The Impact of Acute Social Stress on Working Memory Updating in Social Anxiety Disorder

Arya Adyasha[1,*], Anushka Sanjay Shelke[2], Nilesh Kumar Sahu[2], Haroon R Lone[2]
[1]Department of Biological Sciences, Indian Institute of Science Education and Research, Bhopal
[2]Department of Electrical Engineering and Computer Sciences, Indian Institute of Science Education and Research, Bhopal
[*]arya20@iiserb.ac.in

Abstract

Social anxiety disorder (SAD) is characterized by cognitive biases that impair emotional information processing. This study examines how acute social stress affects working memory (WM) updating in socially anxious individuals using an emotional 2-back task. A 2×2 factorial design (N = 137) categorized participants into socially anxious (SA) and non-anxious (NSA) groups, further divided into stressed and control conditions. Acute stress was induced via speech anticipation, and subjective stress ratings were recorded. Mixed-effects modelling revealed independent negative effects of both social anxiety and acute stress on WM updating, including reduced accuracy, increased false alarms, lower discriminability (d-prime), and increased inverse efficiency score. Notably, disgusted facial expressions enhanced task efficiency under stress. Findings suggest stress-related cognitive deficits in social anxiety are additive rather than interactive, highlighting potential targets for intervention. This study contributes to understanding emotion-cognition interactions and extends research to understudied cultural contexts.

Keywords: Working memory updating; social anxiety disorder; acute social stress; emotional 2-back task.

Introduction

Social Anxiety Disorder (SAD) is a prevalent condition, affecting 4.7–17% of the global population (Salari et al., 2024). It is marked by intense fear or anxiety in social interactions, performance situations, or evaluative contexts. Cognitive theories suggest that individuals with SAD exhibit deficits in emotional and interpersonal information processing, leading to hyper-vigilance toward threat-related or negative stimuli (Lazarov et al., 2021) and a tendency to misinterpret ambiguous or neutral stimuli as negative (Chen, Milne, Dayman, & Kemps, 2019). These attentional and interpretational biases shape how information is encoded, processed, and retrieved from Working Memory (WM), contributing to distorted cognitive processing.

Behavioral studies indicate that socially anxious individuals exhibit deficits in updating positive content in working memory. The first study (Segal, Kessler, & Anholt, 2015) to demonstrate a cognitive bias in WM updating related to social anxiety used an emotional 2-back task. They measured intrusion costs and found that participants with high social anxiety showed a reduced intrusion cost for positive stimuli, suggesting an enhanced ability to inhibit positive content when it was irrelevant. Similarly, a recent study (Yuan, Sun, Zhang, & Cui, 2024) reported that socially anxious individuals exhibited longer response times when updating WM with positive words, indicating deficits in positive information retrieval.

These maladaptive information-processing patterns may be more pronounced, particularly for emotional stimuli, when social anxiety is triggered. The Attentional Control Theory (ACT) (Eysenck, Derakshan, Santos, & Calvo, 2007) suggests that trait anxiety can interact with in-the-moment stress to give rise to state anxiety. An fMRI based study (Boehme et al., 2014) has shown how people with social anxiety tend to experience acute social stress in higher intensity. Neural correlates in SAD patients and healthy controls, during the anticipation of public speaking versus a control condition, show decreased ventral striatum activity, hyperactivated insula, and amygdala hyperactivation in the first half of anticipation.

Recent studies have examined how the interplay between acute stress and social anxiety affects higher cognitive processes, such as risky decision-making (Hengen & Alpers, 2021; Richards et al., 2015). Their findings reveal a differential impact of stress on individuals with high versus low social anxiety. The influence of situational stress and trait anxiety on visual working memory has been investigated using a single-probe change detection paradigm (Spalding et al., 2021). While it was found that situational stress reduces accuracy in a visual binding memory task, the stressor did not significantly interact with trait anxiety. Although a few studies have examined WM difficulties in processing emotional information in SAD, the impact of acute stress—and its interaction with social anxiety—on executive functions such as WM updating remains largely unexplored.

Our study addresses this gap by examining the effect of acute stress on WM updating for emotional content. Our contribution in this study is not just limited to applying stress to an existing paradigm but also investigating working memory updating in socially anxious individuals from collectivist South Asian cultures, where hierarchy and familial expectations influence cognitive biases. We adapted the well-validated N-back paradigm (Braver et al., 1997; Smith & Jonides, 1997) while using three types of facial expressions (positive, neutral, and negative) as stimuli.

To induce acute social stress, we employed a speech anticipation task, a well-established and reliable stressor (Richards et al., 2015; Hengen & Alpers, 2021). Our primary hypotheses are: (1) individuals with social anxiety will show impaired WM updating performance compared to non-anxious individuals, (2) acute stress will further modulate WM perfor-

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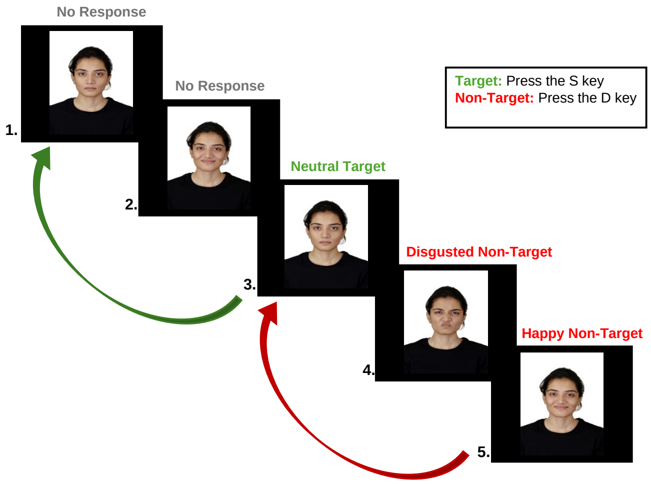

Figure 1: Presentation of 2-back task with emotional stimuli. Adapted from (Wadhera et al., 2018).

mance, either exacerbating impairments in anxious individuals (if stress compounds existing deficits) or affecting both anxious and non-anxious individuals similarly (if stress impacts WM updating independently of anxiety), and (3) emotional valence will differentially impact WM performance. This theoretical framework allows us to investigate how dispositional (trait anxiety) and situational (stress) factors influence cognitive performance.

Methodology

Participants

Participants were recruited through on-campus advertisements and screened for social anxiety using the *Social Interaction Anxiety Scale (SIAS)*, a 20-item questionnaire that measures social interaction anxiety on a 5-point Likert scale, ranging from "not at all characteristic of me" to "extremely characteristic of me." Participants scoring ≥ 43 were classified as socially anxious (SA), while those scoring ≤ 33 were classified as non-socially anxious (NSA), based on clinically accepted cut-offs.

A total of 137 participants were recruited. Half of the SA and NSA participants were randomly assigned to a stress condition, creating four groups: (1) SA-Stressed (N = 32, Female = 9, age: $\overline{X}$ = 19.68, σ= 1.37), (2) SA-Control (N = 35, Female = 11, age: $\overline{X}$ = 20.54, σ = 2.46), (3) NSA-Stressed (N = 32, Female = 9, age: $\overline{X}$ = 19.98, σ = 1.69), (4) NSA-Control (N = 35, Female = 12, age: $\overline{X}$ = 19.69, σ = 1.36). This study employed a 2×2 between-subjects factorial design to explore the effects of anxiety level (SA vs. NSA) and stress condition (Stressed vs. Control) on WM updating performance.

The study received ethical approval from the *Institutional Review Board*, and informed consent was acquired from all participants after briefing them through a standard information sheet. Participants received either a refreshment box or bonus points for their course credit as a token of appreciation.

Materials

Choice of stressor Our goal was to ensure that participants in the stressed group performed the WM updating task under social stress. To induce acute social stress, these participants were given the following instructions:

"*As part of this study, you'll have to give a speech immediately after completing the 2-back task. There will be no time provided for preparation. You must speak for at least 2 minutes on a given topic in front of the coordinator. Your speech will be video and audio recorded for evaluation. Please keep in mind that this speech follows right after the task.*."

The anticipation of the upcoming speech was designed to elicit anticipatory anxiety, while the presence of the coordinator and the recording of the speech aimed to induce the fear of negative evaluation. This has been shown to be an effective stressor in prior studies (Richards et al., 2015; Hengen & Alpers, 2021).

Emotional 2-back task The emotional 2-back task is a modified version of the well validated N-back paradigm (Braver et al., 1997; Smith & Jonides, 1997) that is often used as a WM updating task. Each trial began with the presentation of a facial expression stimulus (see Fig. 1). Participants were instructed to press 'S' if the current facial expression matched the one presented two trials earlier (a "Same" response) or 'D' if it differed (a "Different" response).

Task block structure The 2-back task consisted of 324 trials, organized into 12 blocks of 26 trials each, adapted from prior research (Levens & Gotlib, 2010). The number of trials and blocks were determined through piloting to ensure task completion with minimum fatigue or disengagement. Within each block, the same facial identity was maintained to isolate the effects of emotional expressions without introducing variability from changing identities. The first two trials of each block were no-response trials. Response trials began from the third trial onward, resulting in 24 valid trials per block. Facial expressions (positive, negative, and neutral) were pseudo-randomized so that each block contained 12 match trials (where the facial expression matched the one from two trials prior) and 12 non-match trials (where it did not). Match trials were further equally distributed among positive, negative, and neutral match trials. Six blocks featured male facial identities, and six featured female identities to ensure balanced representation. The block order was randomized across participants to counterbalance sequence effects.

Stimuli The facial expression stimuli used in the task were obtained from the IIMI Emotional Face Database (Tewari, Mehta, & Srinivasan, 2023). This database was chosen over other widely used repositories to account for cultural variations in emotion recognition, as prior research shows that individuals interpret facial expressions more accurately and responsively when they are culturally congruent. Therefore,

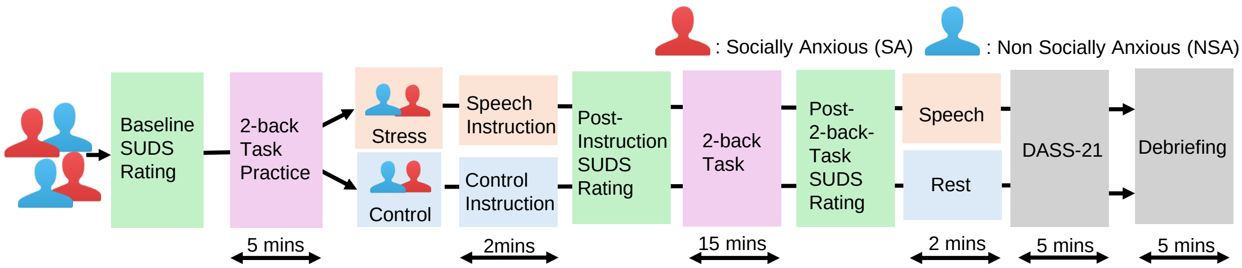

Figure 2: Experimental procedure.

using a database featuring Indian faces ensures that the stimuli are ecologically valid and culturally relevant. Participants from the pilot study validated the stimuli's effectiveness. These are a separate group of 19 participants with similar age ranges who rated facial images using a valence-arousal affect grid (Russell, Weiss, & Mendelsohn, 1989), with valence (1 = unpleasant, 9 = pleasant) on the horizontal axis and arousal (1 = low, 9 = high) on the vertical axis. Ratings for the 12 identities used in the study showed expected patterns: *Happy* had the highest valence ($\overline{X} = 7.34, \sigma = 1.28$) and moderate arousal ($\overline{X} = 4.76, \sigma = 2.00$), *Disgusted* had low valence ($\overline{X} = 2.38, \sigma = 1.34$) but slightly higher arousal ($\overline{X} = 5.04, \sigma = 2.24$), and *Neutral* had moderate valence ($\overline{X} = 4.66, \sigma = 1.13$) with the lowest arousal ($\overline{X} = 2.57, \sigma = 1.55$).

Task presentation The task was programmed using PsychoPy v2024.2.1. In each trial, a facial expression stimulus appeared for 1200 ms, followed by a 1200 ms inter-stimulus interval. Reaction time measurement began with stimulus onset, and participants could respond anytime within the 2400 ms window, determined via a pilot study. They were instructed to respond accurately without guessing. Each block started with a 3000 ms fixation cross. After the 6th block, participants had a break for as long as they wanted. The task lasted ∼15 minutes, with 288 valid trials across 12 blocks.

Questionnaire To validate our choice of stressor we collected participants' perceived stress levels using the Subjective Units of Distress Scale (SUDS) ratings at crucial time points (See Fig 2). It is a self-report scale ranging from 0 to 100, where 0 indicates complete relaxation and 100 represents the highest distress imaginable. SUDS is easy to use and well-validated in both clinical and research settings (Tanner, 2012). Additionally, to account for any additional baseline psychological distress we used the Depression, Anxiety, and Stress Scale-21 (DASS-21) (Lovibond, 1995). It is a widely used self-report questionnaire designed to assess emotional states across three domains: depression, anxiety, and stress.

Procedure

The study began with an introduction and informed consent, followed by a baseline assessment of the participants' affective state (see Fig. 2 for an illustration of the experimental procedure). Each participant was then introduced to the task and completed a practice session consisting of 25 trials, with feedback provided after each trial. These practice trials were not included in any subsequent analysis.

Social stress condition Participants in the social stress condition received the speech instructions described in Section Choice of stressor to induce acute social stress. After receiving the instructions, participants completed a second set of SUDS ratings before proceeding with the 2-back task. Following the completion of the task, an additional set of SUDS ratings was collected.

Control condition Participants in the control condition did not receive the speech instructions. Instead, they were informed that no additional activities would follow the 2-back task. These participants were given a 2-minute rest, during which they sat in a relaxed position. SUDS ratings were collected for the control group at the same Time-points as the stress condition group.

Both groups completed a post-study questionnaire, DASS-21. Finally, all participants were debriefed.

Data analysis pipeline

Questionnaire DASS-21 scores were calculated & interpreted based on established guidelines (Lovibond, 1995). Raw SUDS as well as DASS-21 scores were used in analysis.

Main analysis To account for individual differences in task performance, we employed mixed-effects models with random intercepts for each participant. Three regression models were used based on the dependent variable's distribution: linear regression for unbounded continuous variables, Gamma regression for positively skewed unbounded continuous variables, and Beta regression for bounded continuous variables. When multiple models were considered, the Akaike Information Criterion (AIC) guided model selection. All reported mixed models were assessed for statistical assumptions using QQ plots of residuals and residuals vs. predicted values to evaluate normality and homoscedasticity. No outliers were detected. For pairwise comparisons, Tukey's correction was applied.

In a 2-back task, participant performance is primarily measured using two metrics: **accuracy** (whether the response is correct) and **reaction time** (the duration taken to respond). However, for a more detailed picture of the participants performance, beyond overall accuracy, additional performance indices were derived: (i) *Hits:* Correctly pressing the "S" button in response to match trials (targets). (ii) *False alarms:* Incorrectly pressing the "S" button in response to non-match trials (non-targets). (iii) *Misses:* Failing to press the "S" button in response to targets. (iv) *Correct rejections:* Correctly refraining from pressing the "S" button in response to non-targets.

Further performance metrics were calculated from hits and false alarms: **Hit rate:** Proportion of targets correctly identified. **False alarm rate:** Proportion of non-targets incorrectly identified as targets. **d-prime (d'):** A sensitivity measure calculated as z(Hit Rate) – z(False Alarm Rate), where z represents the Z-score (Stanislaw & Todorov, 1999). These additional metrics have been suggested to be incorporated for a more fine-grained analyses (Meule, 2017).

Additionally, the **Inverse Efficiency Score (IES)** was computed by dividing the mean reaction time (in milliseconds) by the proportion of correct responses for each participant, separately for each emotional category and trial type (Ashby & Townsend, 1986). Consequently, separate IES values were used for match and non-match trials in the analysis.

All statistical analyses were conducted in R (version 4.4.2), while initial data cleaning, organization, parameter calculations, and structuring were performed in Python 3.10.

Results

Quality control analyses

Potential confound variables To account for the effect of age and gender, the following steps were taken. The analysis revealed no significant differences in age among the groups, as indicated by the ANOVA: $F(3,133) = 1.86$, $p = 0.139$. Similarly, the gender distribution was equal across groups, as demonstrated by the chi-squared test: $\chi^2 = 0.70$, $p = 0.873$. High dispositional stress, anxiety and existing depressive symptoms may have a negative effect on WM updating. Hence, to account for that, we checked the DASS-21 scores of all participants for Depression, Anxiety and Stress. The SA group scored significantly higher than the NSA group in terms of total score, F(1, 135) = 33.348, ($p <.001$). However, there was no significant difference between the two stressed and control groups, F(1, 135) = 2.382, ($p = 0.125$) and none of the participants scored above the clinical cut-off in the 3 categories.

Manipulation check We first checked whether the social stress manipulation was effective. Successful induction should lead to a significant increase in SUDS from baseline to post-instructions and post-2-back-task for NSA-stressed and SA-stressed groups, but not for controls. A Gamma regression model of SUDS ratings on Anxiety (SA vs. NSA), Stress condition (Control vs. Stressed), and Time-points (Baseline, Post-instructions, Post-2-back-task) showed a significant Time-points × Stress condition interaction (β = 0.23364, CI_{95} = [0.0238, 0.4434], p = 0.02905), along with significant main effects for all three factors. Pairwise comparisons (Tukey correction) revealed no significant differences between groups at baseline.

Post-instruction ratings showed a significant increase for SA-stressed (β = -0.3856 -0.3856, CI_{95} = [-0.537, -0.234], $p < 0.001$) and NSA-stressed (β = -0.4160, CI_{95} = [-0.561, -0.271], $p < 0.001$), confirming successful stress induction. Post-2-back-task, SUDS ratings significantly increased for NSA-stressed, SA-stressed, and SA-control as well (β = 0.3105, CI_{95} = [0.164, 0.457], $p < 0.001$), suggesting the emotional 2-back task itself induced stress in SA-control. NSA-control showed stable SUDS ratings with no significant effects. Although the Anxiety × Time-points interaction was non-significant, SA individuals had higher overall SUDS ratings than NSA counterparts.

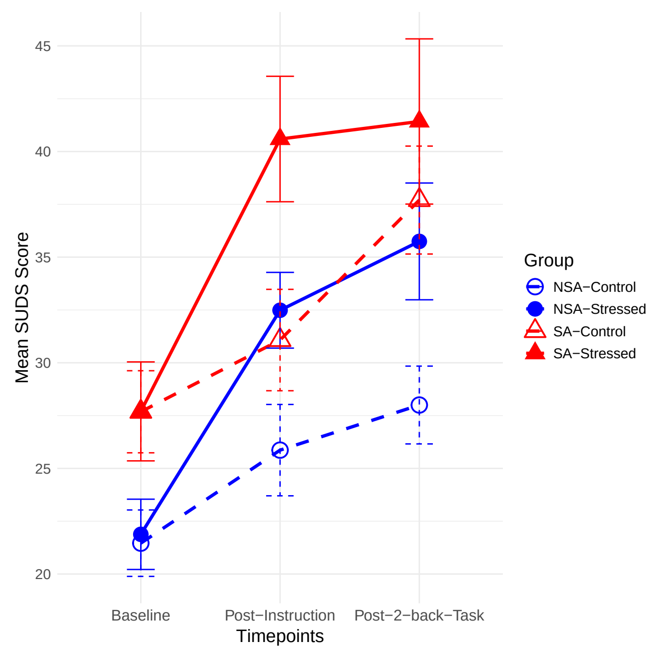

Figure 3: SUDS ratings of four groups at different time points. Note: error bars represent ± SEM; NSA = Non-Socially Anxious ; SA = Socially Anxious.

Performance analysis

Hit rate To check the effect of Anxiety (SA vs. NSA), Stress (Stress vs. Control), and Emotions (Disgusted vs. Happy vs. Neutral) on the hit rate, we estimated a mixed-effects beta regression and regressed the hit rate onto these factors with participant-ID as random effects[1] (AIC: -810.9). There was no significant interaction. Hence, it was dropped from the model and its AIC improved (AIC: -816.8). We found a significant negative effect of Anxiety (β = -0.40, CI_{95}

[1]Gender was included as a fixed effect in all models but did not significantly impact the results.

= [0.21, 0.59], $p < 0.001$) as well as a significant negative effect of Stress (β = -0.51, CI_{95} = [-0.70, -0.32], $p < 0.001$). The main effect of Emotions was also significant. Paired contrasts revealed only a significant difference between disgusted and neutral expressions (β = -0.1257, CI_{95} = [-0.22, -0.03], p = 0.0217). Hence, the takeaway is that Anxiety and Stress negatively impact the hit rate independently of each other, and disgusted expressions significantly reduced the hit rate compared to neutral expressions.

False alarm rate Similarly, for False Alarm rate, mixed-effects model with beta regression showed significant positive effect of Anxiety(β = 0.325, CI_{95} = [0.13, 0.52], p = 0.0012), and Stress (β = -0.429, CI_{95} = [-0.63, -0.23], p <0.001). Interestingly, the False Alarm rate was lowest for disgusted face, with showing a better performance from both happy(β = -0.3898, CI_{95} = [-0.49, -0.29], $p < 0.001$) and neutral expressions (β = -0.3342, CI_{95} = [-0.43, -0.24], p <0.001). Again, the interaction (AIC: -892.6) was not significant; upon dropping which, the model AIC improved (AIC: -897.1). Anxiety and Stress increased the chances of participants reporting targets incorrectly, while the participants' performance improved for disgusted faces with a lower false alarm rate.

d-prime We estimated a linear mixed model with Anxiety, Stress, & Emotion as the fixed effect and participant ID as the random effect (AIC: 553.5). Here also, the interaction terms were not significant, which led to those being dropped (AIC: 545.7). We found a significant difference between SA and NSA individuals (β= -0.43, CI_{95} = [-0.62, -0.24], p <0.001) as well as stressed and control (β = 0.568, CI_{95} = [0.38, 0.76], p <0.001). For Emotions, disgusted expression had the highest d-prime, with it significantly differing from both happy (β = 0.2177,CI_{95} = [0.14, 0.30], p <0.001) and neutral expressions (β = 0.1275, CI_{95} = [0.05, 0.20], p = 0.0028). This means that anxiety and stress reduced discriminability, while disgusted faces led to improved discriminability, compared to both happy and neutral faces.

Speed-accuracy trade-off Observing overall mean accuracy and reaction time across the four groups revealed a potential speed-accuracy trade-off. The SA-Stressed group exhibited the lowest accuracy ($\overline{X} = 0.6587$, $\sigma = 0.4742$) but a surprisingly low reaction time ($\overline{X} = 0.9182$, $\sigma = 0.3392s$), similar to the NSA-Control group, which had the highest accuracy ($\overline{X} = 0.8274$, $\sigma = 0.3779$) and a comparable reaction time ($\overline{X} = 0.9258$, $\sigma = 0.3038s$). This suggests the SA-Stressed group may have adopted a speed-accuracy trade-off strategy, prioritizing speed over accuracy. The SA-Control group showed moderate accuracy ($\overline{X} = 0.7475$, $\sigma = 0.4345$) but the highest reaction time ($\overline{X} = 0.9977$, $\sigma = 0.3426s$). Meanwhile, the NSA-Stressed group exhibited intermediate accuracy ($\overline{X} = 0.7386$, $\sigma = 0.4394$) and reaction time ($\overline{X} = 0.9665$, $\sigma = 0.3188s$), aligning more closely with the SA-Control group. To further explore this, we calculated the IES, a composite index that accounts for both reaction time and accuracy separately for match and non-match trials.

IES-match The mixed-effects Gamma regression model for IES revealed significant effects of Anxiety, Stress, and Emotions. Anxiety significantly affected IES, with NSA individuals showing lower scores than SA individuals (β = -0.137, CI_{95} = [-0.2187, -0.0553], p = 0.0010). Stress also increased IES, with stressed individuals exhibiting higher scores than controls (β = 0.117, CI_{95} = [0.0352, 0.1988], p = 0.0052). Emotions had a significant main effect, with post-hoc analysis showing that IES for disgusted faces was higher than for neutral expressions (β = 0.0594, CI_{95} = [0.0295, 0.0893], p = 0.0003), while other comparisons were non-significant. These findings suggest that anxiety and stress impair task efficiency (higher IES), whereas disgusted expressions may lower efficiency compared to neutral expressions in match trials.

IES-non-match The mixed-effects Gamma regression model for IES in the non-matching condition revealed significant effects of Anxiety, Stress, and Emotions, along with notable interactions. Anxiety significantly increased IES, with NSA individuals performing more efficiently (β = -0.149, CI_{95} = [-0.253, -0.045], p = 0.0050), while stress alone had no significant effect (β = 0.036, CI_{95} = [-0.070, 0.142], p = 0.512). However, a three-way interaction between Anxiety, Stress, and Emotions indicated that main effects of emotion were modulated by both anxiety and stress.

Post-hoc comparisons (as shown in Fig. 4) revealed that in NSA-control, disgusted expressions led to significantly lower IES than neutral expressions (β = -0.079, CI_{95} = [-0.132, -0.026], p = 0.0086). A similar but stronger trend was observed in SA-control, where disgusted expressions significantly lowered IES compared to both happy (β = -0.124, CI_{95} = [-0.177, -0.071], $p < 0.001$) and neutral expressions (β = -0.133, CI_{95} = [-0.186, -0.080], $p < 0.0001$), with no difference between happy and neutral (p = 0.936).

In NSA-stressed, disgusted expressions again lowered IES compared to happy (β = -0.150, CI_{95} = [-0.203, -0.097], $p <$ 0.001) and neutral expressions (β = -0.139, CI_{95} = [-0.191, -0.087], $p < 0.001$), though no difference emerged between happy and neutral (p = 0.896). In SA-stressed, disgusted expressions further enhanced efficiency, lowering IES compared to happy (β = -0.091, CI_{95} = [-0.146, -0.036], p = 0.0032) and neutral expressions (β = -0.205, CI_{95} = [-0.260, -0.150], $p < 0.001$). Additionally, happy expressions significantly improved efficiency over neutral (β = -0.115, CI_{95} = [-0.170, -0.060], p = 0.001), highlighting an amplified emotional impact under stress.

Overall, anxiety consistently impaired efficiency. Disgusted expressions enhanced task performance across all groups, while happy and neutral expressions were less optimal, particularly under stress.

Discussion & Conclusion

Our study investigated the impact of acute stress on WM updating for emotional content, with a particular focus on individuals with social anxiety. Our results show a success-

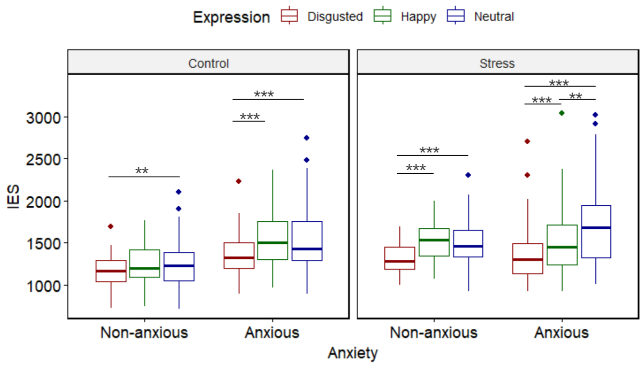

Figure 4: Distribution of Inverse Efficiency Score (IES) in ms for non-match trials across participant groups. Group-level differences across the three emotional categories is visualized. Significant differences are marked with $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

ful manipulation to induce stress in both SA-stressed and NSA-stressed groups. Going forward, they indicate that social anxiety and acute stress independently impair WM updating, with significant reductions in hit rate, increased false alarm rate, diminished discriminability (d-prime), and increased IES, particularly for non match trials. Our primary hypothesis was that acute stress would exacerbate WM updating deficits in individuals with social anxiety. While we observed that both anxiety and stress negatively affected performance, the absence of a significant interaction effect suggests that their contributions to WM impairments are largely additive rather than synergistic. This aligns with prior research indicating that stress and anxiety independently impair executive functions (Spalding et al., 2021). Previous findings showed that stress reduces working memory performance but does not necessarily interact with trait anxiety. Our findings also reflect this pattern for emotional content. The deficit in performance seen in SA-control implies that anxious individuals are already operating at a cognitive disadvantage, and stress further impairs performance.

We found a differential impact of emotional expressions on WM updating. Interestingly, the effect of emotions, especially, disgusted faces on task performance varied between match and non match trials. The dual competition model (Pessoa, 2009) explains the observed difference as a competition between emotional and cognitive processes. In match trials, which rely on recognition and have lower cognitive demand, emotional stimuli capture attention and interfere with performance (Van Dillen, Heslenfeld, & Koole, 2009). In contrast, non-match trials require recall and impose higher cognitive demands, leading to greater resource allocation for task performance, reducing emotional interference, and even enhancing performance through arousal-driven attention (Gray, Braver, & Raichle, 2002; Lindström & Bohlin, 2011; Luo et al., 2014).

Notably, a significant three-way interaction emerged only for Non-Match IES, where SA-stressed individuals exhibited greater impairment specifically for neutral expressions. This increased IES for neutral expressions may indicate diverting too much neural resources for emotionally salient stimuli over neutral ones, a pattern consistent with attentional bias theories in anxiety (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007). As a result, for SA-stressed impairment for neutral stimuli was accompanied by improve task efficiency for disgusted faces.

Such improvement may reflect adaptive responses that facilitate processing of socially salient stimuli under threat. Cultural context may also play a role as participants from collectivist cultures might be particularly sensitive to socially evaluative expressions such as disgust, potentially increasing task engagement. Conversely, happy expressions did not significantly improve performance, diverging from previous literature linking positive affect to improved performance (Yang, Yang, & Isen, 2013). A possible explanation is that under high cognitive load and stress, the arousing or attentional value of positive stimuli may be attenuated.

These findings have important implications for understanding cognitive deficits in social anxiety and the broader impact of stress on executive function. The increase in perceived stress level after the task in the SA-control group suggests that performance impairment is due to sheer stress from the task. Future research should investigate whether WM impairments in social anxiety can be mitigated through cognitive training or stress regulation interventions. Moreover, including a non-emotional version of the task could clarify whether the observed impairments are specific to emotional processing or reflect broader WM deficits.

This study primarily relies on self-reported measures, which may introduce bias in assessing social anxiety and stress. The sample comprises university students from a specific cultural background, limiting generalizability to broader populations. While the study establishes correlations, causal relationships between social anxiety, stress, and working memory deficits remain unclear. Additionally, neuroimaging studies could elucidate the neural mechanisms underlying these effects, particularly the role of the prefrontal cortex in compensatory control under stress.

Our study provides compelling evidence that both social anxiety and acute stress impair WM updating, with no significant interaction. These findings contribute to the growing body of literature on anxiety-related cognitive deficits and stress-induced impairments in executive function, while also highlighting the unique role of emotional stimuli in modulating performance. Understanding these mechanisms can inform interventions aimed at improving cognitive flexibility and emotional regulation in socially anxious individuals.

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