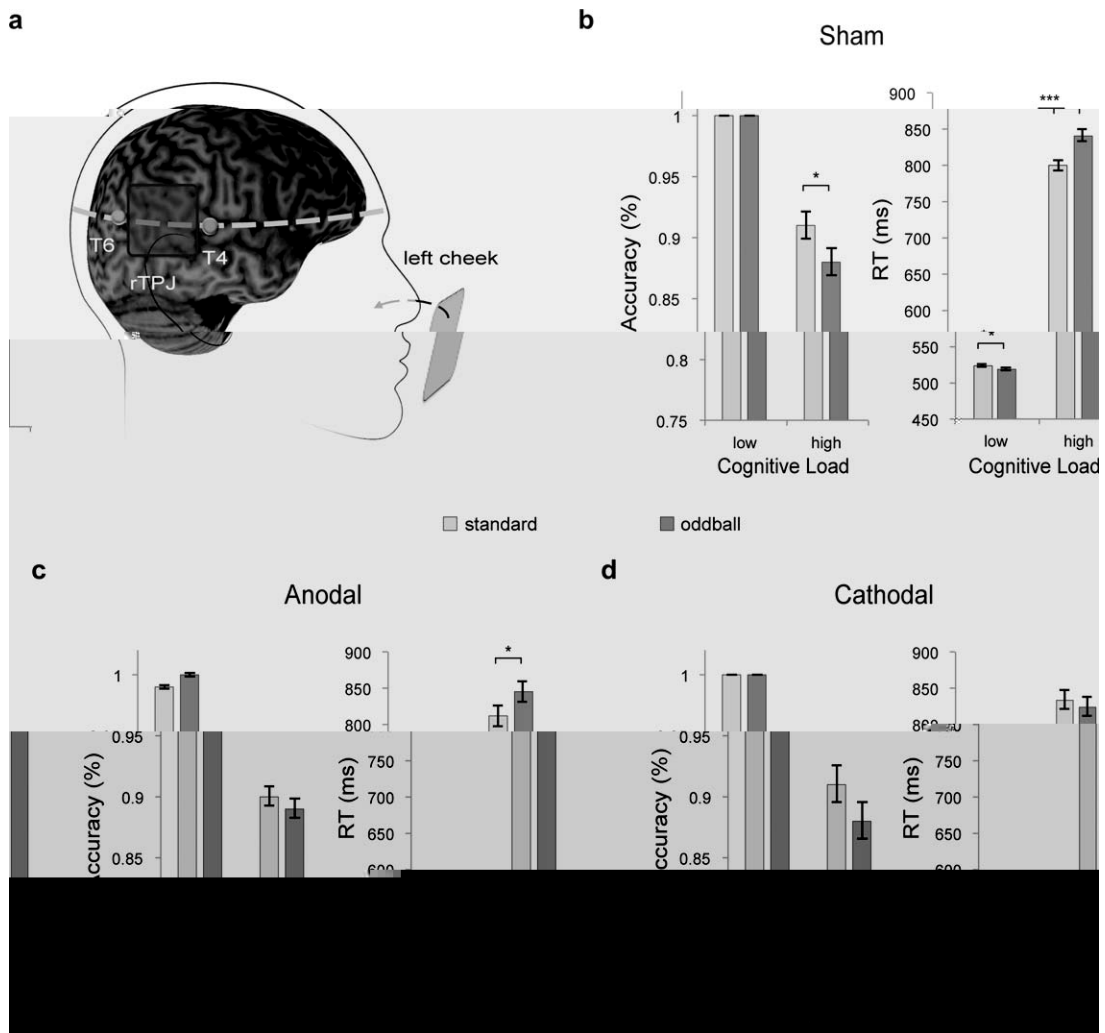


Figure 7. tDCS results. (a) schematic representation of the locations of the tDCS. (b–d) results of Sham, anodal, and cathodal tDCS. Significance is indicated by the asterisk (* $P < 0.05$; *** $P < 0.001$).

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations. The text highlights that proper record-keeping allows for better decision-making and helps in identifying areas for improvement.

2. The second part of the document focuses on the role of leadership in setting a clear vision and direction for the organization. It states that leaders should communicate this vision effectively to all employees, ensuring that everyone understands their role in achieving the organization's goals. The text also mentions that leaders should lead by example and demonstrate the values and behaviors they expect from their team.

3. The third part of the document addresses the importance of fostering a positive and collaborative work environment. It suggests that organizations should encourage open communication and teamwork among employees. The text notes that a supportive work environment can lead to higher employee morale and productivity, which are essential for the organization's long-term success.

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1. The first part of the document discusses the importance of maintaining accurate records of all transactions. This is essential for ensuring the integrity of the financial statements and for providing a clear audit trail. The records should be kept up-to-date and should be easily accessible to all relevant parties.

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5. The fifth part of the document is a conclusion that summarizes the key points of the report. It emphasizes the importance of the findings and the need for continued monitoring and reporting. It also expresses confidence in the organization's ability to overcome any challenges that may arise.

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7. The seventh part of the document is an appendix that contains additional information that is not included in the main body of the report. This may include raw data, detailed calculations, or other supporting documents. It is important to ensure that this information is clearly organized and easy to find.

8. The eighth part of the document is a final section that provides a summary of the report and offers any final thoughts or recommendations. This is a good opportunity to reiterate the key findings and to express any final thoughts on the organization's future prospects.

