## Supplemental Material

# Inhibition of Lateral Prefrontal Cortex Produces Emotionally Biased First Impressions: A TMS/EEG study

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## Supplemental Method

### MRI session & acquisition parameters

MRI data were acquired with a 3.0 T GE scanner (GE Healthcare, Waukesha, WI) using an 8-channel coil. High-resolution 3D T1-weighted inversion recovery fast gradient echo (Mugler, 1990) anatomical images were collected in 160 contiguous 1.25 x 1.25 x 1.25-mm sagittal slices (TE = 2.3 ms; TR = 5.6 ms; flip angle = 12°; FOV = 240 x 240 mm; 192 x 192 x 160 data acquisition matrix, inversion time TI = 450 ms). Resting state and diffusion weighted imaging scans were also acquired.

### TMS stimulation protocol

TMS was delivered to the left LPFC and to medial S1 with a Magstim Super Rapid magnetic stimulator (Magstim, Whitland, UK) equipped with a Fig.-8 stimulating coil. Precise TMS targeting on a subject-by-subject basis was achieved using a Navigated Brain Stimulation (NBS) system (Nextstim, Helsinki, Finland) that uses infrared-based frameless stereotaxy to map the position of the coil and the subject's head in relation to the space of the individual's high-resolution MRI.

We used a continuous TMS protocol—continuous theta-burst (cTBS)—consisting of 50Hz trains of 3 TMS pulses repeated every 200 ms continuously over a period of 20 seconds (300 pulses total). cTBS administration for 20 seconds has been shown to depress activity in the stimulated brain region for up to 20 minutes after stimulation (Huang, Edwards, Rounis, Bhatia, & Rothwell, 2005).

As is typical with this TMS protocol, we delivered cTBS at 80% of active motor threshold. The active motor threshold was defined as the lowest stimulus intensity that elicited at least five twitches and/or sensations in 10 consecutive stimuli delivered at the motor cortex,

while the subject maintained a voluntary contraction of index and thumb fingers at about 20% of maximum strength. cTBS was delivered with the coil placed tangentially to the scalp, and with the handle pointing posteriorly. The stimulation varied between 32 to 57% of the maximum stimulator output (0.93 T at coil surface) ($M$ = 51.14%, $SD$ = 6.12%).

**TMS session procedures**

The TMS session began with a broad overview of the experiment. Next, participants sat at a leather chair with their eyes positioned 80cm away from a computer monitor (ASUS HDMI set to 60Hz refresh rate; 53cm screen width; 1920 x 1080 pixels resolution), and underwent EEG net placement and channel preparation. During the EEG preparation, participants practiced the tasks. Throughout the experiment, participants were offered frequent breaks as well as water and food items.

Following EEG net preparation, the lights were dimmed. The session began with a 3-min recording of eyes-closed resting state EEG activity. For this recording, participants were asked to remain as still as possible, including to avoid body movements and moving their eyes behind their closed eyelids. Next, participants underwent a 4-min recording of their eyeblink rate (data not reported here), followed by the administration of state mood questionnaires (PANAS, STAI & IPANAT).

cTBS was administered for 20 seconds to LPFC and to S1, with the TMS site order counterbalanced across participants. As part of a larger study, participants underwent another TMS application to each cortical site followed by a task aimed at measuring visual awareness (data not reported here), where task order (affective coloring vs. awareness task first) was counterbalanced across subjects. Neither task nor TMS site order interacted with the TMS effects

on the Affective Coloring task (*ps* > .2); and the statistical significance of tests reported here remained equivalent after controlling for effects of TMS site and task order.

Upon completion of the Affective Coloring task, eyes-closed resting state EEG activity was recorded for 3 minutes, followed by a 4-min eyeblink recording. Next, participants' mood was assessed, using the PANAS, STAI & IPANAT.

In the middle of the experiment (i.e., following TMS administration to LPFC or S1) participants took a 15-min break. Then, the sequence of steps delineated above was repeated, with cTBS administered to the other TMS site (LPFC or S1)[1].

At the end of the session, EEG channels were digitalized. Then, participants completed post-testing and trait questionnaires and were debriefed. Lastly, they were asked to complete an online assessment 3 days later.

**EEG data acquisition parameters**

EEG data were acquired using a 62-channel net (Easy Cap; http://easycap.brainproducts.com/) and recorded using Brain Vision software (http://www.brainvision.com/) at 1000Hz (online broadband filtered .016-1000 Hz).

Resting EEG data were recorded for 3 minutes (180s). The first and last 15s of recordings were removed to maximize artifact-free data. Next, data were down-sampled to 500Hz and offline bandpass filtered between .5-55 Hz. Those data were epoched into 1-second chunks, and visually inspected for artifacts. Epochs with large body movements and/or eye movements were eliminated (8.98% of epochs (1,618 out of 18,000). Bad channels were also removed and interpolated (average: 3.35 channels per participant, SD = 1.68; range: 0-8 channels).

[1] For 3 subjects, due to time constraints, a second pre-TMS EEG baseline was not recorded. For those 3 participants, the first EEG baseline recording taken in the beginning of the session was used as their pre-TMS baseline and subtracted from both LPFC and S1 post-TMS EEG recordings.

**Baseline (no TMS) affective coloring**

As shown in ***Fig. 2a***, temporary disruption of LPFC function via inhibitory cTBS produced affective coloring, an effect that was not observed in the control condition, when cTBS was administered to S1 (left medial post-central gyrus). This null result suggests an effective discounting of prior emotional processing while evaluating an unrelated stimulus (Li, Moallem, Paller, & Gottfried, 2007), which is consistent with prior work adopting mild emotional cues in affective priming paradigms (Li et al., 2007; Murphy & Zajonc, 1993; Rotteveel, de Groot, Geutskens, & Phaf, 2001). Nonetheless, to ascertain that this null affective coloring result following TMS administration to S1 accurately reflects what would be expected at baseline (i.e., in the absence of TMS), we analyzed the data of a highly similar study from our laboratory that utilizes the same set of stimuli, instructions, and comparable sample characteristics and stimulus presentation timing as adopted in the reported TMS study, as detailed below. In doing so, we obtained a similar null result as observed following cTBS administration to S1 (see ***Fig. S1*** and control/S1 in ***Fig. 2a***), suggesting that the TMS active control condition (S1) is an accurate proxy for normative affective processing conditions (i.e., in the absence of TMS).

*Participants*: Healthy participants from the community in Madison, WI were recruited as part of an ongoing study on the impact of mindfulness on emotion regulation. The data reported here were collected as part of their baseline (pre-intervention) session. We analyzed the data of participants whose age range fell within the range recruited for the TMS study reported in the manuscript (N = 33; M = 28.84 y old; SD = 3.12; 19 males). *Procedure*: Participants were asked to indicate their first impression of the neutral faces shown after the brief presentation of happy or fearful faces. Each neutral face was presented only once and randomly assigned to an

emotional valence condition. Emotional facial expressions (fearful or happy) were shown for 16.7 ms. Novel neutral faces were shown 3 s after the presentation of emotional faces for 200 ms, and participants used a binary (1 vs. 2) scale to indicate their preference for the novel person ("1": "do not like at all"; "2": "like very much"). As in the TMS study, they were given 1.5 s to respond. This task used a total of 12 identities (half female) making fearful and happy facial expressions. Each unique emotional face was shown twice.

***Fig. S1.*** At baseline (in the absence of TMS administration), likeability ratings of novel neutral faces were not influenced by unrelated emotional expressions briefly shown seconds earlier, $t(32) = .257$, $p = .79$, 95% CI difference = [-0.063, 0.081], $d_z = .04$—thereby mirroring the behavioral results obtained in the TMS control condition reported in the main manuscript (cTBS to S1; ***Fig. 2a***). Error bars represent the within-subjects standard error of the mean difference between valence conditions.

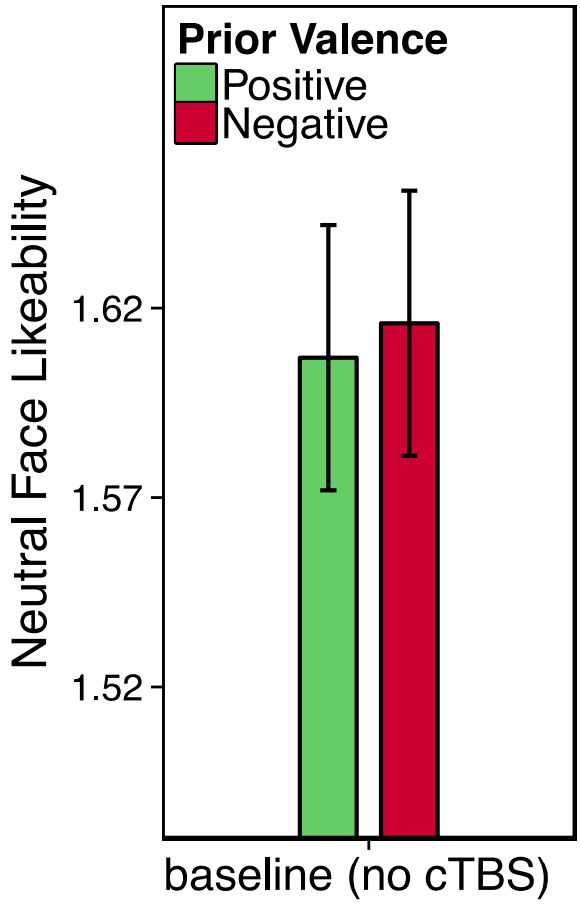
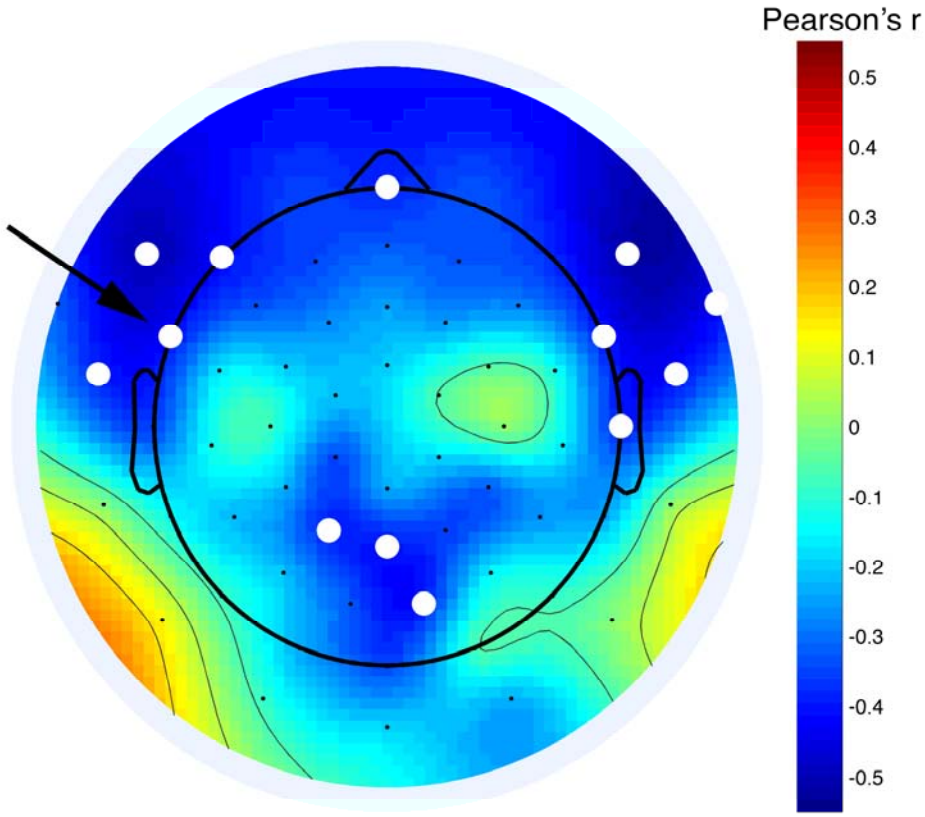


***Fig. S2.*** Topography of the across-subjects correlation between affective coloring behavior and changes in EEG alpha power from baseline following cTBS to left LPFC. Affective coloring is associated with less cortical excitability in fronto-parietal electrodes as indexed by larger alpha power following cTBS administration to left LPFC ($p < .05$, denoted by white circles), which is consistent with the anatomical connectivity of the LPFC site targeted in this study (*Method, TMS sites*). Each dot represents an electrode; electrodes located on the sides of the head are depicted outside of the circle. The electrode site located closest to the TMS coil during cTBS administration to left LPFC (channel F7) is indicated by the arrow (same electrode in which alpha power was interrogated and plotted on ***Fig. 2b***).



Note that the change in alpha power in F7 (left LPFC) was highly correlated with the change in alpha power in the additional frontoparietal electrodes revealed by the above-depicted topoplot: F7 and right-LPFC alpha change (average across depicted electrodes) $r = .688$, $p < .001$, F7 and parietal alpha change (average across depicted electrodes) $r = .615$, $p = .001$. Further, as shown above, the magnitude of the correlation between change in alpha power and affective coloring behavior was similar across these electrode sites: F7 (left LPFC) $r = .41$; right LPFC $r = .443$; parietal $r = .449$.

*Table S1.* Correlation coefficient (Pearson's *r*) between likeability ratings of neutral faces obtained in the laboratory (TMS session) and online 3 days after the session (N=144 faces), reported as a function of TMS site (LPFC, Control/S1) and preceding emotional stimulus valence (Negative, Positive).

| | *LPFC TMS* | | *Control/S1 TMS* | |
|---|---|---|---|---|
| | *Negative* | *Positive* | *Negative* | *Positive* |
| Pearson's *r* (*p* value) | $r(142) = .455$ ($p < .00001$) | $r(142) = .439$ ($p < .00001$) | $r(142) = .488$, ($p < .00001$) | $r(142) = .373$ ($p < .00001$) |