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# Effects of Acute Stress and Single-Session Physiological Biofeedback on Attention Network Components in Healthy Young Women: A Within-Subject Experimental Study

Zahra Jeihounian[1], Reza Khosrowabadi *[2]

[1] *Institute for Cognitive and Brain Sciences, Shahid Beheshti University, Tehran, Iran*

[2] *Institute for Cognitive and Brain Sciences, Shahid Beheshti University, Tehran, Iran*

**Abstract**

**Objective:** Attentional control is a fundamental cognitive function, comprising alerting, orienting, and executive control networks as described by Posner's model. Acute stress induced by experimental paradigms, such as the Trier Social Stress Test (TSST), can affect attentional performance. Physiological biofeedback techniques, including respiratory and heart rate variability (HRV) training, have been proposed as interventions to alleviate stress-related cognitive impairments.

**Method**: This within-subject experimental study involved 25 healthy female volunteers screened for mental health using the General Health Questionnaire (GHQ) and the Depression, Anxiety, and Stress Scale (DASS). Participants completed the Attention Network Test (ANT) under three sequential conditions: baseline (no intervention), acute stress induction (TSST), and physiological biofeedback training. Cognitive performance across each attentional network was compared using repeated measures ANOVA, the Friedman test, and appropriate post-hoc analyses (Bonferroni, LSD, Wilcoxon).

**Results:** Significant differences were observed in several ANT network scores across conditions ($p < .05$). However, post-hoc analyses indicated that most improvements occurred only from baseline to subsequent phases, with no consistent enhancement following biofeedback compared to the stress condition.

**Discussions:** Acute stress induction produced limited and selective effects on attentional network performance. The short-term physiological biofeedback intervention did not yield substantial recovery. Overall, neither intervention resulted in consistent improvements

* Corresponding author

*Email addresses: r_khosroabadi@sbu.ac.ir*

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across all attentional indices, underscoring the need for extended intervention protocols and more diverse cognitive outcome measures in future research.

**Keywords*:*** Attention network test, acute stress, cognitive performance, physiological biofeedback, trier social stress test.

## 1. Introduction

Attention is a multifaceted cognitive process that enables individuals to process environmental information while selectively filtering out irrelevant stimuli (Posner & Petersen, 1990). According to Posner's attentional network model, attention comprises three semi-independent yet interacting subsystems: the alerting network, which supports sustained readiness to respond; the orienting network, which enables the selection of sensory information; and the executive control network, which resolves conflict among competing responses (Posner & Petersen, 1990; Petersen & Posner, 2012). These networks are commonly assessed using the Attention Network Test (ANT), a well-validated paradigm that provides behavioural indices of alerting, orienting, and executive control through specific reaction-time contrasts (Fan et al., 2002; Fan et al., 2005).

Acute stress is a potent modulator of attentional functioning and may either impair or facilitate performance, depending on contextual and individual factors, including stress intensity, timing, and task demands (Arnsten, 2009; Shields et al., 2017). Laboratory stress paradigms, such as the Trier Social Stress Test (TSST), reliably induce psychophysiological stress responses by activating both the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (Kirschbaum et al., 1993). At the neural level, acute stress triggers catecholaminergic and glucocorticoid effects that alter prefrontal-limbic interactions, thereby influencing attention and cognitive control processes (Hermans et al., 2014). Importantly, prior findings suggest that these effects are network-specific: while stress-related arousal has been shown to enhance alerting or vigilance, executive control often deteriorates. Several studies-particularly those conducted in short-term laboratory settings-have reported mixed or null effects on attentional performance (Cornelisse et al., 2011; Plessow et al., 2011; Qin et al., 2009; Schoofs et al., 2008).

Physiological biofeedback interventions, particularly combined respiratory and heart rate variability (HRV) biofeedback, have attracted growing attention for their capacity to modulate autonomic regulation and reduce stress-related cognitive disruptions (Lehrer & Gevirtz, 2014; Shaffer & Ginsberg, 2017). By training individuals to regulate breathing patterns and cardiac vagal activity-often at a resonance frequency near 0.1 Hz-HRV biofeedback aims to enhance parasympathetic function, strengthen top-down prefrontal control, and improve emotional and cognitive regulation under stress (Chen et al., 2023; Lehrer et al., 2020). Despite growing empirical support, findings on the cognitive benefits of biofeedback remain inconsistent, particularly in short-duration or experimental contexts, with studies reporting selective improvements in attentional components, impairments in executive control, or null effects on overall attentional performance (Plessow et al., 2011; Schoofs et al., 2008).

Notably, the interaction between acute stress and biofeedback in shaping the efficiency of specific attentional networks remains insufficiently understood. Most stress studies

employing the TSST have focused on endocrine or global cognitive outcomes, whereas biofeedback research has typically been conducted without experimentally induced stress (Agnihotri et al., 2025; Prinsloo et al., 2019). This methodological separation limits insight into whether respiratory and HRV biofeedback can serve as an immediate countermeasure against stress-related alterations in distinct attentional networks, as measured by the ANT.

Furthermore, relatively few studies have examined these mechanisms across all female samples. Sex-specific differences in stress responsivity, autonomic regulation, and prefrontal functioning-shaped by hormonal fluctuations and reproductive factors-may influence the impact of both stress and biofeedback on attention (Kogler et al., 2023; Lighthall et al., 2019). Addressing these gaps, the present study aimed to investigate the effects of acute stress induction and subsequent short-term physiological biofeedback intervention on the three attentional networks assessed by the ANT in healthy young women. Based on prior literature, we hypothesized that:

1. cute stress (via TSST) would selectively modulate attentional networks, potentially enhance alerting while impairing executive control.

2.The brief biofeedback intervention would facilitate partial recovery of attentional performance relative to the stress condition.

By integrating these conditions within a single experimental design and using a repeated-measures approach, our study sought to clarify both the independent and interactive effects of acute stress and biofeedback on attention. We further contribute to the literature by employing a homogeneous female sample and a standardized ANT protocol, potentially informing sex-specific cognitive performance optimization strategies in stressful environments.

## 2. Method

### Participants

Twenty-five healthy female volunteers (mean age = 22.20 years, SD = 2.06) participated in this study. Inclusion criteria were:

Absence of current psychiatric, neurological, or cardiovascular disorders, confirmed using the 28-Item General Health Questionnaire (GHQ-28; Goldberg & Hillier, 1979) and the Depression, Anxiety, and Stress Scales (DASS-21; Asghari et al., 2008; Lovibond & Lovibond, 1995).

No use of psychoactive medication, alcohol, nicotine, or caffeine for at least 48 hours before testing (to prevent interference with acute stress responses; Kogler et al., 2023).

Self-reported normal or corrected-to-normal vision.

Exclusion criteria included excessive fatigue or inability to maintain task focus, as well as voluntary withdrawal before protocol completion. Written informed consent was obtained from all participants. The study was approved by the Institutional Review Board of Shahid Beheshti University (Approval Code: [IR.SBU.REC.1404.023]) in accordance with the Declaration of Helsinki.

## Design

A within-subject, repeated-measures design was implemented with three sequential conditions:

1. Baseline-two consecutive ANT administrations separated by a no-intervention phase.
2. Acute stress induction-Trier Social Stress Test (TSST).
3. Physiological biofeedback-HRV-biofeedback.

The order was fixed to avoid bidirectional carryover effects (Prinsloo et al., 2019). Total session duration was approximately 140 minutes per participant.

## Measures

### A) Attentional Network Test (ANT)

The adult version of the ANT (Fan et al., 2002; Rohani et al., 2023), adapted to Persian, was used to assess alerting, orienting, and executive control.

### B) Trier Social Stress Test (TSST)

The TSST (Goodman et al., 2023; Kirschbaum et al., 1993) consisted of three 5-minute phases:

Preparation for a public speaking task

Delivering the speech to a neutral jury panel

Performing serial subtraction under evaluative observation

### C) Spielberger State Anxiety Inventory-Short Form (STAI-6)

The STAI-6 (Marteau & Bekker, 1992) was used immediately after the TSST to confirm elevated state anxiety before the next ANT session.

### D) HRV-Biofeedback

HRV biofeedback equipment (TAT Technology, Canada; distributed by Farmed Tajhiz, Tehran, Iran) was used. The system included a fingertip photoplethysmograph (HRV sensor) and a respiration belt sensor, integrated to provide real-time visual feedback on heart rate and breathing patterns. Participants performed paced breathing at 0.1 Hz (≈ six breaths per minute) to achieve high HRV coherence (Agnihotri et al., 2025; Chen et al., 2023; Lehrer et al., 2023).

### E) Psychometric Questionnaires

GHQ-28 (Goldberg & Hillier, 1979), Persian validation by Montazeri et al. (2003)

DASS-21 (Lovibond & Lovibond, 1995), Persian validation by Asghari et al. (2008)

Note. Scores below the established clinical cutoff points on both the GHQ-28 (< 23) and the DASS-21 (all subscales < 10) were required for inclusion in the study; participants exceeding these cutoffs were excluded during screening.

**Procedure**

A) Phase 1-Baseline

ANT session 1 (T1)-20 min

No-intervention phase-20 min (participants remained seated without cognitive or physiological intervention)

ANT session 2 (T2)-20 min

B) Phase 2-Acute Stress

TSST-approximately 15 min (three 5 min stages)

STAI-6-5 min, immediately after TSST

ANT session 3 (T3)-20 min immediately after STAI-6 completion

C) Phase 3-Biofeedback

HRV-biofeedback session-20 min

ANT session 4 (T4)-20 min immediately after biofeedback

All sessions were conducted in a controlled laboratory environment with identical hardware/software configurations. The same experimenter administered all interventions to minimize procedural variability.

**Statistical Analysis**

Reaction times below 200 ms or above 1500 ms were excluded (Nomura et al., 2024). Shapiro-Wilk tests were used to assess the normality of the distribution.

Normally distributed data: Repeated Measures ANOVA with Bonferroni-adjusted post hoc comparisons ($\eta^2p$ as effect size)

Non-normal data: Friedman test with Wilcoxon signed-rank tests (Bonferroni-adjusted; Kendall's Was effect size)

Analyses were run in SPSS 27 with $\alpha$ set at 0.05.

## 3. Results

**Descriptive Statistics**

Table 1 presents the means and standard deviations for the attentional network effects (Alerting, Orienting, and Executive Control) across the four stages: Baseline (T1), No-Intervention (T2), Post-Stress (T3), and Post-Biofeedback (T4).

***Table 1****. Means and Standard Deviations (ms) of Attentional Network Effects Across the Four Stages*

| Effect | Baseline M (SD) | No-Intervention M (SD) | Post-Stress M (SD) | Post-Biofeedback M (SD) |
|---|---|---|---|---|
| Alerting | 41.36 (42.372) | 48.52 (34.616) | 53.32 (40.118) | 52.8 (30.741) |

| | | | | |
|---|---|---|---|---|
| Orienting | 37.32 (19.424) | 33.52(25.538) | 30.08 (25.093) | 33.36 (17.11) |
| Executive Control | 120.04 (37.464) | 109.52 (31.157) | 122 (44.678) | 117.6 (36.035) |

*Note: M = mean; SD = standard deviation. Values indicate reaction time differences between cue and target types in milliseconds.*

**Testing for Normality**

The Shapiro-Wilk test showed that Orienting scores met the normality assumption at all stages ($p > .05$). Executive Control deviated from normality only at T4 ($p = .022$), which was considered acceptable, while Alerting violated the assumption at three stages ($p < .05$). Consequently, Orienting and Executive Control were analyzed using repeated-measures ANOVA, whereas Alerting was examined with Friedman test.

**Inferential Statistics**

A) Alerting

Friedman's test indicated no significant differences across stages, $\chi^2(3) = 4.7$, $p = .195$, Kendall's W = 0.06 (small effect).

B) Orienting

The repeated-measures ANOVA revealed no significant effect of stages, $F(3) = 0.466$, $p = .707$, partial $\eta^2 = .019$ (small effect).

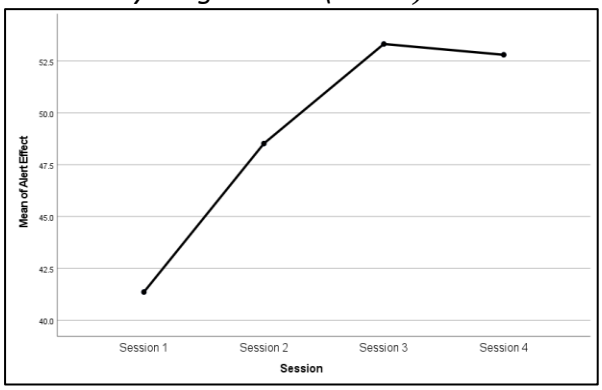
C) Executive Control

The repeated-measures ANOVA revealed no significant effect of stages, $F(3) = 1.526$, $p = .215$, partial $\eta^2 = .06$ (small effect).

**Summary of Findings**

Across all attentional network components, the experimental interventions (acute stress induction and physiological biofeedback) did not yield statistically significant effects. Although the sample size (n = 25) limits statistical power, the consistently small effect sizes indicate that the interventions produced minimal changes in attentional performance. Observed improvements from Session 1 to later sessions appear to be driven primarily by practice effects, as repeated exposure to the Attention Network Test is known to enhance performance independently of experimental manipulation.

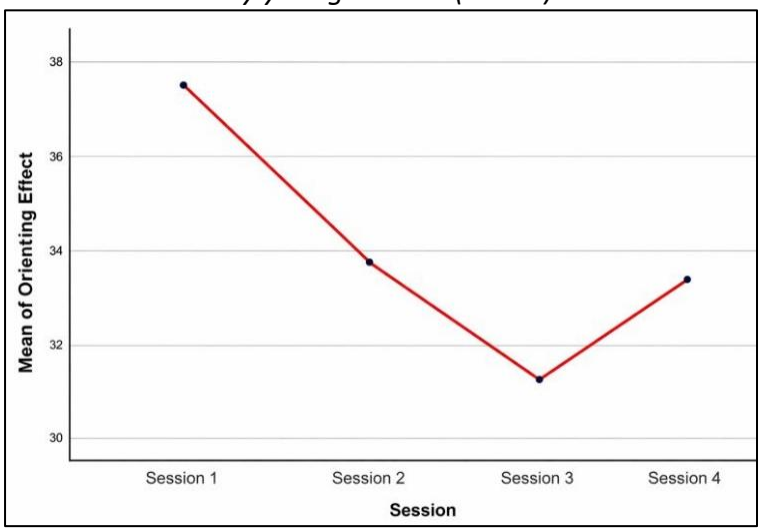
**Figure 1**. *Changes in the alerting network effect across experimental conditions in healthy young women (n = 25).*




Note: Mean values of the alerting network effect across four sequential sessions of the Attention Network Test (ANT) in healthy young women (n = 25). Session 1 = Baseline;

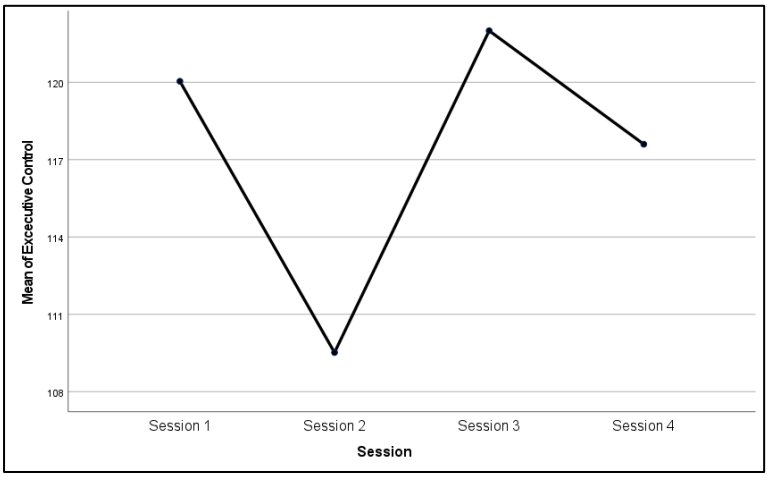
Session 2 = No-intervention phase; Session 3 = Post-Trier Social Stress Test (TSST); Session 4 = Post-physiological biofeedback. The alerting effect increased steadily from Session 1 to Session 3, then decreased slightly after the biofeedback intervention. ANT = Attention Network Test; TSST = Trier Social Stress Test.

**Figure 2**. *Changes in the orienting network effect across experimental conditions in healthy young women (n = 25).*




Note: Mean values of the orienting network effect across four sequential sessions of the Attention Network Test (ANT) in healthy young women (n = 25). Session 1 = Baseline; Session 2 = No-intervention phase; Session 3 = Post-Trier Social Stress Test (TSST); Session 4 = Post-physiological biofeedback. The orienting effect declined progressively from Session 1 to Session 3, reaching its lowest value after the stress intervention, followed by a partial recovery in Session 4. ANT = Attention Network Test; TSST = Trier Social Stress Test.

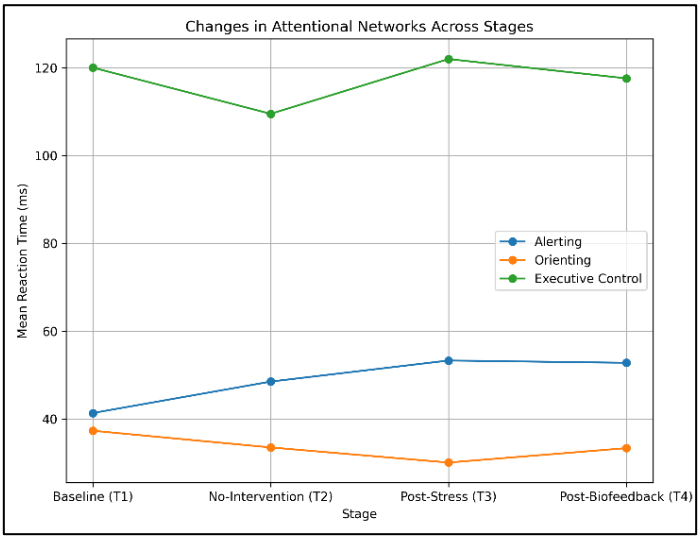
**Figure 3.** *Changes in the executive control network effect across experimental conditions in healthy young women (n = 25).*




Note: Mean values of the executive control network effect across four sequential sessions of the Attention Network Test (ANT) in healthy young women (n = 25). Session 1 = Baseline; Session 2 = No-intervention phase; Session 3 = Post-Trier Social Stress Test (TSST); Session 4 = Post-physiological biofeedback. The executive control effect decreased from Session 1 to Session 2, increased markedly after the stress intervention in Session 3, and then

declined moderately following the biofeedback phase. ANT = Attention Network Test; TSST = Trier Social Stress Test.

**Figure 4.** *Mean reaction times (ms) for the alerting, orienting, and executive control networks across experimental conditions in healthy young women (n = 25).*




Note: Mean reaction times (ms) for the Alerting, Orienting, and Executive Control networks across the four sequential sessions of the Attention Network Test (ANT) in healthy young women (n = 25). Session 1 = Baseline; Session 2 = No Intervention phase; Session 3 = Post-Trier Social Stress Test (TSST); Session 4 = Post-Physiological Biofeedback. The alerting effect increased from Session 1 to Session 3, with minimal change thereafter; the orienting effect showed a progressive decline, peaking at Session 3, followed by partial recovery; the executive control effect decreased initially, increased markedly after stress induction, and declined moderately following biofeedback. ANT = Attention Network Test; TSST = Trier Social Stress Test.

## 4. Discussion

The present study investigated the effects of acute stress induction and a single session of physiological biofeedback on the three attentional networks-alerting, orienting, and executive control-in healthy young women. Contrary to the study hypotheses, no significant condition-related differences were observed across attentional outcomes. Instead, performance changes appeared to be mainly attributable to repeated task exposure and increased familiarity with the Attention Network Test (ANT), a finding consistent with prior evidence of practice-related improvements in attentional performance independent of experimental manipulation (Fan et al., 2002; MacLeod et al., 2010).

A central consideration in interpreting these findings is the influence of hormonal fluctuations during the menstrual cycle on cognitive performance and stress responsivity. Substantial evidence indicates that variations in estrogen and progesterone levels across the menstrual cycle modulate hypothalamic-pituitary-adrenal (HPA) axis activity and cognitive processes underlying attentional and executive control (Andreano et al., 2008; Lighthall et al., 2019). These hormones interact with neural systems critical for stress regulation, particularly within prefrontal cortical circuits, thereby shaping individual differences in cognitive responses to acute stressors (Shansky & Woolley, 2016).

At the neurocognitive level, both stress exposure and hormonal states influence prefrontal cortex functioning and associated top-down control mechanisms. Acute stress has been shown to disrupt prefrontal-dependent executive processes through catecholaminergic and glucocorticoid effects, resulting in diminished top-down regulation and a shift toward more stimulus-driven or habitual responding (Arnsten, 2009; Pessoa, 2009). Such stress-related alterations in cognitive control are further moderated by estrogen and progesterone, which can either buffer or exacerbate stress-induced impairments depending on menstrual cycle phase (Shansky & Woolley, 2016; Lighthall et al., 2019). Consequently, unmeasured hormonal variability in the present sample may have contributed to heterogeneous cognitive responses, thereby reducing sensitivity to experimentally induced stress effects at the group level.

Consistent with this interpretation, prior studies have reported phase-dependent and sex-specific differences in stress-related modulation of executive control and attentional performance (Lighthall et al., 2019; Kogler et al., 2023). In contrast to studies demonstrating pronounced stress effects under hormonally vulnerable conditions, the present findings suggest relative stability of attentional network efficiency when participants are tested within their natural menstrual cycles without phase-specific stratification. Such stability may partially account for the absence of condition-specific differences in attentional outcomes observed here.

Beyond hormonal influences, several methodological factors likely contributed to the observed null results. Repeated administration of attentional tasks is known to produce learning and practice effects that can obscure subtle experimental manipulations, particularly in within-subject designs (Fan et al., 2002; Kelly et al., 2015). Importantly, in the present study, the first two assessments-both serving as baseline measurements-were conducted consecutively on the same day. This sequencing may have amplified short-term learning effects or performance stabilization, thereby reducing variability and limiting the detection of subsequent stress- or biofeedback-related changes in attentional performance.

In addition, the timing of multiple assessments within a single day may have interacted with circadian rhythms, fatigue, or attentional adaptation processes. Prior research indicates that both cognitive performance and cortisol secretion exhibit diurnal variation, which can modulate responses to stress and mental demands (Dickerson & Kemeny, 2004; Schmidt et al., 2012). The accumulation of testing-related fatigue or attentional habituation across same-day sessions may therefore have further attenuated observable experimental effects.

Individual differences in stress reactivity represent another plausible explanation for the absence of significant group-level effects. Laboratory stress paradigms do not elicit uniform physiological or subjective stress responses across individuals, and variability in autonomic, endocrine, or affective reactivity can substantially moderate cognitive outcomes (Dickerson & Kemeny, 2004; Shields et al., 2017). In relatively healthy, low-stress samples-such as the present cohort-such heterogeneity may obscure subtle effects of acute stress or short-term biofeedback on attentional functioning.

Finally, the limited duration of the biofeedback intervention should be considered when interpreting the null findings. Evidence suggests that meaningful changes in autonomic regulation, cognitive control, and stress resilience typically emerge following repeated or extended biofeedback training rather than from a single brief session (Goessl et al., 2017; Lehrer & Gevirtz, 2014). Thus, the absence of significant biofeedback-related effects in this

study may reflect insufficient intervention dosage rather than the inefficacy of biofeedback per se.

Taken together, the present findings underscore the complex interplay among hormonal context, stress physiology, learning-related effects, and individual differences in shaping attentional performance in women. Future research would benefit from incorporating menstrual cycle phase-specific testing, direct hormonal assessments (e.g., salivary estradiol and progesterone), stricter control over testing schedules, and multi-session biofeedback protocols. Such methodological refinements may enhance sensitivity to stress- and biofeedback-related effects and clarify their impact on attentional networks in female populations (Lighthall et al., 2019; Shansky & Woolley, 2016).

## 5. Conclusion

In summary, acute stress and a single brief biofeedback session did not produce significant alterations in attentional network efficiency beyond practice-related improvements in healthy young women. These findings suggest that short, single-session interventions may be insufficient to elicit measurable cognitive changes, particularly when hormonal regulation, learning effects, and individual variability in stress responsivity shape attentional processes. Future research should adopt multi-session designs, carefully consider the timing of testing, control, or record menstrual cycle phases, and include hormonal markers to clarify how biological rhythms modulate responsiveness to cognitive and stress-regulation interventions.

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**References**

Agnihotri, R., Kumar, M., & Singh, R. (2025). “Acute effects of heart rate variability biofeedback on autonomic regulation and cognitive performance under stress.” *Applied Psychophysiology and Biofeedback.* Advance online publication.

Andreano, J. M., Arjomandi, H., & Cahill, L. (2008). “Menstrual cycle modulation of the relationship between cortisol and long-term memory.” *Psychoneuroendocrinology, 33(6), 874-882.* https://doi.org/10.1016/j.psyneuen.2008.03.009

Arnsten, A. F. T. (2009). “Stress signalling pathways that impair prefrontal cortex structure and function.” *Nature Reviews Neuroscience, 10(6), 410-422.* https://doi.org/10.1038/nrn2648

Asghari, A., Saed, F., & Dibajnia, P. (2008). "Psychometric properties of the Depression Anxiety Stress Scales-21 (DASS 21) in a non-clinical Iranian sample*." Iranian Journal of Psychiatry and Clinical Psychology, 14(3), 234-243*.

Chen, C. Y., Huang, C. J., & Chen, Y. C. (2023). "Effects of heart rate variability biofeedback on cognitive performance and stress regulation*: A systematic review." Psychophysiology, 60(8), e14257*. https://doi.org/10.1111/psyp.14257

Chen, X., Zhang, Y., Wang, Y., & Liu, C. (2023). "Effects of heart rate variability biofeedback on autonomic regulation and cognitive performance: *A systematic review."* Applied Psychophysiology and Biofeedback, 48*(2), 123-138*. https://doi.org/10.1007/s10484-023-09576-4

Cornelisse, S., Van Stegeren, A. H., & Joëls, M. (2011). "Implications of psychosocial stress on memory formation in a typical male versus female population." *Psychoneuroendocrinology, 36*(4), 569-578. https://doi.org/10.1016/j.psyneuen.2010.09.002

Dickerson, S. S., & Kemeny, M. E. (2004). "Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research." *Psychological Bulletin, 130*(3), 355-391. https://doi.org/10.1037/0033-2909.130.3.355

Fan, J., McCandliss, B. D., Sommer, T., Raz, A., & Posner, M. I. (2002). "Testing the efficiency and independence of attentional networks." *Journal of Cognitive Neuroscience, 14*(3), 340-347. https://doi.org/10.1162/089892902317361886

Fan, J., McCandliss, B. D., Fossella, J., Flombaum, J. I., & Posner, M. I. (2005). "*The activation of attentional networks."* NeuroImage, 26*(2), 471-479.* https://doi.org/10.1016/j.neuroimage.2005.02.004

Goessl, V. C., Curtiss, J. E., & Hofmann, S. G. (2017). "The effect of heart rate variability biofeedback training on stress and anxiety: A meta-analysis." *Psychological Medicine, 47*(15), 2578-2586. https://doi.org/10.1017/S0033291717001003

Goldberg, D. P., & Hillier, V. F. (1979). *"A scaled version of the General Health Questionnaire."* Psychological Medicine, *9*(1), 139-145. https://doi.org/10.1017/S0033291700021644

Goodman, W. K., Janson, J., & Wolf, J. M. (2023). *"Meta-analytical assessment of the Trier Social Stress Test*." *Psychoneuroendocrinology, 145,* 105934. https://doi.org/10.1016/j.psyneuen.2022.105934

Hermans, E. J., Henckens, M. J. A. G., Joëls, M., & Fernández, G. (2014). "Dynamic adaptation of large-scale brain networks in response to acute stressors*."* Trends in Cognitive Sciences, 18*(6), 304-314*. https://doi.org/10.1016/j.tics.2014.03.006

Kelly, A. M. C., Uddin, L. Q., Biswal, B. B., Castellanos, F. X., & Milham, M. P. (2015). "Competition between functional brain networks mediates behavioral variability." *NeuroImage*, *39*(1), 527-537. https://doi.org/10.1016/j.neuroimage.2007.08.008

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). "The Trier Social Stress Test—A tool for investigating psychobiological stress responses in a laboratory setting." *Neuropsychobiology*, *28*(1-2), 76-81. https://doi.org/10.1159/000119004

Kogler, L., Müller, V. I., Chang, A., Eickhoff, S. B., Fox, P. T., Gur, R. C., & Derntl, B. (2023). "Sex differences in stress-related functional brain activation patterns." *Neuroscience & Biobehavioral Reviews, 144, 104955.* https://doi.org/10.1016/j.neubiorev.2022.104955

Lehrer, P. M., & Gevirtz, R. (2014). "Heart rate variability biofeedback: How and why does it work?" *Frontiers in Psychology, 5, 756*. https://doi.org/10.3389/fpsyg.2014.00756

Lehrer, P. M., Kaur, K., Sharma, A., Shah, K., Huseby, R., Bhavsar, J., & Zhang, Y. (2020). "Heart rate variability biofeedback improves emotional and physical health and performance: A systematic review and meta-analysis." *Applied Psychophysiology and Biofeedback, 45(3), 109-129*. https://doi.org/10.1007/s10484-020-09466-z

Lehrer, P. M., Vaschillo, B., & Vaschillo, E. (2023). "Resonance frequency biofeedback training to increase heart rate variability: Rationale and manual for training." *Applied Psychophysiology and Biofeedback, 48*(1), 1-14. https://doi.org/10.1007/s10484-022-09553-8

Lighthall, N. R., Salmon, D. P., & Gonzalez, R. (2019). "Neurocognitive responses to stress across the menstrual cycle." *Psychoneuroendocrinology, 103,* 23-34. https://doi.org/10.1016/j.psyneuen.2019.01.011

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales* (2nd ed.). Psychology Foundation.

MacLeod, C. M., Lawrence, M. A., McConnell, M. M., Eskes, G. A., Klein, R. M., & Shore, D. I. (2010). "Appraising the ANT: Psychometric and theoretical considerations." Journal of Experimental Psychology*: Human Perception and Performance, 36*(1), 99-111. https://doi.org/10.1037/a0017737

Marteau, T. M., & Bekker, H. (1992). "The development of a six-item short form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI)." *British Journal of Clinical Psychology, 31*(3), 301-306. https://doi.org/10.1111/j.2044-8260.1992.tb00997.x

Montazeri, A., Harirchi, A. M., Shariati, M., Ghanbari Motlagh, A., Ebrahimi, M., & Bagheri, N. (2003). "The 12-item General Health Questionnaire (GHQ-12): Translation and validation study of the Iranian version." *Health and Quality of Life Outcomes, 1,* 66. https://doi.org/10.1186/1477-7525-1-66

Nomura, T., Sugiura, N., & Watanabe, K. (2024). "Reaction time data trimming improves accuracy in attentional network analyses." *Journal of Cognitive Neuroscience.* Advance online publication.

Pessoa, L. (2009). "How do emotion and motivation direct executive control?" *Trends in Cognitive Sciences, 13*(4), 160-166. https://doi.org/10.1016/j.tics.2009.01.006

Petersen, S. E., & Posner, M. I. (2012). "The attention system of the human brain: 20 years after." Annual Review of Neuroscience, 35, *73-89*. https://doi.org/10.1146/annurev-neuro-062111-150525

Plessow, F., Kiesel, A., & Kirschbaum, C. (2011). "The stressed prefrontal cortex and goal-directed behaviour: Acute psychosocial stress impairs the flexible implementation of task goals." *Experimental Brain Research, 216*(3), 397-408. https://doi.org/10.1007/s00221-011-2943-1

Posner, M. I., & Petersen, S. E. (1990). "The attention system of the human brain." *Annual Review of Neuroscience, 13,* 25-42. https://doi.org/10.1146/annurev.ne.13.030190.000325

Prinsloo, G. E., Derman, W. E., Lambert, M. I., & Rauch, H. G. L. (2019). "The effect of short duration heart rate variability biofeedback on cognitive performance in healthy individuals." *Applied Psychophysiology and Biofeedback, 44*(1), 1-11. https://doi.org/10.1007/s10484-018-9421-9

Prinsloo, G. E., Rauch, H. G. L., & Derman, W. E. (2019). "A brief review and clinical application of heart rate variability biofeedback in sports, exercise, and rehabilitation medicine." *Physiology & Behavior, 197,* 198-203. https://doi.org/10.1016/j.physbeh.2018.10.031

Qin, S., Hermans, E. J., Van Marle, H. J. F., Luo, J., & Fernández, G. (2009). "Acute psychological stress reduces working memory-related activity in the dorsolateral prefrontal cortex." *Biological Psychiatry, 66*(1), 25-32. https://doi.org/10.1016/j.biopsych.2009.03.006

Rohani, M., Fathi-Ashtiani, A., & Fan, J. (2023). "Psychometric properties of the Persian version of the Attention Network Test." *Basic and Clinical Neuroscience, 14*(2), 215-228.

Schmidt, M., Collette, F., Cajochen, C., & Peigneux, P. (2012). "A time to think: Circadian rhythms in human cognition." *Cognitive Neuropsychology, 24*(7), 755-789. https://doi.org/10.1080/02643290701754158

Shaffer, F., & Ginsberg, J. P. (2017). "An overview of heart rate variability metrics and norms." *Frontiers in Public Health, 5,* 258. https://doi.org/10.3389/fpubh.2017.00258

Shansky, R. M., & Woolley, C. S. (2016). "Considering sex as a biological variable will be valuable for neuroscience research." *Journal of Neuroscience, 36*(47), 11817-11822. https://doi.org/10.1523/JNEUROSCI.1390-16.2016

Shields, G. S., Sazma, M. A., & Yonelinas, A. P. (2017). "The effects of acute stress on core executive functions: A meta-analysis and comparison with cortisol." *Neuroscience & Biobehavioral Reviews, 68,* 651-668. https://doi.org/10.1016/j.neubiorev.2016.06.038