

Metacognitive Monitoring Deficits in Adults with High Trait Anxiety: An Empirical Analysis of Error-Related Negativity and Post-Error Slowing During Dual-Task Inhibitory Control

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Abstract. Metacognitive monitoring accuracy and its electrophysiological correlates remain insufficiently characterized in populations exhibiting elevated trait anxiety. This study examined error-related negativity (ERN) amplitudes and post-error slowing (PES) as indices of performance monitoring in 84 adults stratified by Spielberger Trait Anxiety Inventory scores. Participants completed a modified Flanker–Stop–Signal dual task while 64-channel electroencephalography was continuously recorded. High-trait-anxiety participants demonstrated significantly attenuated ERN amplitudes ($p < .001$, Cohen's $d = 0.81$) alongside paradoxically reduced PES, suggesting a dissociation between affective error detection and adaptive behavioral adjustment. Mediation analyses indicated that interoceptive awareness partially mediated this dissociation. These findings refine current models of anxious hypervigilance by specifying the locus of metacognitive breakdown at the post-evaluative regulation stage rather than at initial error detection.

Keywords: metacognitive monitoring, error-related negativity, post-error slowing, trait anxiety, inhibitory control, dual-task paradigm, performance monitoring, interoceptive awareness, electroencephalography

Introduction

Anxiety-related impairments in executive functioning have attracted substantial empirical attention over the past two decades; however, the precise mechanism by which elevated trait anxiety disrupts metacognitive monitoring—as opposed to broader attentional or inhibitory processes—remains a matter of active theoretical debate. In 2024–2026, with global prevalence rates for anxiety disorders estimated at approximately 4.05% of the world population and rising sharply among working-age adults, understanding the cognitive

architecture underlying maladaptive self-regulation has become a public health imperative (WHO, 2024). The capacity to detect one's own errors, evaluate performance accuracy, and subsequently modulate behavior constitutes the core of metacognitive monitoring, a construct operationalized at the neural level through the error-related negativity (ERN) component of the event-related potential (ERP) waveform and the behavioral index of post-error slowing (PES). The ERN, a fronto-central negative deflection peaking approximately 50–100 ms following an erroneous response, is generated predominantly in the anterior cingulate cortex (ACC) and is widely accepted as a marker of automatic conflict detection within the performance-monitoring system. Post-error slowing, by contrast, reflects a slower, deliberative compensatory mechanism whereby response latency on the trial immediately succeeding an error is systematically prolonged—an index of adaptive behavioral regulation. Critically, these two indices are theoretically dissociable: the ERN indexes the rapid, affective-evaluative phase of error processing, while PES reflects the subsequent, cognitively mediated adjustment phase. Prior research has linked high trait anxiety to ERN hyperamplification, interpreted within the reinforcement sensitivity theory framework as reflecting excessive punishment sensitivity. Yet accumulating evidence challenges this hypervigilance model, with several studies reporting ERN attenuation in trait-anxious samples under high cognitive load conditions. A principal gap in existing literature concerns the role of interoceptive awareness—defined as the accurate perception of internal bodily signals—as a moderating or mediating variable in the ERN–PES relationship. Individuals with high trait anxiety exhibit well-documented interoceptive dysregulation, which may disrupt the internal feedback loop required for translating error detection signals into adaptive behavioral change. Furthermore, the majority of extant studies have employed single-task paradigms, thereby underestimating the metacognitive demands imposed by real-world dual-task environments in which inhibitory control must be sustained across competing response channels simultaneously. The present study addresses these gaps through a pre-registered, within-subjects empirical design employing a novel Flanker–Stop-Signal dual-task protocol coupled with 64-channel high-density EEG acquisition and source-localization procedures. The paper is structured as follows: Section 2 details the methodological protocol including participant stratification, EEG preprocessing pipeline, and statistical modeling approach; Section 3 presents electrophysiological and behavioral results stratified by anxiety group; Section 4 provides mediation models incorporating interoceptive awareness scores; and Section 5 situates these findings within current theoretical frameworks of anxious metacognition and delineates clinical implications for cognitive-behavioral intervention targeting performance monitoring deficits.

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