

# Predicting Self-Esteem Instability Using Rejection Sensitivity, Daily Stress Reactivity, Social Feedback Valence, and Emotional Reactivity in LSTM Models

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## ABSTRACT

**Objective:** To evaluate the efficacy of a Long Short-Term Memory (*LSTM*) neural network in predicting intra-individual self-esteem instability utilizing continuous ecological momentary assessment data encompassing trait rejection sensitivity, daily stress reactivity, social feedback valence, and momentary emotional reactivity.

**Methods and Materials:** A longitudinal Ecological Momentary Assessment study was conducted over 21 days with a final sample of  $N = 452$  young adults from Spain. Participants completed the Rejection Sensitivity Questionnaire and responded to multiple daily prompts assessing momentary stress, social feedback valence, emotional reactivity, and state self-esteem. An *LSTM* neural network was designed to capture the non-linear, time-dependent relationships within this multi-dimensional data, and its performance was benchmarked against traditional linear regression and standard Recurrent Neural Network (*RNN*) architectures.

**Findings:** The proposed *LSTM* architecture significantly outperformed baseline models, capturing 61% of the variance in self-esteem instability ( $R^2 = 0.61$ ) with a low prediction error ( $RMSE = 0.184$ ). Permutation feature importance analysis revealed that momentary emotional reactivity and trait rejection sensitivity were the strongest predictors of self-esteem fluctuations. Additionally, an ablation study on look-back windows identified a 48-hour period ( $t - 8$  assessments) as the optimal temporal framework for forecasting instability.

**Conclusion:** Advanced deep learning models, specifically *LSTM* networks, can accurately decode the complex, non-linear temporal dynamics of self-esteem, providing a powerful computational foundation for future personalized, real-time psychological interventions.

**Keywords:** *Self-esteem instability; Long Short-Term Memory (LSTM); Ecological Momentary Assessment; Rejection sensitivity; Emotional reactivity; Machine learning.*

## 1. Introduction

Self-esteem, broadly defined as an individual's subjective evaluation of their own worth, is a cornerstone of psychological well-being and adaptive

human functioning. Extensive literature has consistently highlighted the profound implications of self-esteem across various domains of life, particularly during critical developmental periods such as adolescence and emerging

adulthood. A robust sense of self-worth operates as a fundamental psychological resource, empowering individuals to navigate academic pressures, social challenges, and the inherent adversities of daily life. For instance, self-esteem has been shown to play a crucial mediating role in the relationship between positive psychological capital, academic engagement, and the reduction of academic procrastination, ultimately fostering enhanced academic performance (Almurumudhe et al., 2024). Furthermore, in the context of broader psychological adjustment and transitional phases, a stable sense of self-esteem significantly bolsters psychological well-being indices, allowing individuals to adapt more effectively to new environments and institutional demands (Ofem, 2023). Conversely, deficits in self-esteem are intrinsically linked to severe negative outcomes, acting as a primary interrelated factor in predicting adolescent depression and amplifying the deleterious impacts of interpersonal stressors (Fiorilli et al., 2019). Given its pervasive influence, high self-esteem is frequently conceptualized as a vital protective factor that buffers against the onset of psychopathology, particularly when adolescents are confronted with severe and unavoidable stressful life events (Gurung et al., 2019).

The foundational development of self-esteem is deeply rooted in early interpersonal environments, particularly within the family unit. According to parental acceptance-rejection theory, the degree of warmth and responsiveness exhibited by primary caregivers fundamentally shapes a young adult's internal working models of self-worth (Chong et al., 2014). Supportive parenting styles are essential for cultivating psychological flexibility and self-esteem, which together act in a chain-mediating capacity to ensure long-term adolescent mental health (Peng et al., 2021). Conversely, environments characterized by high family stress can severely compromise youth mental health, underscoring the necessity of targeted interventions that bolster self-efficacy and future orientation as compensatory psychological mechanisms (Kim et al., 2019). The detrimental effects of academic and environmental stress on adolescent depression are also heavily mediated by the erosion of self-esteem, though active and positive parental monitoring can serve as a moderated mediating factor to mitigate these risks (Kim & Kim, 2024). Beyond explicit parenting behaviors, deep-seated attachment styles formed in childhood establish the regulatory elements that govern adult psychological functioning, where insecure attachment frequently leads to heightened rejection sensitivity and

critically diminished self-esteem, paving the way for eventual psychopathology (Set, 2019).

As individuals transition from familial environments into broader social ecosystems, peer interactions and complex social dynamics become the primary arenas for self-esteem negotiation. The capacity for empathy is intricately tied to how individuals perceive themselves and others within these social matrices. Cognitive empathy, for instance, indirectly influences a child's self-esteem and shapes their moral attitudes and perceived competence, particularly regarding their interactions with marginalized groups or individuals with disabilities (Maftai, 2022). Similarly, fostering empathy and self-compassion among university students has been shown to mutually reinforce self-esteem, creating a positive psychological loop that enhances rational-emotive and cognitive-behavioral outcomes (Tran et al., 2022). High levels of empathy and self-esteem are concurrently associated with significantly greater overall satisfaction with life in adolescent populations (Supervía et al., 2023). However, the modern social landscape is fraught with interpersonal perils, such as traditional bullying and cyberbullying, which serve as highly destructive longitudinal predictors that systematically dismantle self-esteem over time (Juan de Dios Benítez et al., 2024). To combat the psychological friction generated by these negative interpersonal encounters, individuals often rely on prosocial mechanisms like forgiveness; notably, the propensity of an adolescent to forgive is deeply intertwined with their inherent self-esteem, religiosity, and empathy, with environmental social support acting as a critical moderating variable (Susilawati et al., 2025).

Within these complex social environments, the construct of rejection sensitivity—the dispositional tendency to anxiously expect, readily perceive, and intensely overreact to social rejection—emerges as a critical vulnerability factor that profoundly destabilizes self-esteem. High rejection sensitivity operates as a toxic cognitive-affective filter, transforming ambiguous social cues into definitive evidence of personal unworthiness. Research demonstrates that attachment styles heavily influence smartphone addiction behaviors, a modern phenomenon driven by social anxiety, wherein the relationship is significantly mediated by elevated rejection sensitivity and plummeting self-esteem (Hasani et al., 2022). Similarly, among college populations, worry and diminished self-esteem serve as the primary mediating conduits through which insecure attachment styles and rejection sensitivity exert their damaging psychological effects (Khoshkam et al., 2012). Cultivating

internal psychological defenses is therefore imperative; mindfulness practices have shown efficacy in improving psychological well-being by directly reducing rejection sensitivity and concurrently rebuilding self-esteem (Ebrahimi & Mousavian Khatir, 2023). The clinical importance of safeguarding self-esteem is so paramount that school-based resilience interventions are increasingly deploying cluster randomized controlled trials to structurally foster these protective traits in at-risk adolescent populations before clinical deterioration occurs (Llistosella et al., 2023). In extreme pathological manifestations, the pursuit of self-esteem validation can mirror neurochemical addiction pathways, with certain theoretical frameworks and pharmacological models suggesting that narcissistic validation-seeking may neurologically parallel the reward-system hijacking observed in substance use disorders (Kastner-Bosek et al., 2021).

While self-esteem is traditionally conceptualized and measured as a stable trait, contemporary psychological paradigms increasingly recognize its dynamic, fluctuating nature in daily life. Trait self-esteem represents the baseline average of an individual's self-worth, but state self-esteem reflects momentary, transient evaluations that rise and fall in response to immediate internal and external stimuli. It is the magnitude and frequency of these fluctuations—termed self-esteem instability—rather than the baseline level alone, that often predicts severe relational and psychological dysregulation (Göncü & Sümer, 2011). Individuals with high self-esteem instability possess fragile self-concepts that are highly contingent upon continuous external validation. In the digital age, this instability is acutely exacerbated by the pervasive feedback loops inherent in social media platforms, where state self-esteem responses in both adolescents and adults become violently tethered to the valence and volume of immediate digital social feedback (Chen, 2025). Clinical populations exhibit extreme variants of this reactivity; for example, adolescents with Borderline Personality Disorder demonstrate a profound inability to internalize positive social feedback, resulting in altered and highly unstable self-esteem reactivity that fails to stabilize even when they are explicitly shown that they are liked by peers (Gregorova, 2025).

Understanding the intricate mechanics of self-esteem instability requires a paradigm shift away from traditional, cross-sectional methodologies toward intensive longitudinal designs capable of capturing micro-level temporal dynamics. Momentary fluctuations in self-worth are theoretically driven by immediate emotional reactivity to

daily stressors and the specific valence of ongoing social feedback. When an individual with high rejection sensitivity encounters a negative social interaction or a daily stressor, the subsequent cascade of negative emotional reactivity rapidly depresses momentary self-esteem. Over time, these volatile peaks and valleys aggregate into a high index of self-esteem instability. Traditional statistical approaches, such as multiple linear regression or simple autoregressive models, are mathematically ill-equipped to untangle the highly non-linear, interacting, and time-dependent nature of these momentary psychological variables. These legacy models fail to account for complex temporal dependencies, such as how the psychological impact of social rejection experienced on a Tuesday might exert a latent, non-linear decaying influence on emotional reactivity the following Thursday.

To accurately predict the chaotic trajectory of self-esteem instability, psychological science must adopt advanced computational techniques from the field of machine learning, specifically deep learning architectures designed for time-series forecasting. Long Short-Term Memory (*LSTM*) networks, a specialized class of recurrent neural networks, represent the optimal mathematical solution for this challenge. Unlike traditional models, *LSTM* networks are engineered with sophisticated internal gating mechanisms (forget, input, and output gates) that autonomously learn which historical psychological states to retain in long-term memory and which irrelevant fluctuations to discard. This allows the neural network to map the highly complex, multidimensional chronologies of daily stress reactivity, social feedback valence, and momentary emotional states, integrating them with baseline trait rejection sensitivity to generate highly accurate predictions of future self-esteem instability. By leveraging ecological momentary assessment data, *LSTM* models can capture the lived psychological reality of individuals in real-time, uncovering non-linear predictive patterns that are invisible to classical statistics. Bridging the gap between momentary psychological assessment and advanced deep learning forecasting represents a critical frontier in personalized mental health diagnostics. Therefore, the aim of this study is to evaluate the efficacy of a Long Short-Term Memory neural network in predicting intra-individual self-esteem instability utilizing continuous ecological momentary assessment data encompassing trait rejection sensitivity, daily stress reactivity, social feedback valence, and momentary emotional reactivity.

## 2. Methods and Materials

### 2.1. Study Design and Participants

The present study employed an intensive longitudinal observational design utilizing Ecological Momentary Assessment to capture the dynamic fluctuations of self-esteem and its associated psychological predictors in daily life. By capturing real-time data, this design is uniquely suited for generating the complex time-series sequences required for training advanced computational models. The sample consisted of four hundred and eighty-six young adults recruited from various universities and community centers across diverse regions of Spain. To be eligible for inclusion in the study, participants had to be fluent in Spanish, own a smartphone capable of running the designated data collection application, and be between the ages of eighteen and thirty-five. After providing written informed consent, participants completed an initial baseline assessment in the laboratory, followed by a twenty-one-day Ecological Momentary Assessment protocol in their natural environments. During this intensive tracking period, participants received four semi-randomized push notifications per day to report their current psychological states, social interactions, and experiences. Participants were financially compensated for their time based on their compliance rates. To ensure the robust training of the neural network models and maintain sequence continuity, data from participants who completed less than seventy-five percent of the daily prompts were excluded from the final analysis, resulting in a final analytical sample of four hundred and fifty-two participants yielding thousands of unique observation points.

### 2.2. Measures

At the initial baseline assessment, trait rejection sensitivity was measured using the widely validated Spanish adaptation of the Rejection Sensitivity Questionnaire, where participants rated their degree of anxiety and expectations of rejection across various hypothetical interpersonal scenarios on a continuous scale. During the twenty-one-day Ecological Momentary Assessment phase, momentary variables were assessed using abbreviated, validated short-form scales optimized for mobile interfaces to minimize participant burden and reactivity. Daily stress reactivity was operationalized by asking participants to report the occurrence of stressful events since the last prompt and to rate their subjective level of distress and perceived inability

to cope with those specific events. Social feedback valence was captured by asking participants to evaluate the nature of their most recent social interactions, rating the perceived feedback received from others on a continuous slider ranging from highly negative and critical to highly positive and affirming. Emotional reactivity was assessed using a customized, momentary subset of the Positive and Negative Affect Schedule, prompting participants to indicate the current intensity of specific positive and negative emotions. Finally, momentary self-esteem, the foundational variable from which the target outcome was derived, was measured at every single prompt using a validated state version of the Rosenberg Self-Esteem Scale. For the purposes of predictive modeling, self-esteem instability was mathematically operationalized as the intra-individual standard deviation of these momentary self-esteem scores calculated over a rolling time window.

### 2.3. Data Analysis

The predictive modeling of self-esteem instability was conducted utilizing Long Short-Term Memory networks, a highly specialized architecture of recurrent neural networks explicitly designed to learn order dependence and temporal dynamics in complex sequence prediction problems. Prior to model training, the longitudinal data underwent rigorous preprocessing to ensure suitability for deep learning algorithms. This included within-person centering of the momentary predictors to strictly isolate intra-individual psychological fluctuations from inter-individual baseline trait differences. Missing data points within the time sequences, which are inherent to intensive longitudinal designs, were addressed using a combination of forward filling and moving average imputation techniques to meticulously preserve the temporal integrity of the time-series arrays. All input features were subsequently standardized using min-max scaling to bound the data between 0 and 1, ensuring optimal gradient descent and convergence during the neural network training process. The Long Short-Term Memory model architecture consisted of an input layer corresponding to the multivariate time-series sequences, two sequential hidden layers equipped with recurrent dropout mechanisms to systematically prevent overfitting, and a dense output layer predicting the subsequent self-esteem instability metric. The optimization of the network weights was achieved using the Adam optimizer, minimizing the Mean Squared Error loss function defined mathematically as

$$MSE = \frac{1}{n} \sum_{i=1}^n (Y_i - \hat{Y}_i)^2$$

where  $Y_i$  represents the actual observed self-esteem instability and  $\hat{Y}_i$  represents the model's generated prediction. Model performance was evaluated using a rigorous rolling-origin cross-validation strategy specifically adapted for time-series data, ensuring that the strict chronological order of observations was respected and that future data never leaked into the training phase. The final predictive accuracy and generalization capability of the computational models were comprehensively quantified using the Root Mean Squared Error and the Mean Absolute Error on an isolated, held-out testing dataset. All computational analyses, data wrangling, and model building procedures were executed utilizing the Python programming language in conjunction with the TensorFlow and Keras deep learning frameworks.

### 3. Findings and Results

The primary objective of the data analysis phase was to evaluate the efficacy of a Long Short-Term Memory (LSTM) neural network in predicting intra-individual self-esteem instability using ecological momentary assessment

data. Prior to training the deep learning models, descriptive statistics and bivariate correlations were computed to examine the fundamental relationships between trait rejection sensitivity, momentary variables, and the target outcome. Across the final analytical sample of  $N = 452$  participants, generating a total of 33,896 valid momentary observations, the mean level of momentary self-esteem was relatively high, though intra-individual instability exhibited significant variance. As illustrated in Table 1, bivariate correlation analyses revealed that self-esteem instability was positively and significantly associated with trait rejection sensitivity ( $r = .42, p < .001$ ), daily stress reactivity ( $r = .38, p < .001$ ), and negative emotional reactivity ( $r = .45, p < .001$ ). Conversely, social feedback valence, representing the perceived positivity of recent interpersonal interactions, demonstrated a significant negative correlation with self-esteem instability ( $r = -.31, p < .001$ ). Furthermore, the predictors themselves exhibited expected intercorrelations; for instance, daily stress reactivity and negative emotional reactivity were strongly correlated ( $r = .56, p < .001$ ), necessitating the use of advanced multivariate modeling techniques like LSTMs that can effectively handle multicollinearity and complex interactive temporal dynamics.

**Table 1**

*Descriptive Statistics and Bivariate Correlations of Study Variables*

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5
1. Self-Esteem Instability	0.84	0.29	–				
2. Rejection Sensitivity	11.45	3.12	.42**	–			
3. Daily Stress Reactivity	2.31	0.88	.38**	.29**	–		
4. Social Feedback Valence	6.72	1.45	-.31**	-.22**	-.41**	–	
5. Emotional Reactivity (Negative)	2.15	0.76	.45**	.36**	.56**	-.38**	–

To ascertain the predictive superiority of the proposed LSTM architecture, its performance was benchmarked against three alternative models: a baseline naive forecasting model (predicting the mean of the training set), a standard Ordinary Least Squares (OLS) multiple linear regression model, and a basic Recurrent Neural Network (RNN). Model performance on the isolated testing dataset was evaluated using Root Mean Squared Error (*RMSE*), Mean Absolute Error (*MAE*), and the coefficient of determination ( $R^2$ ). As detailed in Table 2, the LSTM model significantly outperformed all baseline configurations. The LSTM achieved the lowest prediction error ( $RMSE = 0.184$ ,

$MAE = 0.142$ ) and accounted for the highest proportion of variance in future self-esteem instability ( $R^2 = .61$ ). The standard RNN also performed well ( $R^2 = .52$ ), indicating that capturing sequential temporal data is crucial for this psychological phenomenon; however, the LSTM's specialized gating mechanisms allowed it to better capture long-term dependencies in the data, mitigating the vanishing gradient problem that limits basic RNNs. The linear regression model performed poorly in comparison ( $R^2 = .28$ ), emphasizing that the relationships between rejection sensitivity, momentary stressors, and self-esteem instability are highly non-linear and temporally complex.

**Table 2**

*Comparison of Model Performance Metrics for Predicting Self-Esteem Instability*

Model Architecture	<i>RMSE</i>	<i>MAE</i>	<i>R</i> <sup>2</sup>
Naive Baseline (Mean)	0.345	0.288	0.00
OLS Linear Regression	0.292	0.235	.28
Standard RNN	0.221	0.176	.52
LSTM (Proposed)	0.184	0.142	.61

To understand the specific drivers of the LSTM model’s predictions, a permutation feature importance analysis was conducted. This technique evaluates the decrease in model performance (specifically, the increase in *RMSE*) when the temporal sequence of a single predictor is randomly shuffled, thereby breaking its relationship with the true outcome. The results, presented in Table 3, indicate that Emotional Reactivity was the single most critical predictor of self-esteem instability within the network; shuffling its values resulted in an *RMSE* increase of 0.095. This was closely followed by Trait Rejection Sensitivity (increase in *RMSE* = 0.082). Interestingly, while Social Feedback

Valence had the lowest zero-order correlation with the outcome, the neural network identified it as a highly significant feature when interacting temporally with other variables (increase in *RMSE* = 0.068). Daily Stress Reactivity, though important, yielded the lowest relative importance among the primary predictors (increase in *RMSE* = 0.051). These findings suggest that an individual’s internal emotional reactivity and underlying rejection schemas play a more dominant role in driving self-esteem fluctuations than the mere occurrence of daily stressful events.

**Table 3**

*Permutation Feature Importance for the LSTM Model*

Feature	Increase in <i>RMSE</i>	Relative Rank
Emotional Reactivity	0.095	1
Rejection Sensitivity	0.082	2
Social Feedback Valence	0.068	3
Daily Stress Reactivity	0.051	4

Finally, an ablation study was performed to determine the optimal “look-back” window—the specific number of past ecological momentary assessment prompts the LSTM required to most accurately predict the subsequent state of self-esteem instability. The network was iteratively retrained using sequence lengths ranging from  $t - 1$  (incorporating data from only the immediately preceding prompt) up to  $t - 12$  (incorporating data from the previous three full days of prompts). The findings, detailed in Table 4, demonstrate a clear non-linear relationship between sequence length and predictive accuracy. The model’s performance improved significantly as the look-back window increased from

1prompt (*RMSE* = 0.255) to 8prompts (*RMSE* = 0.184), representing approximately two full days of psychological data. However, expanding the sequence length beyond 8prompts (e.g., to 12prompts) yielded diminishing returns and actually resulted in a slight degradation of model performance (*RMSE* = 0.191), likely due to the introduction of temporal noise and the dilution of immediate, salient psychological triggers. This indicates that self-esteem instability is highly dependent on psychological events and reactions occurring within a strict 48-hour preceding window.

**Table 4**

*Impact of Different Look-back Windows (Time Lags) on LSTM Model Accuracy*

Look-back Window (Lags)	Approximate Timeframe	<i>RMSE</i>	<i>MAE</i>
$t - 1$	Previous prompt (~ 4 hours)	0.255	0.201

$t - 4$	Previous day (24 hours)	0.210	0.165
$t - 8$	Previous two days (48 hours)	0.184	0.142
$t - 12$	Previous three days (72 hours)	0.191	0.150

#### 4. Discussion

The primary objective of the present study was to evaluate the efficacy of a Long Short-Term Memory (*LSTM*) neural network in predicting intra-individual self-esteem instability utilizing continuous ecological momentary assessment data. Our findings unequivocally demonstrated that the proposed *LSTM* architecture significantly outperformed traditional linear regression and standard recurrent neural networks, capturing a substantial 61% of the variance in self-esteem fluctuations with a remarkably low prediction error ( $RMSE = 0.184$ ). This superior predictive performance fundamentally validates the premise that the mechanisms governing momentary self-esteem instability are highly non-linear, interacting, and temporally dependent. Traditional cross-sectional methodologies and legacy linear statistical models are evidently ill-equipped to decode the chaotic, real-time trajectory of an individual's self-worth. By successfully mapping the multidimensional chronologies of daily stress reactivity, social feedback valence, and momentary emotional states, our computational model highlights that self-esteem is not merely a static trait, but rather a highly dynamic psychological state that requires advanced time-series forecasting to be fully understood and predicted (Göncü & Sümer, 2011).

The permutation feature importance analysis revealed that momentary emotional reactivity and trait rejection sensitivity were the two most critical drivers of self-esteem instability within the neural network. This hierarchy of predictors aligns seamlessly with existing psychological frameworks which posit that deep-seated vulnerabilities act as cognitive-affective amplifiers in daily life. As previous research has illuminated, insecure attachment styles and high rejection sensitivity frequently precipitate severe deficits in self-esteem, ultimately paving the way for eventual psychopathology (Set, 2019). Individuals harboring heightened rejection sensitivity are predisposed to perceiving ambiguous social cues as direct interpersonal threats, triggering intense negative emotional reactivity that immediately destabilizes their momentary sense of worth. This toxic dynamic is consistently observed in diverse contexts, such as studies demonstrating how rejection sensitivity heavily mediates the relationship between fundamental vulnerabilities—like generalized worry or smartphone addiction—and compromised self-esteem

(Hasani et al., 2022; Khoshkam et al., 2012). Furthermore, the overwhelming influence of emotional reactivity in our predictive model underscores the profoundly fragile nature of unstable self-esteem. This echoes emerging theoretical perspectives that frame extreme validation-seeking and violent self-esteem fluctuations as mirroring the neurochemical pathways and behavioral compulsions observed in clinical addiction models (Kastner-Bosek et al., 2021). When self-esteem operates as a highly reactive, volatile state rather than a stable internal psychological anchor, individuals lack the psychological flexibility required to buffer against negative emotional states, invariably leading to poor mental health outcomes and increased depressive symptoms over time (Peng et al., 2021).

Interestingly, our deep learning model identified social feedback valence as a highly significant temporal predictor, despite its relatively modest zero-order correlation with the final outcome variable. This finding is particularly illuminating, as it suggests that the temporal sequence, accumulation, and specific timing of social interactions matter far more than their isolated occurrence. The neural network recognized that a single negative social interaction might not instantly collapse self-esteem, but a sequential pattern of negative feedback exerts a powerful destabilizing force. The profound impact of continuous social feedback on self-esteem is heavily corroborated by recent literature examining both digital and real-world interpersonal dynamics. For example, momentary self-esteem responses are known to be violently tethered to the relentless, continuous social media feedback loops that dominate the social lives of both adolescent and adult populations (Chen, 2025). Negative social feedback, especially in severe and repeated forms such as traditional bullying and cyberbullying, functions as a highly potent longitudinal predictor of self-esteem erosion (Juan de Dios Benítez et al., 2024). Furthermore, our finding that the computational model required historical temporal data to accurately map this relationship reflects critical observations in clinical populations. Individuals with severe relational dysregulation, such as adolescents with Borderline Personality Disorder, exhibit altered, non-normative self-esteem reactivity to social feedback, often failing to stabilize their self-worth even when they are explicitly presented with

positive peer evaluations (Gregorova, 2025). Conversely, healthy social feedback processing is intrinsically linked to cognitive empathy and prosocial behaviors, which mutually reinforce a stable, rather than unstable, sense of self-worth in young adults (Maftai, 2022; Supervía et al., 2023; Tran et al., 2022). When these empathetic and social support systems fail, or when prosocial mechanisms like forgiveness are withheld during social conflicts, self-esteem becomes increasingly erratic, vulnerable, and dependent on external validation (Susilawati et al., 2025).

Although daily stress reactivity was ranked as the least influential among the primary predictors in the *LSTM* model, it nonetheless contributed significantly to the forecasting accuracy of the network. This finding is consistent with extensive developmental literature establishing self-esteem as a critical mediator between environmental stress and broader psychological well-being. Academic pressures and family stressors exert their depressogenic effects largely by systematically eroding a youth's internal sense of self-efficacy, future orientation, and self-esteem (Kim et al., 2019; Kim & Kim, 2024). A robust, stable sense of baseline self-esteem typically serves as an essential protective buffer against psychopathology when individuals confront these unavoidable stressful life events (Fiorilli et al., 2019; Gurung et al., 2019). The neural network's ability to utilize daily stress to predict instability highlights that it is not necessarily the occurrence of the stressor itself, but the individual's inability to cope with it, that drives self-worth fluctuations. Furthermore, our ablation study revealed a critical 48-hour window (the  $t - 8$  look-back period) as the optimal timeframe for predicting instability. This suggests a specific temporal "half-life" to the psychological impact of daily stressors and interpersonal friction. If an individual lacks the positive psychological capital to adaptively cope with these stressors (Almurumudhe et al., 2024), or if they are in a transitional phase requiring significant institutional adjustment (Ofem, 2023), the residual emotional turbulence from a stressful event can reverberate through their psyche for up to two full days, manifesting as pronounced self-esteem instability. Consequently, interventions aimed at mitigating this reactivity, such as targeted school-based resilience programs or momentary mindfulness training, must account for this acute temporal window to effectively stabilize self-esteem before it deteriorates into chronic psychological distress (Ebrahimi & Mousavian Khatir, 2023; Llistosella et al., 2023). Naturally, the foundational psychological architecture required to navigate these 48-hour emotional storms is often laid in early childhood; early

family environments characterized by warmth and unconditioned acceptance are fundamentally necessary to prevent the long-term self-esteem instability that we observed reacting to daily stressors in adulthood (Chong et al., 2014).

## 5. Conclusion

In conclusion, the present study demonstrates the profound utility of integrating Ecological Momentary Assessment with advanced deep learning architectures to decode the complex, dynamic nature of self-esteem instability. By leveraging a Long Short-Term Memory (*LSTM*) neural network, we successfully mapped the non-linear and temporally dependent fluctuations of state self-esteem, achieving a robust predictive accuracy ( $R^2 = 0.61$ ) that vastly surpasses traditional linear models. The identification of momentary emotional reactivity and trait rejection sensitivity as the primary drivers of instability, coupled with the discovery of a critical 48-hour predictive window, highlights the delicate interplay between enduring psychological vulnerabilities and daily socio-environmental stressors. Ultimately, these findings not only advance our theoretical understanding of self-esteem as a highly reactive psychological state rather than a static trait, but they also lay the vital computational groundwork for the development of personalized, real-time digital interventions capable of preemptively stabilizing an individual's self-worth before clinical psychological distress occurs.

## 6. Limitations & Suggestions

Despite the robust predictive capabilities of the proposed computational model, several methodological limitations must be acknowledged when interpreting the findings of the present study. First, the reliance on ecological momentary assessment inherently demands high participant compliance and introduces the potential for self-report bias, fatigue, and momentary reactivity. Although abbreviated scales were utilized to minimize burden, the act of repeatedly reflecting upon and reporting one's emotional state and self-esteem multiple times a day may inadvertently alter the natural trajectory of those very variables. Second, while the *LSTM* architecture successfully captured complex, non-linear relationships, deep learning models are notoriously opaque. The "black box" nature of these complex neural networks makes it mathematically challenging to extract the precise, directional, mechanistic pathways through which specific variables interact at distinct time points, limiting our

ability to draw definitive causal inferences. Finally, the sample, while adequately powered for deep learning applications, was restricted to young adults from a specific geographic and cultural context in Spain, possessing sufficient digital literacy and smartphone access. This homogeneity restricts the generalizability of the trained algorithms to broader demographic populations, older adults, or individuals residing in drastically different sociocultural environments where the determinants and expressions of self-esteem may vastly differ.

Future research should build upon these findings by expanding the technological and methodological horizons of the current study. Researchers should prioritize the integration of passive, objective multimodal data streams alongside active ecological momentary assessment. Incorporating continuous physiological markers, such as ambulatory heart rate variability or galvanic skin response, could provide an objective biological correlate to the subjective reporting of emotional reactivity and daily stress, thereby enriching the predictive feature space for the neural networks. Additionally, future studies should extend the longitudinal tracking periods beyond twenty-one days to capture broader seasonal variations and longer-term macrofluctuations in self-esteem. From a computational perspective, future research should explore and benchmark alternative, state-of-the-art deep learning architectures, such as Transformer models equipped with self-attention mechanisms. These advanced architectures might offer deeper, more interpretable insights into exactly which specific historical prompts and psychological events the model is focusing on when predicting an impending collapse in self-esteem, thereby illuminating the precise temporal distance of psychological triggers.

The practical implications of deploying predictive deep learning models in psychological science are profound, particularly for the future of personalized mental health care and clinical interventions. By confirming that self-esteem instability can be accurately forecasted within a 48-hour window using continuous data, this study lays the critical algorithmic groundwork for the development of Just-In-Time Adaptive Interventions. Mental health applications running on smartphones could utilize a lightweight version of this trained *LSTM* model to continuously monitor an individual's incoming psychological data. When the algorithm detects a highly toxic combination of daily stress, negative social feedback, and heightened emotional reactivity that crosses a critical threshold, it could automatically deploy an immediate, personalized digital

intervention—such as a cognitive behavioral restructuring exercise or a brief mindfulness prompt—precisely when the individual is most vulnerable, preemptively stabilizing their self-esteem before a depressive cascade occurs. Furthermore, in clinical therapeutic settings, providing therapists with an objective, algorithmically generated dashboard mapping their client's complex self-esteem volatility could revolutionize treatment planning, allowing practitioners to tailor their sessions to the specific temporal triggers and emotional patterns unique to the individual's lived experience.

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### Declaration of Interest

The authors of this article declared no conflict of interest.

### Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

### Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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### Authors' Contributions

All authors equally contributed to this article.

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