Targeting the DLPFC to Enhance Memory Control: Divergent Effects on Social and Nonsocial Memories

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Running head: Causal Effects of DLPFC Stimulation on Voluntary Forgetting

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Abstract

Voluntary forgetting, governed by top-down inhibitory control in the prefrontal cortex, plays a critical role in adaptive memory regulation. This study investigated the causal role of the right dorsolateral prefrontal cortex (rDLPFC) in the forgetting of social and nonsocial memories. Employing high-frequency (10 Hz) repetitive transcranial magnetic stimulation (rTMS) in an offline protocol, we modulated rDLPFC activity (Active TMS condition) and compared it to a Control TMS condition targeting the vertex. Participants completed a directed forgetting (DF) task framed in social and nonsocial contexts. Results revealed a dissociation in rDLPFC involvement: stimulation significantly enhanced the forgetting of negative nonsocial memories but did not affect social memories. Furthermore, social anxiety moderated forgetting performance; individuals with higher social anxiety struggled to forget negative social feedback in the Control TMS condition, a difficulty alleviated by rDLPFC stimulation. These findings suggest that voluntary forgetting of social and nonsocial memories engages distinct neural mechanisms and highlighting rDLPFC stimulation as a potential intervention for reducing maladaptive memory biases associated with social anxiety.

Keywords: voluntary forgetting; directed forgetting paradigm; rTMS; emotional memory; social memory

Introduction

Not all memories are equally desired. The ability to voluntarily forget unwanted memories, a phenomenon termed *voluntary forgetting* (Anderson & Hanslmayr, 2014; Hu et al., 2017), serves a critical adaptive function in human cognition and emotional well-being (Fawcett et al., 2024; Nørby, 2015). By suppressing distracting or distressing memories, individuals can focus on current priorities and mitigate the negative impact of past experiences on emotional health (Engen & Anderson, 2018). Conversely, difficulties in memory control are linked to heightened susceptibility to psychiatric conditions such as depression, social anxiety, and post-traumatic stress disorder (Costanzi et al., 2021; Mary et al., 2020; Seinsche et al., 2023; Stramaccia et al., 2021). Investigating the mechanisms underlying voluntary forgetting and exploring strategies to enhance this capacity are therefore of profound theoretical and clinical relevance.

Voluntary forgetting is driven by top-down inhibitory processes that suppress the encoding and retrieval of undesired information (Anderson & Hanslmayr, 2014; Anderson & Hulbert, 2021). The prefrontal cortex, particularly the right dorsolateral prefrontal cortex (rDLPFC), plays a key role in this process, modulating activity in memory-related regions such as the hippocampus (Levy & Anderson, 2012; Oehrn et al., 2018; Rizio & Dennis, 2013). The item-method *directed forgetting* (DF) paradigm (Bjork, 1989) is a widely used experimental framework for studying voluntary forgetting during encoding. In this task, participants are presented with items followed by cues indicating whether each item is to-be-remembered (TBR) or to-be-forgotten (TBF). Superior recall of TBR items over TBF items, known as the DF effect, reflects the efficacy of memory control mechanisms (Basden & Basden, 2013).

Neuroimaging studies have consistently shown greater activation in the prefrontal cortex during attempts to forget compared to attempts to remember (Gamboa et al., 2018; Nowicka et al., 2010; Wylie et al., 2008; Yang et al., 2016), with successful forgetting linked to enhanced rDLPFC-mediated downregulation of hippocampus (Oehrn et al., 2018; Rizio & Dennis, 2013). These findings demonstrate the rDLPFC's crucial role in nonsocial memory control. However, the mechanisms underlying voluntary forgetting of socially significant memories remain largely unexplored.

Humans are inherently social, and many unwanted memories originate from interpersonal experiences (Nørby, 2018; Rohde et al., 2018; Xie et al., 2021). While most DF research focuses on nonsocial content, studies suggest that people have a unique capacity to spontaneously forget negative social feedback to preserve self-esteem. This phenomenon, known as *mnemic neglect* (Sedikides et al., 2016), is often attributed to insufficient encoding of self-threatening social information (Rigney et al., 2021; Zengel et al., 2018; Yao et al., 2021). However, individuals with affective disorders, such as depression and social anxiety, struggle to forget negative self-relevant social memories, leading to persistent emotional distress (Saunders, 2011; Zengel et al., 2015). Developing strategies to enhance the active forgetting of social memories could have significant implications for reducing cognitive and emotional burdens associated with such conditions (Einarsen & Mikkelsen, 2002; Fung & Alden, 2017; Rappaport & Barch, 2020).

Non-invasive brain stimulation techniques, such as repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS), have emerged as powerful tools for modulating prefrontal activity. These techniques not only help elucidate the neural underpinnings of cognitive functions but also hold promise for treating psychiatric disorders such as depression and anxiety (Gershon et al., 2003; Perera et al., 2016; Pitcher et al., 2021; Polanía et al., 2018). Preliminary evidence highlights the causal role of the rDLPFC in memory control. For instance, low-frequency rTMS, which deactivates the rDLPFC, has been shown to impair DF performance (Xie et al., 2020), while disrupting prefrontal activity via tDCS similarly diminishes the DF effect (Imbernón et al., 2022; Silas & Brandt, 2016). However, whether these effects extend to social memories, which are inherently different from nonsocial ones due to their interpersonal and emotional significance, remains unexamined.

The present study aims to address this gap by investigating the causal role of rDLPFC stimulation in the voluntary forgetting of social versus nonsocial memories.

Using high-frequency (10 Hz) rTMS to enhance rDLPFC activity, we recruited participants to complete a DF task in either a social judgment context (framed as peer feedback) or a nonsocial context. By employing a within-subject design, we hypothesized that rDLPFC stimulation would enhance DF performance for nonsocial memories but exert minimal effects on social memories, given the tendency for self-threatening social information to undergo spontaneous forgetting (Rigney et al., 2021; Sedikides et al., 2016; Zengel et al., 2018).

Additionally, we examined the moderating role of psychiatric symptoms, particularly social anxiety, on the effects of rDLPFC stimulation. Previous research suggests that impaired prefrontal control contributes to memory regulation difficulties in individuals with depression and social anxiety (Costanzi et al., 2021; Delaney et al., 2020; Stramaccia et al., 2021), who often struggle to forget distressing social memories (Saunders, 2011; Zengel et al., 2015). We hypothesized that participants with higher social anxiety would exhibit greater improvements in social DF performance following rDLPFC stimulation. These findings could inform neuromodulation-based interventions for alleviating memory biases and emotional distress associated with social anxiety.

Methods

Participants

This study recruited two groups of participants: a nonsocial memory group and a social memory group. Based on prior TMS research in our lab using social feedback materials (Li et al., 2022), we initially aimed to recruit 40 participants per group to achieve adequate statistical power. To account for the possibility that some participants might not believe the social evaluative cover story (Nasso et al., 2020), a total of 90 healthy, right-handed college students from Shenzhen University were recruited—40 for the nonsocial group and 50 for the social group.

After post-experiment interview, 8 participants in the social group were excluded due to disbelief in the cover story, resulting in a final sample of 82 participants.

Sensitivity analyses conducted using G*Power 3.1 indicated that this sample size provided 80% statistical power to detect an effect size of f = 0.13 in a mixed design ANOVA, assuming a false positive rate of 5%.

In the nonsocial group (n = 40, 18 males), participants were aged 18 to 23 years (M ± SD = 19.7 ± 1.5). In the social group (n = 42, 23 males), participants were aged 18 to 25 years (20.2 ± 1.7). None of the participants had prior experience with TMS. Demographic characteristics for both groups are summarized in Table 1. The study was approved by the Ethics Committee of Shenzhen University. All participants provided written informed consent before participation and were monetarily compensated (60 CNY/hour).

Experimental Materials and Study Design

The directed forgetting (DF) task used 80 two-character adjectives (40 negative and 40 positive) selected from the Chinese Affective Words System (CAWS; Wang et al., 2008), which are commonly used to describe personality traits. Negative and positive words were counterbalanced across the four conditions (*TMS condition* × *DF cue*), with 10 words assigned to each condition. The word sets were balanced for valence and arousal ratings across conditions (*p*s > 0.05).

For the recognition test, an additional 80 adjectives were selected from the CAWS to serve as new items. There were no significant differences in valence and arousal between old and new word sets (*p*s > 0.05).

As in previous studies using a similar social evaluative cover story (Nasso et al., 2020; Xie et al., 2023), positive social feedback conditions were included to enhance the credibility of the cover story. However, since the study focused on the voluntary forgetting of negative memories, positive feedback conditions were excluded from the analyses. This resulted in a 2 (*Material group*: Social vs. Nonsocial) × 2 (*TMS condition*: rDLPFC-activated Active vs. vertex-activated Control) × 2 (*DF cue*: TBR vs. TBF) mixed design. The two within-subject factors were *TMS condition* and *DF cue*, while the between-subject factor was *Material group*.

Experimental Procedure

The experiment consisted of five phases (Figure 1A).

Phase 1: Preparation Stage. Participants in the social group were informed that the study aimed to examine brain activity during the processing of social feedback. Upon registration, participants provided an identity photo, which they were told would be evaluated by peers from a neighboring university. They were informed that their peers had selected one of two opposite adjectives (e.g., "honest" vs. "dishonest") to describe their first impression, and that these adjectives would be presented during the task (Nasso et al., 2020; Somerville et al., 2006). Participants were debriefed post-experiment to assess their belief in this cover story.

Participants in the nonsocial group were told that the study explored the relationship between brain activity and attentional control. Both groups received an introduction to the TMS equipment and procedures before the experiment began.

Phase 2 and 4: Active and Control Blocks. In the active block, participants received 15 minutes of high-frequency (10 Hz) repetitive TMS (rTMS) stimulation over the rDLPFC. In the control block, they received identical stimulation over the vertex, serving as a control site (Figure 1B). The order of the active and control blocks was counterbalanced across participants.

Following each stimulation session, participants completed a DF task. Each trial began with a 1-sesond fixation cross, followed by a positive or negative adjective presented for 2 seconds. A second fixation cross appeared for 0.5 seconds, after which a cue indicating "Remember" ("记") or "Forget" ("忘") was displayed for 3 seconds (Figure 1C). The task included 40 trials per block, divided into four conditions: Positive-Remember, Positive-Forget, Negative-Remember, and Negative-Forget, with 10 trials per condition. Trial order was pseudo-randomized within blocks.

After the DF task, participants took a 3-minute break before completing an old/new recognition task. In this task, 40 old words and 40 new words were randomly presented, and participants indicated whether the word was old or new within 2 seconds. Each trial ended with a 1-second blank screen.

Phase 3: Questionnaires and Rest. Participants completed a battery of questionnaires, including: the Beck Depression Inventory-II (BDI-II; Beck et al., 1996), the State-Trait Anxiety Inventory—Trait Form (STAI-T; Spielberger et al., 1983), the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), the Rejection Sensitivity Questionnaire (RSQ; Downey & Feldman, 1996), and the Revised Social Anhedonia Scale (RSAS; Eckblad et al., 1982). The questionnaire phase lasted approximately 50 minutes, allowing participants a rest period to minimize carryover effects between TMS sessions.

Phase 5: Free recall Task. Approximately one hour after completing the final recognition task, participants were asked to recall as many words as possible from the DF task, regardless of their associated cue type (TBR or TBF). They had 10 minutes to write down the recalled words, which were subsequently scored for accuracy.

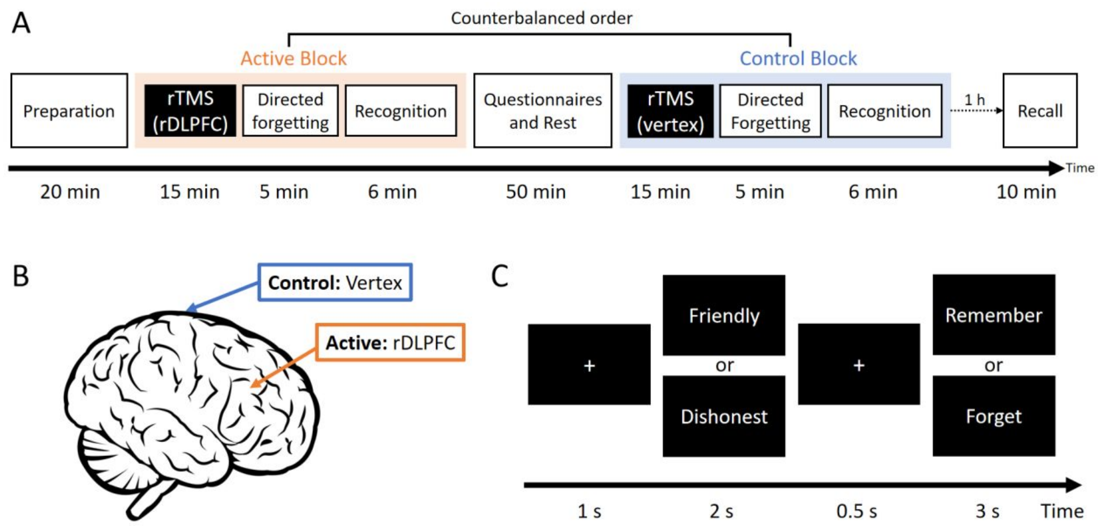

Figure 1. Experimental procedures. A, Overview of the five phases of the experiment. B, Stimulation positions for the two TMS conditions: the right dorsolateral prefrontal cortex (rDLPFC) for the Active and the vertex for Control condition. C, Illustration of a single trial in the directed forgetting task.

Repetitive Transcranial Magnetic Stimulation (rTMS)

An offline TMS protocol was used to minimize potential side effects that could affect task performance. In the Active condition, rTMS targeted the rDLPFC, while the vertex was chosen as the control site. The vertex was selected because stimulating this area induces a similar scalp sensation to the Active condition (Li et al., 2022; Zhao et al., 2021).

A figure-of-eight coil connected to a magnetic stimulator (M-100 Ultimate; Yingchi, Shenzhen, China) was used to deliver stimulation pulses. Coil placement was determined based on the International 10/20 EEG system, with the right DLPFC corresponding to the F4 site and the vertex corresponding to the Cz site (Li et al., 2022; Zhao et al., 2021). Resting motor thresholds (rMT) were measured at the C3 site.

Stimulation was applied at 10 Hz, 90% of the participant's rMT (Lefaucheur et al., 2008; Li et al., 2022; Park et al., 2017). Each session lasted 15 minutes, comprising 30 trains of 4-second stimulation with 26-second inter-train intervals. In total, each session delivered 1200 pulses.

Statistical Analysis

Statistical analyses were performed using jamovi 1.0.7.0 (https://www.jamovi.org). Descriptive data are reported as Mean ± Standard Deviation (SD), unless otherwise specified.

Repeated-measures ANOVAs were conducted to assess task performance. Within-subject factors were *TMS condition* (Active vs. Control) and *DF cue* (TBR vs. TBF), and the between-subject factor was *Material group* (Social vs. Nonsocial).

To explore relationships between self-reported measures and task performance, two-tailed Pearson's correlations were conducted between questionnaire scores (BDI-II, STAI-T, LSAS, RSQ, and RSAS) and behavioral indicators (hit rate, false alarms, recognition *d'*, and recall accuracy) separately for each group. Due to the exploratory nature, correlations were not corrected for multiple comparisons.

Results

For clarity, descriptive data (Mean ± SD) for all measured variables, excluding false alarms, are presented in Table 2.

Recognition Performance

Participants' hit rates (Hit) and false alarm rates (FA) were calculated for each condition. Noted that TBR and TBF items were intermixed with a common set of new items during each recognition task, there were four FA conditions: Social-Active (0.30 ± 0.18), Social-Control (0.31 ± 0.17), Nonsocial-Active (0.30 ± 0.19), and Nonsocial-Control (0.28 ± 0.17).

Hit Rates. A repeated-measures ANOVA revealed a significant main effect of *DF cue* ($F(1,80) = 103.881$, $p < 0.001$, $\eta_p^2 = 0.565$), with higher hit rates for TBR items compared to TBF items. Additionally, a two-way interaction between *DF cue* and *TMS condition* was observed ($F(1,80) = 6.985$, $p = 0.010$, $\eta_p^2 = 0.080$). Simple effects analysis indicated that rDLPFC activation reduced hit rates for TBF items compared to the Control condition ($p = 0.004$), but had no effect on TBR items ($p = 0.339$). Besides, a two-way interaction was found between *DF cue* and *Material group* ($F(1,80) = 6.419$, $p = 0.013$, $\eta_p^2 = 0.074$). Simple effects analysis revealed that participants in the Social group showed a trend toward higher hit rates for TBF items compared to the Nonsocial group ($p = 0.088$), whereas hit rates for TBR items were comparable across groups ($p = 0.333$).

Moreover, a significant three-way interaction was found ($F(1,80) = 6.745$, $p = 0.011$, $\eta_p^2 = 0.078$). To break down this three-way interaction, we tested the *DF* × *TMS* interaction separately for each group. Results showed that this two-way interaction was significant in the Nonsocial group ($F(1,39) = 13.515$, $p < 0.001$, $\eta_p^2 = 0.257$) but not in the Social group ($F(1,41) = 0.001$, $p = 0.974$, $\eta_p^2 = 0.000$). Specifically, in the Nonsocial group, active TMS reduced hit rates for TBF items compared to the control TMS condition ($p < 0.001$) and showed a trend toward improving hit rates for TBR items ($p = 0.074$).

In addition, in the Social group, participants' social anxiety scores were positively correlated with hit rates in the TBR-Control ($r = 0.354$, $p = 0.021$) and TBF-Control ($r = 0.338$, $p = 0.029$) conditions. However, these correlations disappeared in the TBR-Active ($r = 0.234$, $p = 0.135$) and TBF-Active ($r = 0.206$, $p = 0.192$) conditions.

False Alarms. A repeated-measures ANOVA yielded no significant main effects or interactions across conditions.

Recognition Sensitivity (d'). Recognition sensitivity (*d'*) was calculated using the formula: $d' = z(\text{Hit}) - z(\text{FA})$ (Macmillan & Creelman, 1991). Higher *d'* values reflect better discrimination between old and new items. Given the lack of significant FA effects, *d'* patterns were primarily driven by differences in hit rates.

A significant main effect of *DF cue* was found ($F(1,80) = 113.466$, $p < 0.001$, $\eta_p^2 = 0.586$), with TBR items recognized better than TBF items, consistent with the DF effect (Anderson & Hanslmayr, 2014; Bjork, 1989). Furthermore, a two-way interaction between *DF cue* and *TMS condition* was observed ($F(1,80) = 7.581$, $p = 0.007$, $\eta_p^2 = 0.087$). Active TMS tended to reduce recognition of TBF items compared to the Control ($p = 0.061$) but did not affect recognition of TBR items ($p = 0.181$). A two-way interaction between *DF cue* and *Material group* was found ($F(1,80) = 9.110$, $p = 0.003$, $\eta_p^2 = 0.102$). Participants in the Social group showed poorer recognition for TBR items compared to the Nonsocial group ($p = 0.048$), whereas recognition for TBF items was comparable ($p = 0.322$).

The key finding was the significant three-way interaction ($F(1,80) = 4.380$, $p = 0.040$, $\eta_p^2 = 0.052$; see Figure 2). To further explore this interaction, we examined the *DF cue* × *TMS condition* interaction within each group. The results revealed that this two-way interaction was significant in the Nonsocial group ($F(1,39) = 10.725$, $p = 0.002$, $\eta_p^2 = 0.216$), but not in the Social group ($F(1,41) = 0.239$, $p = 0.627$, $\eta_p^2 = 0.006$). Specifically, in the Nonsocial group, Active TMS reduced recognition sensitivity for TBF items ($p = 0.013$) but not affect TBR items ($p = 0.224$).

Additionally, in the social group, *d'* scores in the TBF-Control condition were positively correlated with social anxiety scores ($r = 0.313$, $p = 0.044$), indicating that higher social anxiety was associated with reduced ability to forget negative social feedback. However, this correlation disappeared in the TBF-Active condition ($r = -0.215$, $p = 0.171$).

We also examined the impact of TMS on the DF effect of negative social feedback in participants who scored above 60 on the Liebowitz Social Anxiety Scale (N = 18). A paired-samples t-test revealed a trend toward a larger DF effect following rTMS over the rDLPFC (0.591 ± 0.770) compared to the Control TMS condition (0.284 ± 0.608), though this difference did not reach statistical significance ($t(17) = 1.475$, $p = 0.159$, Cohen's $d = 0.348$).

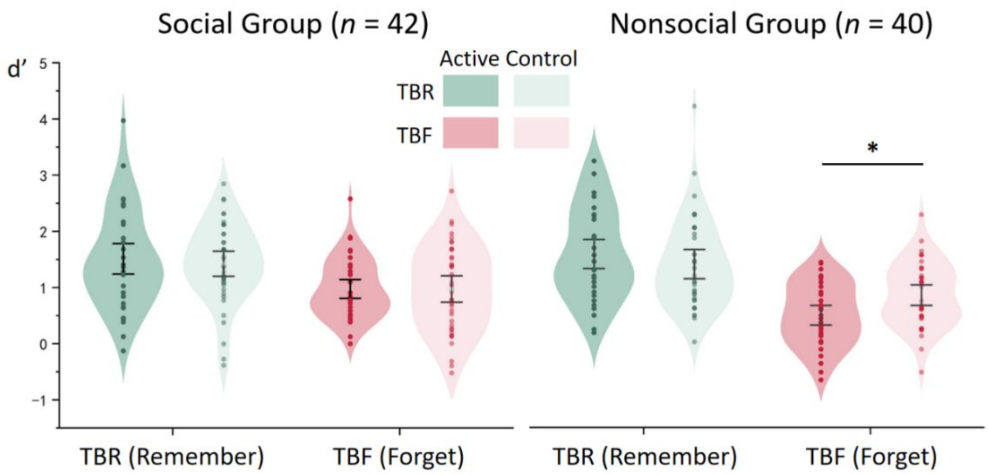

Figure 2. Recognition sensitivity (*d'*) results. A significant three-way interaction was found between the DF cue, TMS condition, and Material group. Post-hoc analyses revealed a significant TMS effect on the TBF condition in the Nonsocial group. Bars represent the standard error of the mean. *$p < 0.05$.

Recall Performance

The ANOVA revealed a significant main effect of *DF cue* ($F(1,80) = 231.522$, $p < 0.001$, $\eta_p^2 = 0.743$), with participants recalling more TBR items than TBF items.

Correlation analyses indicated that, in the social group, recall accuracy was positively correlated with social anhedonia scores in the TBF-Control condition (r = 0.367, p = 0.017), but this correlation disappeared in the TBF-Active condition (r = −0.047, p = 0.768). Additionally, recall accuracy was negatively correlated with rejection sensitivity scores in the TBF-Active condition (r = −0.308, p = 0.047), but not in the TBF-Control condition (r = −0.064, p = 0.686).

Discussion

The ability to voluntarily forget unwanted memories is essential for mental well-being, enabling individuals to discard information that disrupts focus or exacerbates emotional distress (Engen & Anderson, 2018; Hu et al., 2017). This study used a directed forgetting (DF) paradigm and repetitive transcranial magnetic stimulation (rTMS) to investigate the causal role of the right dorsolateral prefrontal cortex (rDLPFC) in the voluntary forgetting of social and nonsocial memories. By contrasting the effects of rTMS in social and nonsocial contexts, our findings reveal distinct neural mechanisms underlying the regulation of these memory types and highlight the potential therapeutic applications of prefrontal stimulation for individuals with social anxiety.

DLPFC and Voluntary Forgetting of Nonsocial Memories

Consistent with prior research, the rDLPFC was found to play a central role in the voluntary forgetting of nonsocial memories (Nowicka et al., 2011; Wylie et al., 2008; see Anderson & Hanslmayr, 2014 for a review), likely via top-down inhibitory control over hippocampal activity (Hubbard & Sahakyan, 2023; Oehrn et al., 2018; Rizio & Dennis, 2013; Anderson & Hulbert, 2021). Our previous work has shown that disrupting rDLPFC activity impairs DF performance (Xie et al., 2020); this study extends these findings by demonstrating that high-frequency rTMS enhances voluntary forgetting of nonsocial memories. This effect was specific to to-be-forgotten (TBF) items, as recognition of to-be-remembered (TBR) items remained intact.

These results align with theoretical models emphasizing the selective inhibitory function of the rDLPFC in memory control, allowing individuals to suppress irrelevant or undesired information while preserving relevant content (Anderson & Hanslmayr, 2014; Anderson & Hulbert, 2021). The findings further underscore the adaptability of prefrontal inhibitory processes in regulating nonsocial memories, which rely heavily on top-down modulation.

Social Memories and Reduced Dependence on DLPFC Control

In contrast, the voluntary forgetting of social memories appeared less dependent on rDLPFC-mediated inhibition. Participants in the social memory group showed no significant enhancement of DF performance following rDLPFC stimulation. This may reflect the automatic suppression of self-threatening social feedback during encoding, reducing reliance on prefrontal control mechanisms for active forgetting (Xie et al., 2021). Supporting this interpretation, participants in the social memory group displayed poorer recognition of TBR items compared to the nonsocial group, consistent with reduced encoding of self-threatening social information (Rigney et al., 2021; Zengel et al., 2018).

These findings suggest that social memory regulation involves distinct or differently weighted neural processes compared to nonsocial memory. While nonsocial memory control relies heavily on rDLPFC-mediated inhibition, the forgetting of social memories may be driven by encoding biases or alternative neural circuits. Further research is needed to delineate the specific mechanisms underlying social memory regulation and their interaction with prefrontal control.

Social Anxiety and Forgetting of Negative Social Feedback

A critical finding of this study was the moderating effect of social anxiety on the forgetting of negative social feedback. In the Control TMS condition, participants with higher social anxiety showed greater difficulty in forgetting TBF social items, consistent with previous research linking social anxiety to impaired voluntary forgetting (Gomez-Ariza et al., 2013). However, this impairment was alleviated under

Active TMS, suggesting that rDLPFC stimulation can mitigate memory biases associated with social anxiety.

Individuals with social anxiety often struggle with spontaneous forgetting of self-threatening memories, leading to persistent emotional distress (Zengel et al., 2015). By enhancing rDLPFC activity, rTMS may strengthen voluntary forgetting mechanisms, helping to counteract these deficits. This finding has clinical implications, as maladaptive retention of negative social memories is a key cognitive feature of social anxiety disorder (SAD; Coles & Heimberg, 2002; Fricke et al., 2024; Seinsche et al., 2023). Prefrontal stimulation may thus represent a promising intervention for alleviating cognitive and emotional burdens in socially anxious individuals, particularly when combined with behavioral therapies targeting memory biases (Gong et al., 2023; Jarcho et al., 2015; Krans et al., 2014; Morgan, 2010).

Limitations and Future Directions

This study has several limitations that warrant consideration. First, the between-subject design may have introduced unmeasured confounds, such as individual differences in baseline memory capacity or task engagement. Future studies using within-subject designs could provide stronger evidence for context-dependent effects. Second, the absence of neuroimaging data limits our ability to directly link behavioral outcomes to changes in neural activity. Incorporating fMRI-guided neuronavigation would improve the precision of TMS targeting and clarify the neural mechanisms underlying memory regulation (Pitcher et al. 2021; Polanía et al. 2018). Third, the sample size for exploratory correlation analyses was modest, highlighting the need for larger, more diverse samples to confirm these findings and enhance generalizability.

Conclusion

This study provides novel evidence of a dissociation in the neural mechanisms underlying the voluntary forgetting of social and nonsocial memories. While rDLPFC stimulation enhanced DF performance for nonsocial memories, it had no significant effect on social memories, likely due to their reliance on automatic encoding biases rather than prefrontal inhibitory control. Importantly, rTMS over the rDLPFC mitigated memory biases in individuals with high social anxiety, offering a potential avenue for targeted interventions. These findings deepen our understanding of the neural basis of memory control and suggest innovative strategies for addressing maladaptive memory retention in clinical populations.

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Data and code availability

The data and code of this study would be available upon reasonable request and with the approval of the School of Psychology, Shenzhen University. More information on making this request can be obtained from the corresponding author D. Zhang (zhangdd05@gmail.com).

Author contributions

D. Zhang, H. Xie and X. Hu designed the research; J. Liang, Y. Luo, and W. Chen collected the data; H. Xie and J. Liang analyzed the data; H. Xie, X. Hu, and D. Zhang wrote and revised the manuscript.

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Tables

Table 1. Demographic characteristics of the two groups (Mean ± SD).

Items	Social group (n = 42)	nonsocial group (n = 40)	Statistics [a]	
			$t_{(80)}$	p
Gender (male/female)	23/19	18/22		
Age (year)	20.2 ± 1.7	19.7 ± 1.5	1.381	0.171
BDI-II	6.6 ± 5.1	5.9 ± 5.5	0.656	0.514
STAI-T	40.8 ± 7.5	41.6 ± 8.4	−0.449	0.655
LSAS	53.7 ± 18.5	49.1 ± 21.2	1.052	0.232
RSQ	10.5 ± 2.6	10.8 ± 2.4	−0.489	0.626
RSAS	9.9 ± 4.5	9.1 ± 5.0	0.813	0.419

[a] Independent samples t-test between the two groups.

BDI-II, the Beck Depression Inventory Second Edition; STAI-T, the Trait form of Spielberger's State-Trait Anxiety Inventory; LSAS, the Liebowitz Social Anxiety Scale; RSQ, the Rejection Sensitivity Questionnaire; RSAS, the Revised Social Anhedonia Scale.

590 Table 2. Mean ± SD of each within-subject condition in the social and nonsocial group.

	Social (*n* = 42)				Nonsocial (*n* = 40)			
	TBR		TBF		TBR		TBF	
	Active	Control	Active	Control	Active	Control	Active	Control
Hit rate	0.76 ± 0.17	0.77 ± 0.15	0.62 ± 0.17	0.64 ± 0.21	0.83 ± 0.15	0.77 ± 0.18	0.52 ± 0.21	0.63 ± 0.20
Sensitivity (*d'*)	1.51 ± 0.88	1.43 ± 0.72	0.98 ± 0.54	0.97 ± 0.76	1.82 ± 0.88	1.63 ± 0.87	0.65 ± 0.60	1.04 ± 0.63
Recall accuracy	0.30 ± 0.14	0.34 ± 0.19	0.09 ± 0.10	0.10 ± 0.13	0.31 ± 0.17	0.26 ± 0.19	0.06 ± 0.09	0.06 ± 0.08

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