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Authors

Sharma, Saurabh
Majumdar, Debabrata
Guha, Rajlakshmi

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When Executive Function Meets High Cognitive Demand: Psychophysiological Signatures Modulated by Anxiety

Saurabh Sharma (sharmasaurabh220223@kgpian.iitkgp.ac.in)[1],
Debabrata Majumdar (mdebabrata@gmail.com)[2] & Dr. Rajlakshmi Guha (rajg@cet.iitkgp.ac.in)[1]
[1]Rekhi Centre of Excellence for the Science of Happiness, Indian Institute of Technology Kharagpur, West Bengal, India
[2]BC Roy Hospital, Indian Institute of Technology Kharagpur

Abstract

Executive functioning relies on the coordinated interaction of attention, working memory (WM) and cognitive control and is particularly vulnerable to anxiety-related disruption. Despite extensive research, few studies have simultaneously examined behavioral performance, visual attention, and physiological arousal across systematically varying cognitive demands and anxiety severity. Using a multimodal approach, we assessed WM performance, eye-movement indices, and electrodermal activity (EDA) in 83 participants, including healthy individuals with low or high trait anxiety and individuals with clinically diagnosed generalized anxiety disorder (GAD). Participants completed a dual n-back task, a baseline visual task, and executive tasks with graded complexity. The results indicated that the GAD participants showed reduced WM performance, delayed attentional engagement, altered oculomotor dynamics, and elevated autonomic arousal during continuous WM update. Anxiety severity interacted with task complexity for performance time and EDA amplitude, whereas eye-movement measures were less sensitive to increasing executive load. Together, these findings support Attentional Control Theory and Processing Efficiency Theory, highlighting anxiety-related inefficiencies under executive demand and identifying performance timing and autonomic arousal as sensitive markers of executive dysfunction in anxiety, with implications for cognitive assessment and intervention design.

Keywords: Executive Function; cognitive demand; anxiety; eye tracking; electrodermal activity

Introduction

Executive functioning enables goal-directed behavior through working memory (WM), attentional control, and inhibition—processes that are increasingly constrained as cognitive demands rise (Vytal et al., 2013). Among the factors that modulate executive efficiency under high load, anxiety plays a central role. Conceptualized along a continuum from trait vulnerability to clinically diagnosed disorders (Böttger et al., 2023; Cuthbert & Insel, 2013), anxiety is a multidimensional construct involving affective, cognitive, and physiological components. Substantial evidence indicates that anxiety compromises executive control by disrupting attentional regulation and increasing cognitive effort and autonomic arousal, effects that are minimal under low demand but intensify with task complexity (Eysenck & Calvo, 1992; Eysenck et al., 2007; Myles et al., 2020).

Processing Efficiency Theory (PET) and Attentional Control Theory (ACT) account for these effects by proposing that anxiety biases attention toward stimulus-driven processing, reducing efficiency rather than performance accuracy (Eysenck & Calvo, 1992; Eysenck et al., 2007, 2023). As executive demands increase, anxious individuals are expected to recruit compensatory control mechanisms, particularly during high-load WM updating and inhibitory control (LeDuke et al., 2023; Minnick et al., 2020). However, research typically examines behavioral, oculomotor, or autonomic indices in isolation, limiting insight into how these systems jointly support executive control under increasing mental load (Majeed et al., 2023). In addition, trait and clinical anxiety are rarely compared within the same framework, despite evidence for qualitative differences in executive functioning.

One promising approach to addressing these gaps is eye-tracking, which provides a sensitive index of the attentional dynamics underlying executive functioning. Measures such as fixation stability, saccadic latency, and gaze allocation capture moment-to-moment fluctuations in attentional control during task performance. Under increased cognitive demand, anxious individuals exhibit altered oculomotor patterns, including rapid initial orienting and reduced attentional stability, reflecting biased competition between bottom-up salience and top-down executive control (Armstrong & Olatunji, 2012; Derakshan & Koster, 2010). These oculomotor signatures have direct implications for WM maintenance, updating, and inhibitory control (Kadosh et al., 2024).

Executive engagement under increasing cognitive demand is accompanied by changes in autonomic arousal, commonly indexed by electrodermal activity (EDA). EDA reflects sympathetic activation associated with cognitive effort during task engagement (Naveteur et al., 2005). Anxiety is reliably linked to elevated autonomic reactivity, suggesting greater physiological costs of executive control under high demand. Multimodal studies integrating behavioral, oculomotor, and psychophysiological measures indicate that executive processing under increasing cognitive demand is supported by coordinated attentional and autonomic responses. While some eye-movement indices remain relatively stable across task demands, behavioral performance and EDA show robust load-dependent modulation, particularly in anxious populations (Allsop & Gray, 2014; Coelli et al., 2025; Yin et al., 2025).

Despite extensive research on anxiety and cognition, few studies have jointly examined visual attention, executive performance, and physiological arousal across systematically increasing cognitive demands. Moreover, direct comparisons across the progression from low trait anxiety to clinically diag-

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nosed anxiety disorders remain scarce, leaving open whether attentional, executive, and autonomic markers change systematically with anxiety level under increasing mental demand. To address these gaps, the present study adopts a multimodal approach combining eye-tracking measures of visual attention, EDA as an index of sympathetic arousal, and behavioral performance during WM and executive tasks with graded complexity. By comparing individuals with low trait anxiety (LTA), high trait anxiety (HTA), and generalized anxiety disorder (GAD), the study examines whether anxiety-related differences in attention, arousal, and performance reflect stable trait characteristics or dynamic modulation in response to rising cognitive demand.

Specifically, the study addressed four questions: (i) whether visual attentional and oculomotor metrics differ across levels of anxiety severity, (ii) whether physiological arousal differs between anxiety groups during cognitive task performance, (iii) whether increasing task complexity leads to systematic changes in attentional, physiological, and performance measures, and (iv) whether the effects of task complexity on physiological arousal and performance differ as a function of anxiety severity.

Methodology

Participants

A total of 83 young adults participated in the study. The healthy sample consisted of 65 college students (42 males, 23 females) aged 21–30 years (M = 26.33, SD = 2.98), recruited from a university program. Participants were screened using predefined exclusion criteria, including visual impairments, neurological disorders, and substance use. Poor-quality eye-tracking data (calibration failure or <85% valid gaze samples) led to exclusion prior to analysis. Trait anxiety was assessed using the State–Trait Anxiety Inventory (STAI-Y2), and participants were categorized into low trait anxiety (LTA; n = 39) and high trait anxiety (HTA; n = 26) groups based on standardized scores.

The clinical sample included 18 participants with a diagnosis of generalized anxiety disorder (GAD), recruited through psychiatric referral from B. C. Roy Hospital, Indian Institute of Technology Kharagpur. The clinical group had a mean age of 25.11 years (SD = 2.54), and diagnoses were confirmed according to ICD-10 criteria (F41.1). All participants provided written informed consent, and the study was approved by the Institutional Ethics Committee of IIT Kharagpur (Approval No. IIT/SRIC/DEAN/2023).

Experimental Paradigm and Tasks

The present study employed three tasks to assess WM, attention, and executive control under varying cognitive demands: a dual n-back task, a Baseline Visual Task (BVT), and an Arithmetic Visual Task (AVT). Tasks were designed to systematically manipulate executive and WM demands while maintaining constant visual characteristics, thereby emphasizing top-down executive control and minimizing bottom-up perceptual variability.

Dual-Modal 1-Back Task (D1B) WM capacity was assessed using a dual-modal 1-back task (Lawlor-Savage & Goghari, 2016) involving simultaneous visual and auditory stimuli. Participants indicated whether each stimulus matched the preceding item in the same modality via keyboard responses. The task comprised two blocks of 21 trials, with performance calculated as an equally weighted composite accuracy score across visual and auditory conditions.

Baseline Visual Task (BVT) The BVT served as a low-demand reference condition. Each trial began with a fixation cross (“+”) followed by a seven-character arithmetic equation (three characters per side of a relational symbol “<” or “>”). Participants summed the digits on each side and judged whether the relational symbol correctly represented the comparison (right mouse click = True; left mouse click = False). The task included 12 randomized trials with constant visual features and minimal executive demands.

Arithmetic Visual Task (AVT) The AVT systematically increased cognitive demand across three difficulty levels while maintaining constant visual characteristics (eight-character equations with four characters on each side of the relational symbol). Each level consisted of six randomized trials: Level 1: Sum numerical digits and vowels (A, E, I, O, U; value = 1) while ignoring consonants, then evaluate the relational symbol. Level 2: Sum numerical digits and consonants (value = 2) while ignoring vowels. Response mapping was reversed (left = True; right = False) to increase rule-switching and inhibitory demands. Level 3: Sum odd numbers on the left and all numbers on the right, including vowels (value = 2) on both sides while ignoring other characters. An auditory distractor composed of mixed letters and numbers was presented concurrently. This level required integration of multiple rules, suppression of irrelevant input, and sustained top-down attention.

Experimental Design and Procedure

After providing written informed consent, healthy participants completed the STAI–Y2 to assess trait anxiety and were classified into LTA and HTA groups using standardized cutoffs (Spielberger, 1983), whereas GAD participants did not complete the STAI–Y2. Eye movements were recorded with a Tobii Pro X3–120 eye tracker (120 Hz; 1920 × 1080) at 60 cm following a five-point calibration, and EDA was recorded using a Shimmer GSR+ device on the index and middle fingers of the non-dominant hand. Data were synchronized in Tobii Pro Lab. Participants completed three tasks in a fixed order: D1B, BVT, and AVT. D1B measured WM under controlled conditions, BVT served as a low-demand reference, and AVT imposed increasing executive and attentional demands. BVT and AVT were self-paced, with performance indexed by total completion time (TCT). Eye-tracking, EDA, and behavioral data were recorded continuously, and the fixed order minimized carryover effects while enabling assessment of anxiety-related differences across task demands.

Physiological Recordings & Data Preprocessing

Raw eye movement and EDA signals were preprocessed independently prior to feature extraction. Eye-movement preprocessing followed established procedures (Kiefer et al., 2017), including removal of missing samples, computation of gaze displacement, estimation of temporal intervals, and derivation of gaze velocity profiles. EDA data were trimmed to remove extreme values, corrected for movement artifacts, smoothed using a moving-window filter, and temporally aligned with the eye-tracking data stream. All pre-processing steps were implemented using custom Python scripts.

Feature Extraction

From the cleaned multimodal signals, the extracted eye-tracking and EDA features are listed below.

- **Time to First Fixation (TTFF, ms):** latency from stimulus onset to the first fixation, indexing initial attentional orienting.
- **Number of Fixations (NOF):** indexing visual search efficiency.
- **Average Fixation Duration (AFD, ms):** reflecting sustained attentional processing.
- **Mean Saccadic Duration (MSD, ms):** reflecting oculomotor control.
- **Mean Saccadic Amplitude (MSA, deg):** angular distance of saccades.
- **Mean Saccadic Velocity (MSV, deg/s):** reflecting efficiency of eye-movement execution.
- **EDA Responses (Count):** indexing total arousal responses during task.
- **Mean EDA Response Amplitude (μS):** indexing task-related autonomic activation.

Statistical Analyses Methods

All statistical analyses were conducted using IBM SPSS Statistics (Version 29) and proceeded in two phases. Phase 1 examined anxiety-related differences in WM task performance, eye-tracking indices, and physiological measures using one-way analyses of variance (ANOVAs). Phase 2 investigated task-related effects by first assessing group differences during the BVT, followed by two-way repeated-measures ANOVAs to evaluate within-subject effects of task complexity, between-subject effects of anxiety group, and their interaction across higher-demand visual–cognitive tasks. Prior to inferential analyses, all variables were screened for statistical assumptions. Normality was assessed using the Shapiro–Wilk test and was considered acceptable across groups, with minor deviations tolerated given the sample sizes (minimum $n = 18$ per group). Homogeneity of variance was evaluated using Levene's test; when violated, Welch's correction was applied. Effect sizes were reported using η^2. For repeated-measures analyses, sphericity was tested using Mauchly's test, and Greenhouse–Geisser corrections were applied when necessary. Outliers were identified via standardized residuals and winsorized to limit undue influence. To control for Type I error, Bonferroni-adjusted post hoc comparisons were applied. Results indicated monotonic increases in performance measures, eye-movement indices, and EDA metrics across AVT complexity levels, with all pairwise contrasts achieving statistical significance ($p < .001$).

Results and Discussion

This section comprises two phases. Phase I assesses group differences in anxiety, WM performance, and related oculometric and arousal markers during the D1B task. Phase II examines these measures within the same anxiety groups, from a BVT to progressively more complex AVT.

Phase I – Continuous Working Memory Task

The primary aim of this study was to determine whether anxiety-related variation in psychophysiological responses during WM engagement reflects differences in WM capacity, and whether oculometric and autonomic indices discriminate anxiety groups under executive load. Group differences in WM performance, eye-movement behavior, and autonomic arousal during the D1B are summarized in Tables 1.

WM performance differed significantly across anxiety groups. Participants with LTA and HTA showed comparable performance, whereas participants with GAD exhibited markedly reduced WM scores. Consistent group differences were also observed in oculometric and autonomic measures. Relative to both LTA and HTA groups, participants with GAD exhibited prolonged TTFF, fewer and shorter fixations, longer saccade durations, larger saccade amplitudes, and elevated saccade velocities, indicating altered oculomotor dynamics under executive load. In contrast, LTA and HTA participants did not differ reliably across eye-movement measures. Autonomic responses mirrored these attentional differences, with GAD participants showing elevated EDA, indexed by increased response frequency and amplitude, relative to both LTA and HTA groups, which again exhibited largely overlapping physiological profiles.

These results are consistent with ACT (Eysenck et al., 2007)), which posits that anxiety primarily disrupts processing efficiency under high WM demand. Prolonged TTFF, reduced fixation density, and shorter fixation durations in GAD participants indicate delayed engagement and diminished fine-grained visual sampling (Coombes et al., 2009). Concurrently, longer-duration, larger-amplitude, and higher-velocity saccades suggest reduced top-down regulation of eye movements (Bittencourt et al., 2013), consistent with impaired prefrontal–oculomotor coordination during sustained executive updating (Caldani et al., 2019). Extending prior work, these oculomotor alterations were evident during continuous WM updating rather than being restricted to classical

Table 1: One-way ANOVA was conducted to examine differences across anxiety groups in WM performance, eye-movement metrics, and EDA during the D1B task. Values are reported as mean (SE).

Measure	**LTA (SE)**	**HTA (SE)**	**GAD (SE)**	$F(2,80)$	p	η^2	**Pairwise comparisons**
WM Performance	75.64 (2.06)	75.96 (2.10)	54.72 (2.67)	7.63	$< .001$	.160	LTA, HTA > GAD
TTFF	176.37 (14.34)	177.41 (20.54)	358.38 (43.55)	16.04	$< .001$	.286	GAD > LTA, HTA
NOF	16098.26 (751.26)	14495.33 (1291.92)	5406.03 (823.95)	27.51	$< .001$	.407	LTA, HTA > GAD
AFD	662.45 (59.92)	668.28 (54.42)	306.88 (30.91)	9.58	$< .001$	.193	LTA, HTA > GAD
MSD	31.57 (0.40)	31.38 (0.41)	28.52 (1.42)	5.22	.007	.115	LTA, HTA > GAD
MSA	165.86 (5.75)	176.20 (6.89)	225.68 (10.15)	16.31	$< .001$	.290	GAD > LTA, HTA
MSV	4.96 (0.13)	4.94 (0.18)	5.58 (0.23)	3.57	.033	.082	GAD > LTA
EDA Responses	2000.15 (151.49)	1993.92 (167.96)	3337.28 (333.87)	11.70	$< .001$	.226	GAD > LTA, HTA
Mean EDA Amplitude	1.42 (0.20)	1.46 (0.31)	2.72 (0.54)	4.30	.017	.097	GAD > LTA, HTA

inhibitory control paradigms (Basanovic et al., 2023). The absence of reliable oculometric differences between LTA and HTA participants suggests that subclinical anxiety does not induce qualitative changes in gaze organization during emotionally neutral executive tasks. Although trait anxiety has been linked to subtle attentional inefficiencies, such effects appear context-dependent and may not manifest under sustained cognitive demand (Crawford et al., 2017; Shah et al., 2025). Finally, elevated EDA in GAD participants indicates heightened autonomic arousal during WM updating, suggesting that while oculomotor alterations may reflect stable task-engagement characteristics, autonomic and behavioral measures more directly index anxiety-related increases in arousal (Ahmadi et al., 2024).

Phase II – Effects of Task Complexity

In this phase, we first report group differences in BVT, followed by AVT results across increasing cognitive complexity, and then integrate findings from both tasks to address the study's research questions.

Baseline Visual Task (BVT) Group differences in behavioral, oculomotor, and autonomic measures during the BVT are summarized in Table 2. Under conditions of minimal cognitive demand, no significant group differences were observed in TCT, indicating preserved overt behavioral efficiency across LTA, HTA, and GAD groups.

Despite comparable behavioral performance, significant group differences emerged in early attentional orienting. TTFF was longer in the GAD group relative to LTA, indicating slower allocation of visual attention to task-relevant stimuli. Additional oculomotor differences were observed, with the GAD group showing fewer fixations, shorter fixation and saccade durations, and increased saccade amplitude and peak velocity, reflecting reduced attentional stability and heightened scanning.

Autonomic measures further differentiated the groups. EDA was elevated in the GAD group compared to LTA and HTA, indicating heightened sustained arousal, while no group differences were observed in EDA amplitude.

Overall, the BVT results indicate that clinical anxiety is associated with altered attentional allocation, oculomotor control, and autonomic arousal even under minimal task demands, despite intact behavioral performance.

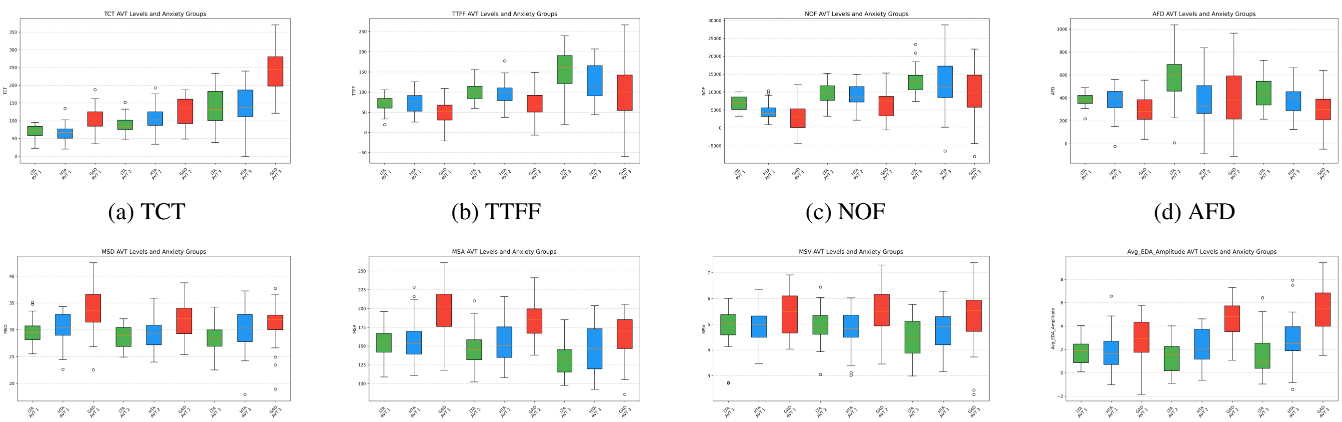
Arithmetic Visual Task (AVT) Results of the two-way repeated-measures ANOVA are presented in Table 3. The mean differences for all performance, oculomotor, and arousal metrics are illustrated in Figure 1. TCT increased monotonically with task complexity, confirming the effectiveness of the cognitive demand manipulation. A main effect of group indicated that the GAD group exhibited slower overall performance compared to both LTA and HTA participants, who did not differ from each other. Additionally, a significant Task Complexity × Group interaction revealed that performance costs increased disproportionately with task difficulty in the GAD group.

TTFF increased with task complexity, reflecting delayed attentional orienting under higher load. A main effect of group showed shorter TTFF in the GAD group compared with non-clinical participants, but the absence of an interaction indicates similar load-related modulation across anxiety levels. Fixation metrics also varied with task complexity. AFD increased with demand, reflecting greater attentional engagement, but fixation durations were consistently shorter in the GAD group than in LTA and HTA. NOF similarly increased with complexity, with fewer fixations in GAD, highest in LTA, and intermediate in HTA. The absence of interactions suggests parallel scaling of fixation behavior across groups from different baselines. Saccadic parameters were systematically influenced by task complexity. MSD and MSA increased with demand, while peak saccadic velocity decreased, consistent with reduced oculomotor efficiency under load. Across all levels, GAD participants exhibited longer saccades, larger amplitudes, and higher peak velocities than non-clinical groups. The absence of interaction effects suggests preserved load-dependent modulation across anxiety levels.

EDA showed dissociable effects across indices. EDA responses exhibited main effects of task complexity and group, reflecting increased autonomic activation with demand and

Table 2: One-way ANOVA was conducted to examine differences among anxiety groups in BVT performance, eye-tracking measures, and EDA. Values are reported as mean (SE).

Measure	**LTA (SE)**	**HTA (SE)**	**GAD (SE)**	$F(2, 80)$	p	η^2	**Pairwise comparisons**
TCT	49.45 (2.10)	49.71 (2.77)	48.41 (3.16)	0.05	.948	< .01	–
TTFF	46.06 (2.13)	40.25 (2.52)	35.66 (3.51)	3.96	.023	.09	GAD < LTA
NOF	3342.76 (206.82)	3176.92 (345.15)	2289.53 (222.09)	3.63	.031	.08	GAD < LTA
AFD	345.12 (13.20)	374.50 (23.42)	257.88 (19.24)	8.33	< .001	.17	GAD < LTA, HTA
MSD	31.14 (0.59)	30.86 (0.51)	28.50 (0.80)	4.13	.020	.09	GAD < LTA
MSA	170.91 (5.81)	172.20 (6.50)	217.83 (17.10)	7.28	.001	.15	GAD > LTA, HTA
MSV	5.15 (0.14)	5.21 (0.18)	6.42 (0.40)	8.94	< .001	.18	GAD > LTA, HTA
EDA Responses	407.68 (20.83)	434.38 (33.88)	570.53 (52.84)	6.02	.004	.13	GAD > LTA, HTA
Mean EDA Amplitude	1.50 (0.20)	2.07 (0.42)	1.42 (0.41)	1.15	.323	.03	–



(a) TCT (b) TTFF (c) NOF (d) AFD

(e) MSD (f) MSA (g) MSV (h) Mean EDA Amplitude

Figure 1: Box plots of TCT, TTFF, NOF, AFD, MSD, MSA, MSV, and mean EDA amplitude metrics across AVT levels and anxiety groups. Group means are indicated.

elevated arousal in GAD. In contrast, EDA amplitude showed a significant Task Complexity × Group interaction, driven by increased phasic reactivity in GAD as task demands rose, while LTA and HTA remained relatively stable. Overall, attentional and oculomotor measures scaled similarly with increasing demand across groups, whereas behavioral efficiency and autonomic reactivity—particularly phasic EDA—showed heightened load sensitivity in clinical anxiety.

Discussion

The present study provides a multimodal assessment of how anxiety severity modulates visual attention, executive performance, and autonomic arousal under increasing cognitive demands. By integrating eye-tracking, EDA, and behavioral measures across LTA, HTA, and GAD groups, the findings support ACT and PET while extending their predictions to abstract, non-emotional executive tasks (Eysenck et al., 2007, 2023). The results suggest that clinical anxiety may exhibit qualitatively distinct patterns relative to subclinical trait anxiety.

Addressing the first two research questions, group differences in attentional and physiological markers emerged even under minimal demands in the BVT. Behavioral performance remained comparable across groups, consistent with prior work showing that low-demand tasks often fail to reveal anxiety-related impairments (Basten et al., 2012; Sari et al., 2016). In contrast, oculomotor and autonomic differences were evident. Individuals with GAD showed delayed time to first fixation and less stable gaze behavior, indicating altered early attentional orienting and reduced efficiency of internally driven control under low salience (Derakshan & Koster, 2010; Fadardi et al., 2022). Elevated EDA further supports persistent sympathetic arousal in clinical anxiety (Sari et al., 2016), suggesting relatively stable attentional and autonomic alterations rather than transient state effects.

Consistent with the third research question, increasing task complexity in the AVT produced systematic effects across participants. Greater executive demand led to longer completion times, increased fixation frequency and duration, and slower, more spatially constrained saccades, replicating established mental load effects (Coombes et al., 2009; Ekin et al., 2025). While this confirms the effectiveness of the manipulation, the arithmetic nature of the task may introduce variability due to individual differences in numerical ability. However, the con-

Table 3: A two-way repeated-measures ANOVA was conducted to examine the effects of anxiety group and task complexity on performance, oculomotor, and EDA measures during the AVT task.

Measure	Task Complexity	Group	Interaction	Pairwise Comparisons
TCT	F = 115.19***, η^2 = .590	F = 24.84***, η^2 = .383	F = 4.99**, η^2 = .111	GAD > LTA, HTA
TTFF	F = 95.69***, η^2 = .545	F = 8.59***, η^2 = .177	ns	GAD < LTA, HTA
NOF	F = 75.52***, η^2 = .486	F = 6.60**, η^2 = .142	ns	GAD < LTA
AFD	F = 10.05***, η^2 = .112	F = 6.48**, η^2 = .139	ns	GAD < LTA
MSD	F = 5.46**, η^2 = .064	F = 8.58***, η^2 = .177	ns	GAD > LTA, HTA
MSA	F = 16.69***, η^2 = .173	F = 7.70***, η^2 = .161	ns	GAD > LTA, HTA
MSV	F = 3.81*, η^2 = .088	F = 7.49**, η^2 = .158	ns	GAD > LTA
EDA Responses	F = 80.40***, η^2 = .671	F = 8.82***, η^2 = .181	ns	GAD > LTA
Mean EDA Amplitude	F = 14.81***, η^2 = .156	F = 19.30***, η^2 = .325	F = 10.47***, η^2 = .207	GAD > LTA, HTA

Note. ns = Not Significant; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

vergence of behavioral, oculomotor, and autonomic findings suggests that the observed effects are not solely attributable to domain-specific skill differences.

Across complexity levels, individuals with GAD showed persistent oculomotor alterations, including reduced fixation durations and energetically costly saccades, reflecting reduced attentional efficiency (Ortiz-Peregrina et al., 2023). The absence of Group × Complexity interactions for fixation- and saccade-based measures suggests that these indices capture relatively stable attentional characteristics rather than scaling with executive load. This aligns with evidence linking trait anxiety to enduring attentional differences (Ursache & Raver, 2014; Wang et al., 2022; Zainal & Newman, 2022). In this context, TTFF may index early attentional vigilance that is heightened in anxiety even under low demand.

In contrast, behavioral timing and autonomic responses showed selective sensitivity to task demands. Individuals with GAD exhibited disproportionate slowing and increased EDA amplitude at higher complexity levels, consistent with ACT predictions that performance is maintained at the cost of increased effort and physiological strain (Eysenck et al., 2007, 2023; Zainal & Newman, 2018). Elevated EDA further indicates increased sympathetic cost rather than adaptive scaling (Coelli et al., 2025). These effects were not observed in HTA alone, suggesting qualitative differences between subclinical and clinical anxiety, although the lack of a shared continuous anxiety measure limits interpretation along a unified continuum (Liu et al., 2022). More broadly, these findings inform models of cognitive control under varying demands and highlight the value of integrating behavioral, physiological, and oculomotor measures.

Conclusion & Implications

This study examined anxiety-related differences in behavioral performance, oculomotor dynamics, and autonomic arousal in tasks that vary in cognitive complexity and executive control demands. Individuals with GAD showed reduced processing efficiency during continuous WM updating, reflected in prolonged temporal measures and increased EDA amplitude as task complexity increased, while low- and high-trait anxiety groups exhibited largely comparable profiles. The effects of interaction between the anxiety group and the complexity of the task were primarily observed in temporal performance and EDA. In contrast, fixation- and saccade-based oculomotor measures did not systematically vary with increasing executive load, suggesting that these indices may reflect relatively stable attentional characteristics. However, in low-complexity conditions, eye-movement and autonomic measures differentiated groups even in the absence of performance differences, highlighting their sensitivity to subtle attentional variations. Overall, the findings support the view that clinical anxiety is associated with disrupted attentional control under increasing executive demand, consistent with ACT and PET. More broadly, these results inform models of cognitive control by demonstrating how cognitive resources are allocated under varying task demands. Behavioral timing and autonomic amplitude emerged as sensitive indicators of processing inefficiency, whereas oculomotor measures indexed more stable attentional allocation patterns, underscoring the value of multimodal approaches. However, these group-based comparisons should be interpreted with caution due to the absence of a common continuous anxiety metric and the relatively small clinical (GAD) sample. Although tasks were administered in a fixed order, the selective nature of group × complexity interactions suggests that fatigue or practice effects are unlikely to fully account for the findings; nevertheless, future counterbalanced designs would strengthen causal interpretation.

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