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SELF-ESTEEM INSTABILITY IN MAJOR DEPRESSIVE DISORDER: A COMPUTATIONAL ANALYSIS OF EXPECTATION UPDATING IN RESPONSE TO PERFORMANCE FEEDBACK

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BACKGROUND AND AIM: Major Depressive Disorder (MDD) has long been associated with low self-esteem in the existing literature (Beck, 1967; Sowislo & Orth, 2013). Although cognitive models of MDD propose low self-esteem as a risk factor for the onset and persistence of depression (Beck, 1967), recent studies emphasize the importance of self-esteem stability rather than merely its level (Kernis, 2005; Franck & De Raedt, 2007). This research is grounded in Hierometer Theory, which conceptualizes self-esteem functions as a gauge that enables individuals to effectively navigate social hierarchies by also motivating adaptive status-seeking behavior (Mahadevan et al., 2019). Within this framework, environmental factors such as social comparison and performance feedback induce dynamic shifts in self-evaluation. Although the cognitive model of depression posits a negative bias in information processing (Beck, 1967), there has been a notable lack of research using objective, experimental tasks to examine how MDD patients update their expectations in response to social-hierarchy-based feedback. Previous studies often relied on self-report measures, which are susceptible to social desirability bias and fail to capture automatic or unconscious regulatory processes. Therefore, this study aimed to investigate how receiving positive and negative social performance feedback affects self-esteem dynamics in MDD patients compared to healthy controls using a novel computational analysis. Consistent with the negative bias framework of the cognitive model, we hypothesized that patients with depression will exhibit significantly higher sensitivity to negative rather than positive social performance feedback compared to healthy controls.

METHODS (Ethics Committee Approval must be obtained and the number should be specified.): The study procedure was initiated with the clinical characterization of 90 participants, comprising 60 patients diagnosed with Major Depressive Disorder (MDD) and 30 healthy controls. To ensure diagnostic accuracy, clinical statuses were validated using the Structured Clinical Interview for DSM-5 (SCID-5), while depressive symptom severity was quantified via the Hamilton Depression Rating Scale (HAM-D) and the Beck Depression Inventory (BDI). Simultaneously, baseline self-esteem levels were established through the Rosenberg Self-Esteem Scale (RSES) to provide a comparative psychological baseline. Subsequently, participants were transitioned to a computer-based setting to participate in an in-house developed digital paradigm. At the beginning of the experiment, to reinforce the social-competitive environment, eleven AI-generated competitors were introduced, and participants were asked to report their initial rank expectations ($g_{(t=0)}$) regarding their performance in the task. The experiment was structured into 24 blocks, each consisting of a total of 6 trials. Each trial sequence comprised a question screen where participants viewed various dice combinations, followed by a response screen where they identified the frequency of a specific target number. Upon completion of each 6-trial block, participants received ranking feedback (r_t) on a vertical scale ranging from 1 (highest) to 12 (lowest), indicating their performance in that block. Immediately following the feedback screen, participants were queried regarding their expected rank for the subsequent block ($g_{(t+1)}$). In the analysis phase, the discrepancy between this feedback and the participant's prior expectation was formalized as a prediction error, $\delta_t=g_t-r_t$. Expectation updating was modeled as $g_{(t+1)}=g_t-\beta_t$, where the update magnitude (β_t) is the product of the prediction error (δ_t) and an individual-specific sensitivity coefficient (k), defined as $\beta_t=k\times\delta_t$. To account for asymmetries in belief updating, separate sensitivity parameters ($k_{positive}$) and ($k_{negative}$) were estimated for feedback better or worse than expected. Within an active inference framework, these coefficients reflect the precision of self-related beliefs and their susceptibility to environmental input. Ethical approval was obtained from the Ege University Faculty of Medicine Clinical Research Ethics

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RESULTS:The MDD and control groups were statistically comparable regarding age, sex, and education duration (Table 1). While the MDD group demonstrated significantly lower baseline self-esteem, as measured by the Rosenberg Self-Esteem Scale (RSES), and lower initial rank expectations compared to controls, objective task performance metrics—including accuracy and reaction times—showed no significant intergroup differences (Table 2). Regardless of feedback direction, the sensitivity coefficient (k_mean) at which MDD patients updated their performance predictions based on feedback was significantly higher than that of healthy controls ($U = 1435.0$, $p = 4.76 \times 10^{-6}$, $r = -0.594$). When receiving positive feedback better than their prediction, the MDD group exhibited a significantly higher coefficient for updating performance expectations compared to controls ($U = 1096.5$, $p=0.0009$, $r=-0.450$). The MDD group also demonstrated a significantly higher update coefficient compared to controls when receiving negative feedback worse than expected ($U = 1374.5$, $p = 4.97 \times 10^{-5}$, $r = -0.527$). Examination of the within-group distribution revealed that k_positive values in the MDD group showed a right-skewed distribution, with some patients developing extreme sensitivity (outliers) to feedback. While patients differed from controls in both feedback types, the effect size for k_negative ($r =-0.53$) was stronger than for k_positive ($r = -0.45$).

CONCLUSIONS:This study demonstrates that self-esteem in Major Depressive Disorder is marked by instability in response to environmental feedback. Our findings suggest that MDD treatment should not solely aim to raise self-esteem levels but must also focus on regulating hypersensitivity to external stimuli and promoting self-esteem stability. Psychotherapeutic interventions that train patients to attribute feedback to specific task conditions rather than viewing it as a reflection of personal inadequacy may be effective in achieving stability and lasting remission. Future research should validate these computational findings in larger clinical cohorts.

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Table 1. Demographic and clinical characteristics of MDD and control groups.

Variable	MDD (N=60)	Controls (N=30)	Statistics
Age, mean years (SD)	37.3 (10.8)	39.9 (12.7)	t = -0.96 df = 88 P = 0.34
Sex, n (%) Male Female	12 (20%) 48 (80%)	6 (20%) 24 (80%)	X2 =0.00 df =1 P > 0.99
Education, median years (SD)	12.8 (3.1)	13.5 (3.3)	t = -0.93 df = 88 P = 0.35
Current medication, n (%) Antidepressant (Total) SSRIs SNRIs NDRI Tricyclics	 60 (100%) 38 (63.3%) 19 (31.7%) 9 (15.0%) 1 (1.7%)	 NA NA NA NA NA	 NA NA NA NA NA
HAMD Total Score, mean (SD)	16.6 (3.8)	NA	NA
BDI Total Score, mean (SD)	24.1 (4.4)	NA	NA

Abbreviations: MDD: Major Depressive Disorder; N: Sample size; SD: Standard Deviation; HAM-D: Hamilton Depression Rating Scale; BDI: Beck Depression Inventory; SSRI: Selective Serotonin Reuptake Inhibitor; SNRI: Serotonin-Norepinephrine Reuptake Inhibitor; NDRI: Norepinephrine-Dopamine Reuptake Inhibitor; NA: Not Applicable.

Table 2. Baseline self-esteem, initial performance expectations, and task performance metrics

Variable	MDD (N=60)	Controls (N=30)	Statistics
RSES Total Score, mean (SD)	13.5 (5.4)	26.5 (2.7)	t = -15.18 df = 88 P= < 0.001
Baseline Performance Expectation ($g_{t=0}$), mean (SD)	3.9 (1.2)	2.0 (0.6)	t = -7.53 df = 88 P= < 0.001
Number of Correct Responses Per Block, mean (SD)	4.1 (1.2)	4.5 (0.9)	t = 1.35 df = 88 P= 0.18
Reaction Time Per Block, mean (SD) (ms)	1213.3 (540.0)	1056.7 (440.0)	t = -1.21 df = 88 P= 0.25

Abbreviations: RSES: Rosenberg Self-Esteem Scale; g(t=0): Baseline rank expectation; ms: Milliseconds; SD: Standard Deviation.