

Beyond Self-Report: Detecting Depressive Symptoms Directly from Neural Activity

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Abstract

Background: Depression is typically assessed through clinical interviews and self-report rating scales. These approaches, however, are vulnerable to self-presentation bias, cognitive load, and limited access to implicit negative schemas. Subtle or under-reported symptoms may therefore go undetected, particularly in groups facing stigma or cognitive impairment. There is therefore a pressing need for direct, sensitive, bias-resistant measures of symptom expression. We asked whether depressive symptoms could be detected directly from neural activity during natural reading, without requiring any overt judgments or introspection.

Methods: Forty adults spanning a wide range of depressive symptoms (indexed by the Beck Depression Inventory-II) read 160 self-relevant depression probes, specifically written to capture core constructs such as low mood, anhedonia, fatigue, guilt, poor concentration, hopelessness, and established risk factors including trauma and social isolation. Each vignette established a context reflecting core clinically relevant experiences and concluded with a first-person statement that was either depression-consistent (e.g., 'Lately my mind has been quite foggy') or depression-inconsistent (e.g., 'Lately my mind has been quite clear'). A matched set of third-person vignettes controlled for general sensitivity to depression-related content and expectancy effects. Neural responses to the critical words were recorded with EEG as participants read the probes naturally, without making explicit judgments.

Results: Depression severity predicted a sustained, highly selective neural response distinguishing self-relevant depression-consistent from depression-inconsistent statements. Between 300–500 ms, reduced neural activity to depression-consistent statements indicated that negative self-schemas influenced expectations at the earliest stage of comprehension. Between 500–1000 ms, larger neural responses to depression-consistent statements reflected greater attentional engagement and motivational salience. These neural signatures scaled continuously with symptom severity, even at subclinical levels, highlighting their sensitivity to individual variation. Importantly, they were absent in non-self-relevant probes, demonstrating selectivity to personally relevant material and ruling out alternative explanations such as general emotional reactivity or differences in contextual prediction.

Conclusions: Depressive symptoms can be detected directly from neural activity during natural reading of self-relevant clinical probes, even in individuals without clinical diagnoses and without overt behavioral responses. This study provides the first demonstration that neural activity alone can reveal how DSM-defined depressive symptoms and risk factors are instantiated in real time during natural comprehension. By capturing how negative self-schemas are recruited online, this approach offers a mechanistic bridge between clinical constructs and brain function. With further development, such probes could form the basis of "neural rating scales" that complement

traditional assessment tools, capturing what patients cannot or will not report. Such measures could provide bias-resistant markers for early detection, continuous symptom monitoring, and individualized treatment planning, advancing the broader goal of precision psychiatry.

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