EDITORIAL

The Heart, the Brain, and the Regulation of Emotion

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Müller and colleagues[1] present a study showing that an electroencephalographic signature of the brain's representation of internal bodily responses (the amplitude of heartbeat evoked potential) is abnormally attenuated in patients with borderline personality disorder (BPD). This deficit predicts symptoms, including the degree of emotional instability, and correlates with structural differences in the gray matter volume in the insula and the anterior cingulate cortex, brain regions engaged during emotional regulation and implicated in the integrative control of mind and body. Patients with BPD in remission show a more normative heartbeat evoked potential, suggesting that strategies to improve mental and physiological integration may enhance psychotherapeutic interventions for this patient group.

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There is an obligatory physiological dimension to emotional experience. Heart rate, respiratory frequency, and sweat gland activity are among the autonomic reactions used as objective indices of the strength of emotional response. Changes in physiology initiate, accompany, and intensify emotions, to the extent that the sensing of bodily signals (interoception) has been considered a fundamental basis to emotional feelings.[2] But people differ; hence, a person's sensitivity to internal bodily responses may be a better determinant of emotional style, predicting one's vulnerability to emotional disorders and the capacity to regulate one's own emotional state. Assessing interoceptive ability is now an active area of experimental research, going beyond self-report questionnaires to quantify interoceptive ability more objectively. The methods have crystalized around tests of heartbeat detection.[3-6] If you can feel your heart beating at rest (without actively palpating your pulse), you should be able to accurately count the number of heartbeats occurring over fixed time intervals or judge whether a sequence of tones are played in time with each heartbeat. Interoceptive ability, quantified from heartbeat detection, is considered a stable trait of an individual.

Across the population, there is a range of ability on such tests, with the majority of healthy people showing relatively poor interoceptive ability.[3,5] Based on "peripheral" theories of emotion,[2] an early prediction was that patients with affective disorders, characterized by strong emotional feelings and poor affect regulation, might show greater heartbeat detection accuracy. States of physiological arousal are characteristic of anxiety, and, correspondingly, symptoms of arousal are featured within many clinical scales of anxiety. On average, interoceptive sensitivity is enhanced across patients with panic and anxiety disorders, with fewer anxious patients classifiable as "poor heartbeat detectors" than nonanxious controls.

However, heartbeat detection accuracy is typically found to be impaired in patients with depression. There are also benefits to having enhanced interoceptive ability, which is associated with more effective intuitive decision making and better emotional self-regulation. To date, however, the clinical impact of this work has been rather disappointing. The explanatory power of heartbeat detection accuracy only weakly predicts an individual's vulnerability to anxiety or other affective disorders. This is also apparent in patients with BPD, who show an equivalent range of heartbeat detection accuracy as healthy controls,[6] which contrasts with the clinical picture of anxiety and emotional instability. Clinical psychology has consequently focused on the importance of cognitive misinterpretation and maladaptive appraisal of bodily signals in the genesis and maintenance of anxiety. Consequently, cognitive and behavioral therapies typically incorporate theoretical models that address the disordered mental processing of physiological arousal. Nevertheless, these higher-order approaches underplay the potential for constitutional differences in interoception to be a precondition of psychopathological vulnerability.

In their study, Müller and colleagues[1] return to the fundamental issue of the quality of the central representation of the bodily signals. They demonstrate a difference in an electrocortical signature of the integrity of the body-brain axis in BPD, and relate this to the characteristic expression of emotional dysregulation related to early-life trauma and adversity. Müller and colleagues[1] go further by reporting a relationship with the structural integrity of the brain in patients with BPD, who show a relative reduction in gray matter volume within the insula and anterior cingulate cortices,[1] both regions implicated in the representation and control of emotion-related bodily arousal and the engendered affective feelings.[4,7] The implication is that adverse early-life experiences have an effect on the adaptive maturation of the biological substrates supporting affective control and, perhaps more fundamentally, self-representation.[7] Dissociative symptoms are a clinical expression of disturbed self-representation, and feelings of emptiness with depersonalization and derealization are common experiences of patients with BPD. Dissociation is linked theoretically to the uncoupling of integrative self-processing, notably at the interface between the dynamic representation of the internal body as a physiological entity and the psychological constructions that, in healthy individuals, give rise to a sense of internal agency and control.[7]

The innovative work of Müller and colleagues[1] highlights the fundamental relevance of interoceptive signaling to a personality disorder characterized by emotional instability. The research also coincides with a new understanding of interoceptive processing and with refinements to the measurement of

interoceptive ability from heartbeat detection tests.[5] Müller and colleagues[1] suggest that conventional heartbeat detections tests "are unable to differentiate between actual afferent bodily signals and the active process of attention focusing and perception," whereas the electrocortical heartbeat evoked potentials represent objective indicators of the central "cortical representation of afferent signals from the cardiovascular system independent of attentional focus on the heartbeat."

More work is required to validate this latter claim, yet the approaches are indeed complimentary. While one can intentionally attend to one's own heartbeat, neither the influence of interoceptive signals nor their propensity to break through into conscious awareness is necessarily contingent on attentional focus. It is also essential to distinguish participants' objective behavioral performance on the heartbeat detection test (interoceptive accuracy) from their subjective perception and beliefs about their interoceptive ability (interoceptive sensibility), and from their conscious insight into their own performance (metacognitive interoceptive awareness [ie, the correspondence between detection accuracy and their confidence in their interoceptive performance]).[5] It is important to recognize and quantify these distinct experiential dimensions of interoception because coherence across them is an indicator of effective body-mind integration, protecting against affective and dissociative symptoms, whereas mismatches between objective and subjective dimensions of interoception are likely to be critical to the genesis and maintenance of psychopathology.[5,7]

The findings of Müller and colleagues[1] contribute to a deeper understanding of the neurobiological mechanisms underlying emotional dyscontrol and related symptoms of BPD by demonstrating the value of including a more direct objective neural index of interoception (heartbeat evoked potential) alongside an examination of the relevant structural integrity of the brain (interoceptive cortices including the insula). Nevertheless, although the heartbeat evoked potential amplitude is related to interoceptive accuracy on heartbeat detection tests,[3] its relationships with interoceptive awareness and the breakthrough of bodily sensations into consciousness are yet to be established.

This is an exciting and timely area of research. Interoceptive processes are increasingly considered within affective neuroscience and consciousness research as fundamental influences on human psychology.[7] Moreover, in psychiatry, models of interoceptive control and representation are becoming powerful accounts for specific types of disorders (eg, somatoform and affective) and symptoms (emotional instability, anhedonia, anxiety, and dissociation). Comprehensive accounts of psychopathological mechanisms must consider interoception, yet, presently, this knowledge base is limited. As Müller and colleagues[1] suggest, the impact of identifying and characterizing abnormalities in the body-brain-mind axis will come from the development and application of effective psychotherapeutic, biobehavioral, and neuropharmacologic interventions to enhance affective control and the integrity of self-representation.

ARTICLE INFORMATION

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