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Identification of Spontaneous Thought Dynamic Patterns as Transdiagnostic Markers for Burnout Risk in Students

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ABSTRACT

with repetitive negative thinking (RNT) and other cognitive processes. This study examined whether spontaneous thought dynamics, including RNT, thought persistence, entropy, and self-focus, could serve as transdiagnostic markers of burnout risk. A quantitative cross-sectional correlational study involved 240 university students (mean age = 20.61 years, SD = 1.31; 67.9% female). Data were analyzed using Spearman correlation, Mann–Whitney U tests, multiple linear regression, binary logistic regression, and Receiver Operating Characteristic (ROC) analysis. RNT (ρ = .74), thought persistence (ρ = .75), and self-focus (ρ = .56) were positively correlated with burnout (all p < .001), whereas entropy was negatively correlated (ρ = −.44, p < .001). Multiple regression explained 76.2% of burnout variance (R^2 = .762; F = 92.61; p < .001), with RNT, persistence, entropy, stress, and sleep duration as significant predictors. Logistic regression identified RNT (OR = 2498, p = .043) and persistence (OR = 3.17, p = .008) as significant correlates of high burnout risk (Nagelkerke R^2 = .49). The composite marker demonstrated high discriminative accuracy (AUC = .864). These findings suggest that spontaneous thought dynamics may represent potential transdiagnostic markers of burnout risk, warranting external validation before integration into digital screening tools in higher education.

INTRODUCTION

Academic burnout has become one of the most widely studied mental health issues in higher education psychology over the past decade. Recent evidence syntheses indicate that burnout is common among university students worldwide, including in low- and middle-income countries (Abraham et al., 2024; Kaggwa et al., 2021); a systematic review using the three-dimensional framework estimated prevalence at 55.4% for emotional exhaustion, 31.6% for cynicism, and 30.9% for reduced academic efficacy (Rosales-Ricardo et al., 2021). This condition is

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characterized by three main dimensions: emotional exhaustion (exhaustion), cynicism or depersonalization toward studies (cynicism), and reduced academic efficacy (reduced efficacy), as formulated in the Maslach Burnout Inventory–Student Survey (MBI-SS) framework (Schaufeli et al., 2002). Increasing academic pressure, performance demands, and the transition to a more competitive learning environment make college students a vulnerable population to burnout, with consequences for decreased academic achievement, learning motivation, and overall psychological well-being. Recent research confirms that academic stress contributes significantly to increased student burnout, both directly and through mediating mechanisms such as low social support and fragile self-esteem (Gao, 2023; Zhang et al., 2025).

One important development in contemporary psychopathology is the paradigm shift from a categorical diagnostic approach to a transdiagnostic approach, which starts from the assumption that various psychological disorders share common cognitive and emotional processes (Nolen-Hoeksema & Watkins, 2011). One of the most widely researched transdiagnostic processes is repetitive negative thinking (RNT), a pattern of thinking that is repetitive, passive, difficult to control, and focused on negative content, encompassing both rumination and worry (Ehring & Watkins, 2008). RNT has been shown to play a role in the onset, maintenance, and risk of relapse of various emotional disorders, including depression and anxiety (Ehring & Watkins, 2008; Luo et al., 2025), and continues to be a target for process-based interventions in transdiagnostic cognitive-behavioral psychotherapy. A recent meta-analysis confirmed that interventions specifically targeting RNT are effective in reducing emotional symptoms in young populations, strengthening RNT's position as a cross-disorder intervention target with high clinical value (Bell et al., 2023).

The transdiagnostic approach is theoretically relevant to academic burnout for several reasons. Burnout is understood as a response to chronic, unresolved demands in which emotional and cognitive resources are progressively depleted (Maslach & Leiter, 2016; Schaufeli et al., 2002). According to the perseverative cognition hypothesis, repetitive thinking about stressors prolongs stress-related affective and physiological activation beyond the presence of the stressor itself and may thereby hinder recovery (Brosschot et al., 2006). The Self-Regulatory Executive Function (S-REF) model further proposes that perseverative thinking, together with attentional focus on threat, maintains emotional distress across disorders (Wells & Matthews, 1996), and metacognition has been linked to academic burnout among university students (Sapancı, 2023). Empirically, rumination has been found to mediate the association between academic stress and burnout (Zuo et al., 2024). Taken together, these theoretical and empirical strands suggest that RNT, and the way repetitive thoughts persist over time, may be a shared process linking student burnout to the emotional disorders in which RNT is already established as a transdiagnostic factor.

However, most research on RNT as a transdiagnostic marker has focused solely on negative thought content, with relatively little exploration of the dynamic dimensions of the thought process itself. However, research in spontaneous cognition indicates that spontaneous thoughts possess dynamic characteristics that can be measured quantitatively, such as persistence (the extent to which thoughts remain on the same topic), topic entropy (the variability of shifts

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between thought topics), and degree of self-focus (Mildner & Tamir, 2024). Recent studies using natural language processing have shown that the dynamics of thought topic switching reflect specific adaptive functions, including memory optimization and ongoing goal orientation (Mildner & Tamir, 2024). Similarly, studies of the dynamics of conceptual associations have shown that spontaneous thoughts that are "stuck" in a particular pattern (stuck thought) can be distinguished from thoughts that flow flexibly (for example, individuals high in rumination remain longer in negative conceptual spaces; Andrews-Hanna et al., 2022), and this distinction is relevant to understanding psychopathology.

To avoid conceptual overlap, four related terms are distinguished in this study. Spontaneous thought is the broad category of thoughts that arise without strong deliberate constraints, of which mind wandering is one form (Christoff et al., 2016). Mind wandering refers to the shift of attention away from the task at hand or the external environment toward internally generated thought (Smallwood & Schooler, 2015). Repetitive negative thinking is defined by its negative content and its repetitive, difficult-to-control form, irrespective of whether the thought is task-related, and is a transdiagnostic process rather than a lapse of attention (Ehring & Watkins, 2008). Thought dynamics, finally, describe how thoughts unfold over time: how long they stay on a topic, how they move between topics, and how self-referential they are (Mildner & Tamir, 2024). Thought dynamics therefore cut across the other three constructs. In this study, RNT is treated as the content-and-repetition indicator, whereas persistence, entropy, and self-focus describe the temporal and referential structure of spontaneous thought.

In the context of student burnout, the idea that the dynamics of spontaneous thoughts—not just their content—can be a risk marker remains an area that has not been widely explored empirically in Indonesia. Indonesian studies on student burnout have mostly described its levels or examined its association with psychosocial variables such as academic engagement, using self-report questionnaires (Amarsa et al., 2023; Sari et al., 2025), while Indonesian research on rumination among students has focused on outcomes such as academic achievement and cyberchondria (Gauw & Kartasasmita, 2016; Salim et al., 2024). To our knowledge, no Indonesian study has examined how the temporal dynamics of spontaneous thought relate to academic burnout. Several studies have demonstrated a link between mind wandering and burnout among students, including the mediating role of internet addiction and the moderating role of resilience (Wang, 2023). However, these studies generally measure mind wandering as a single construct and have not dissected its dynamic dimensions separately. Another study found that rumination mediates the relationship between academic stress and burnout, moderated by neuroticism (Zuo et al., 2024), supporting the hypothesis that repetitive thought processes may be closely involved in burnout, not merely as an accompanying symptom but as a process potentially implicated in its development, although causal direction cannot be inferred from such correlational designs. A machine learning-based approach in psychology students also confirmed that burnout risk profiles can be accurately predicted from a combination of psychological and lifestyle variables (Pereira et

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al., 2025), opening up opportunities for the development of more precise, data-driven screening models.

Taken together, the literature points to a specific gap. Research linking repetitive thinking to burnout has relied mainly on retrospective self-report measures of rumination or of mind wandering as a single construct, and the temporal dynamics of spontaneous thought have rarely been examined as markers of academic burnout. The present study addresses this gap by combining four indicators within one task-based assessment. The added value of this combination is that RNT captures what students think about (negative, repetitive content), persistence and entropy capture how their thoughts move (stuck versus flexible), and self-focus captures where attention is directed, so that the incremental contribution of each indicator can be evaluated in the same statistical models and as a composite marker. In addition, deriving these indicators from a thought-sampling task rather than from a retrospective questionnaire offers a perspective that is complementary to self-report measures of burnout.

Based on this description, this study aimed to answer the question of whether spontaneous thought dynamics patterns—operationalized through four indicators: RNT, thought persistence, entropy, and self-focus—can serve as transdiagnostic markers for burnout risk in college students. This study examined three main issues: (1) the strength of the relationship between each spontaneous thought dynamics indicator and the dimensions of burnout; (2) differences in spontaneous thought dynamics patterns between high- and low-risk groups of students experiencing burnout; and (3) the extent to which spontaneous thought dynamics are statistically associated with burnout risk status (multiple linear and logistic regression) and discriminate between high- and low-risk students (ROC analysis), both individually and as a composite marker. The terms "predictive" and "predictor" are used here in the statistical sense of a cross-sectional model and do not imply temporal or causal prediction. Theoretically, this study is expected to enrich the framework of transdiagnostic processes by extending RNT-focused models to academic burnout and by showing whether process-level indicators of spontaneous thought (persistence, entropy, and self-focus) add information beyond the content-based construct of RNT. Practically, the findings are expected to be useful in three ways. First, for early identification, brief task-based indicators of thought dynamics could complement self-report questionnaires in identifying students at elevated risk of burnout, subject to external validation. Second, for intervention, if the associations are replicated in longitudinal work, high thought persistence and low thought variability could direct counselors toward process-focused strategies, such as RNT-targeted, metacognitive, and mindfulness-based approaches, including digital tools (Bell et al., 2023; Martens et al., 2026; Sapancı, 2023; Valentine et al., 2024). Third, for university mental health services in Indonesia, the approach could provide an additional low-burden source of information for counseling units, alongside conventional instruments.

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METHODS

This study employed a quantitative correlational design with a cross-sectional approach. This design was chosen to identify patterns of relationships between spontaneous thought dynamics indicators and dimensions of academic burnout at a single measurement point, while also testing the discriminatory ability of these indicators to predict burnout risk status through a group comparison approach and predictive analysis. Because all variables were measured at a single time point, the design identifies associations rather than causal or temporal relationships; terms such as "predictor" and "predict" are therefore used in a purely statistical sense.

The study participants were 240 active undergraduate students, with a mean age of 20.61 years (SD = 1.31; range 18.0–23.9 years). Of these, 163 participants (67.9%) were female and the remainder male. Based on the burnout risk status categorization determined from the combination of emotional exhaustion, cynicism, and academic efficacy scores on the MBI-SS, 60 participants (25.0%) were classified as high-risk, while 180 participants (75.0%) were classified as low-risk. Sampling was conducted using a convenience sampling technique through an online survey, with inclusion criteria being active student status and willingness to fully follow the data collection procedure. Convenience sampling limits the representativeness of the sample and therefore the generalizability of the findings; this is acknowledged as a limitation in the Discussion.

Spontaneous thought dynamics were measured using four indicators obtained from a computerized thought-sampling task, following an approach developed in natural language processing-based spontaneous thought dynamics research (Mildner & Tamir, 2024). The four indicators are: (1) Repetitive Negative Thinking (RNT) the proportion of negatively charged and repetitive thought episodes during the sampling session, with a score range of 0–1, with higher scores indicating a greater predominance of negative-repetitive thought patterns; (2) Thought Persistence an index of the average duration of thoughts lingering on the same topic before shifting to another, interpreted as a proxy for cognitive rigidity; (3) Entropy a measure of the variability or randomness of thought topic shifts calculated based on the probability distribution of transitions between topics, with higher scores indicating greater variability of thought topics, which is interpreted here as a proxy for cognitive flexibility and exploration rather than as a direct measure of flexibility; and (4) Self-focus the proportion of self-referential thought episodes compared to externally oriented thoughts.

Subjective stress levels were measured using a perceived stress scale ranging from 1–5. Sleep duration was measured through a single self-report item on the average number of hours of sleep per night Stress, sleep duration, age, and gender were entered as covariates because perceived stress is a well-established antecedent of student burnout (Gao, 2023; Zhang et al., 2025), lifestyle factors such as sleep have been shown to contribute to burnout risk profiles in students (Pereira et al., 2025), and age and gender are standard demographic controls, with gender differences documented in rumination (Johnson & Whisman, 2013). Academic burnout was measured using an adaptation of the Maslach Burnout Inventory Student Survey (MBI-SS), which yields scores on three subscales emotional exhaustion (exhaustion), cynicism (cyn), and academic

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efficacy (eff, with higher scores indicating greater efficacy) — as well as a total burnout score as a composite index. The MBI-SS consists of 15 items rated on a 7-point frequency scale (0 = never to 6 = every day); example items are "I feel emotionally drained by my studies" (exhaustion), "I have become less interested in my studies since my enrolment at the university" (cynicism), and "I can effectively solve the problems that arise in my studies" (efficacy) (Schaufeli et al., 2002). The MBI-SS was developed by Schaufeli et al. (2002), and its factorial validity and reliability have been supported in student samples from Europe, China, Thailand, and Sri Lanka (Hu & Schaufeli, 2009; López-Gómez et al., 2025; Schaufeli et al., 2002; Wickramasinghe et al., 2018). Indonesian adaptations have been reported for other burnout instruments (Damayanti & Aulia, 2025; Moelyo & Hanafi, 2022);. Burnout risk status (high risk) was operationalized as a binary variable based on clinical thresholds on the combination of the three subscales, in line with the criterion-based cut-off approach of "exhaustion plus one other subscale" commonly used in the MBI-SS literature. For reference, clinically validated cut-offs for the 15-item MBI-SS (sum scores) have been proposed as 12.5 for exhaustion, 7.5 for cynicism, and 10.5 for reduced efficacy under the "exhaustion + 1" criterion (Wickramasinghe et al., 2018), whereas other studies have used the 75th percentile (Galán et al., 2011) or the 66th percentile (Oliva Costa et al., 2012) of the subscale distributions.

Data collection was conducted online, first explaining the research objectives and obtaining informed consent from each participant. Participants independently completed a mind-sampling task, followed by questionnaires on stress, sleep duration, and academic burnout. All collected data were checked for completeness before analysis; no missing data were found in the final files, so all 240 cases were included in the analysis.

Data analysis was conducted in stages using the Python 3 programming language with the pandas, SciPy, statsmodels, and scikit-learn libraries. The first stage was a descriptive analysis to obtain an overview of the means and standard deviations of all variables, followed by a Shapiro-Wilk normality test to determine the appropriate type of further statistical test. The Shapiro–Wilk test was preferred over the Kolmogorov–Smirnov test because it has greater statistical power to detect departures from normality across a wide range of distributions and sample sizes, whereas the Kolmogorov–Smirnov test has low power and is not recommended when the mean and standard deviation are estimated from the sample, even with the Lilliefors correction (Ghasemi & Zahediasl, 2012; Razali & Wah, 2011). Because significance tests of normality become sensitive to small departures as the sample grows, the choice between parametric and nonparametric procedures was not based on p-values alone but also on the measurement level (bounded scale scores and proportions), the shape of the distributions, and the sample size (Fagerland, 2012; Ghasemi & Zahediasl, 2012). Because some variables (RNT, persistence, stress, and total burnout) showed statistically significant, although small, deviations from normality ($W \geq 0.981$; $p < 0.05$), and several variables were bounded scores, correlation analysis was performed using the Spearman correlation coefficient (rho), and intergroup comparisons used the nonparametric Mann-Whitney U test with rank-biserial correlation effect size estimation (interpreted with the

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benchmarks of 0.10, 0.30, and 0.50 for small, moderate, and large effects, respectively; Cohen, 1992).

The next stage was a multiple linear regression analysis (Ordinary Least Squares) to examine the simultaneous contribution of the four spontaneous thought dynamics indicators to the total burnout score, controlling for stress, sleep duration, age, and gender as covariates. The assumption of multicollinearity was checked using the Variance Inflation Factor (VIF), with a VIF threshold < 10 considered acceptable. Next, a binary logistic regression analysis was conducted to predict high-risk burnout status based on spontaneous thought dynamics, stress, and sleep duration indicators, with results reported as odds ratios (OR) along with 95% confidence intervals. Finally, the discriminatory ability of the spontaneous thought dynamics indicators—both individually and as a standardized composite score (the average z-score of all four indicators) was evaluated using Receiver Operating Characteristic (ROC) analysis by calculating the Area Under the Curve (AUC) as an index of classification accuracy. AUC values were interpreted with the conventional benchmarks (0.70–0.80 acceptable, 0.80–0.90 excellent, ≥ 0.90 outstanding; Hosmer et al., 2013). All statistical tests used a significance level of $\alpha = 0.05$.

RESULTS

1. Descriptive Statistics and Normality Test

Table 1 presents descriptive statistics and the results of the Shapiro-Wilk normality test for all study variables. The test results indicate that the RNT, persistent thoughts, stress, and total burnout variables deviated significantly from a normal distribution ($p < 0.05$), while the entropy, self-focus, sleep duration, emotional exhaustion, cynicism, and academic efficacy variables did not show significant deviations from normality ($p > 0.05$). Based on these findings, correlation analysis and group comparisons in the next stage used a nonparametric statistical approach. The W statistics of the four non-normal variables were close to 1 (0.981–0.987), indicating that the deviations, although statistically significant, were small in magnitude; the nonparametric approach was retained as a conservative option (see Data analysis).

Table 1. Descriptive Statistics and Normality Test of Research Variables (N = 240)

Variables	M	SD	Min	Max	Shapiro-Wilk (W)	p	Distribution
Age (years)	20.606	1.314	18.00	23.95	-	-	-
Sleep duration (hours)	6.555	1.030	4.00	9.00	0.995	0.544	Normal
RNT	0.275	0.110	0.03	0.53	0.987	0.030	Non-normal
Thought Persistence	1.932	0.797	0.50	4.12	0.986	0.017	Non-normal
Entropy	2.120	0.500	0.71	3.50	0.998	0.995	Normal
Self-focus	0.435	0.171	0.05	0.90	0.995	0.635	Normal
Stress	2.761	0.971	1.00	5.00	0.981	0.003	Non-normal
Total burnout	2.273	1.248	0.00	6.00	0.985	0.015	Non-normal

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Emotional exhaustion	2.451	1.071	0.00	5.42	0.993	0.310	Normal
Cynicism	1.875	0.864	0.00	4.01	0.991	0.154	Normal
Academic efficacy	4.433	0.745	2.44	6.00	0.992	0.182	Normal

In general, the mean RNT score of participants was classified as moderate-low (M = 0.275; SD = 0.110) with a score range of 0–1, while the mean total burnout score (M = 2.273; SD = 1.248) was in the moderate category when referring to the score range of 0–6. Of the 240 participants, 60 people (25.0%) were classified into the high-risk group for burnout.

2. The Relationship between Spontaneous Thought Dynamics and Burnout Dimensions

Spearman correlation analysis revealed a consistent pattern of relationships between indicators of spontaneous thought dynamics and all dimensions of burnout (Table 2, Figure 1). RNT and thought persistence showed strong positive correlations with total burnout (rho = 0.740 and rho = 0.747; both $p < 0.001$), as did self-focus (rho = 0.564; $p < 0.001$). In contrast, entropy showed a negative correlation with total burnout (rho = -0.440; $p < 0.001$), indicating that the higher the variability or flexibility of thought topics, the lower the reported level of burnout. According to Cohen's (1992) benchmarks, rho values of 0.74, 0.75, and 0.56 represent large associations and −0.44 a medium-to-large association. These coefficients describe associations only and do not indicate the direction of influence.

Table 2. Spearman Correlation Coefficients between Spontaneous Thought Dynamics Indicators and Burnout Dimensions

Mind Dynamics Indicator	Total Burnout	Emotional Exhaustion	Cynicism	Efficacy
RNT	0.740**	0.601**	0.627**	-0.468**
Thought Persistence	0.747**	0.671**	0.603**	-0.521**
Entropy	-0.440**	-0.358**	-0.350**	0.220**
Self-Focus	0.564**	0.479**	0.475**	-0.409**

Note: ** $p < 0.001$. All coefficients in Table 2 are significant at the $p < 0.001$ level.

The same pattern was seen across all subdimensions of burnout, with the correlation coefficients of RNT and persistence of thoughts consistently being strongest for the dimensions of emotional exhaustion and cynicism, while entropy showed a positive correlation with academic efficacy (rho = 0.220; $p < 0.001$), indicating that greater variability of thought topics was associated with a higher sense of academic competence.

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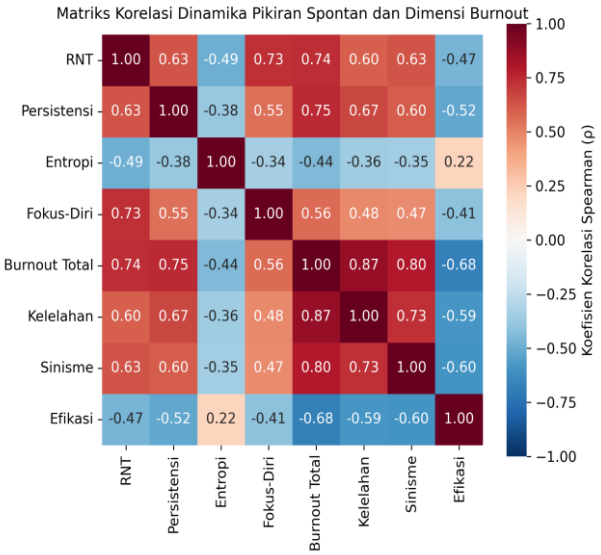


Figure 1. Spearman Correlation Matrix between Spontaneous Thought Dynamics Indicators and Burnout Dimensions

3. Differences in Spontaneous Thought Dynamics between Risk Groups

The Mann-Whitney U test was used to compare scores of the four indicators of spontaneous thought dynamics between the low-risk (n = 180) and high-risk (n = 60) burnout groups. The results in Table 3 and Figure 2 show that the high-risk group had significantly higher RNT, thought persistence, and self-focus scores than the low-risk group, with large effect sizes ($r \geq 0.50$; Cohen, 1992) for RNT ($r = 0.729$), thought persistence ($r = 0.737$), and self-focus ($r = 0.562$). In contrast, the high-risk group showed significantly lower entropy scores, with a moderate effect size ($r = 0.369$).

Table 3. Comparison of Spontaneous Thought Dynamics Scores between Low-Risk and High-Risk Burnout Groups (Mann-Whitney U Test)

Indicator	M (SD) Low Risk (n=180)	M (SD) High Risk (n=60)	U	p	r (rank-biserial)
RNT	0.241 (0.099)	0.376 (0.074)	9336.0	< 0.001	0.729
Thought Persistence	1.677 (0.683)	2.699 (0.600)	9381.0	< 0.001	0.737
Entropy	2.201 (0.491)	1.879 (0.449)	3407.0	< 0.001	0.369
Self-focus	0.393 (0.159)	0.561 (0.143)	8435.0	< 0.001	0.562

4. Multiple Linear Regression

Multiple linear regression (Table 4) examined the simultaneous statistical association of the four thought-dynamics indicators with total burnout, controlling for stress, sleep duration, age, and gender. The model was statistically significant and accounted for 76.2% of the variance in total burnout ($R^2 = .762$; adjusted $R^2 \approx .75$; $F(8, 231) = 92.61$, $p < .001$). RNT, thought persistence, entropy,

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stress, and sleep duration were significant predictors, whereas the contribution of self-focus was not significant.

5. Binary Logistic Regression

Binary logistic regression (Table 5) modeled membership in the high-risk group (n = 60) versus the low-risk group (n = 180). RNT (OR = 2,498; p = .043) and thought persistence (OR = 3.17; p = .008) were significantly associated with higher odds of high-risk status, whereas entropy and self-focus were not significant in the combined models. The model accounted for 49% of the variance (Nagelkerke R^2 = .49). The very large OR for RNT reflects the 0–1 range of the RNT score

6. ROC Analysis and Composite Marker

ROC analysis (Table 6) showed that the composite spontaneous-thought-dynamics score discriminated between high- and low-risk students with an AUC of .864, which falls in the range (0.80–0.90) conventionally described as excellent discrimination (Hosmer et al., 2013); this estimate was obtained in the same sample without cross-validation.

DISCUSSION

This study aimed to identify whether spontaneous thought dynamics patterns can serve as transdiagnostic markers for burnout risk in college students. Overall, the findings are consistent with the three research objectives: spontaneous thought dynamics indicators correlate systematically with all dimensions of burnout, high-risk groups exhibit significantly different thought dynamics patterns than low-risk groups, and the combination of these indicators is associated with, and discriminates between, burnout risk groups.

The finding that RNT and thought persistence were the strongest statistical predictors of burnout in this sample, across correlation, group comparison, linear regression, and logistic regression analyses, aligns with the transdiagnostic framework that positions RNT as a core process underlying various forms of emotional psychopathology (Ehring & Watkins, 2008; Nolen-Hoeksema & Watkins, 2011). As highlighted in meta-analyses of the effectiveness of RNT-based interventions in young populations, repetitive and difficult-to-control thought patterns may be not simply accompanying symptoms of a disorder but processes that help maintain negative emotional states (Bell et al., 2023). In the context of academic burnout, these findings expand the scope of RNT's application from the realm of mood and anxiety disorders to academic exhaustion, suggesting that similar cognitive processes may be relevant to clinically distinct phenomena. This is consistent with the transdiagnostic perspective, but correlational data alone cannot validate the transdiagnostic concept itself.

Several psychological processes may explain why RNT and thought persistence emerged as the strongest statistical predictors. First, according to the perseverative cognition hypothesis, repetitive thinking about stressors prolongs affective and physiological activation after the stressor has passed (Brosschot et al., 2006); for students facing continuous academic demands, thoughts

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that remain on the same negative topic may keep them in a state of arousal that hampers recovery, which corresponds to the exhaustion component of burnout. Second, repetitive negative thinking about study-related failure and evaluation tends to be abstract and evaluative rather than concrete and problem-focused, which impairs problem solving (Watkins, 2008); repeated experiences of unresolved study problems may in turn erode academic efficacy and encourage cynical disengagement as a way of avoiding further distress. Third, from the S-REF perspective, persistent attention to self-referential negative thoughts may consume limited self-regulatory resources that would otherwise support studying (Wells & Matthews, 1996). RNT and persistence index these processes at complementary levels, namely negative and repetitive content and the difficulty of disengaging from a topic, which may explain why they carried most of the explanatory weight while entropy and self-focus contributed less once all indicators were included. Finally, the relationship is probably bidirectional: exhausted students may have fewer cognitive resources to disengage from negative thoughts, and part of the observed association may reflect shared negative affect between the thought-sampling indicators and the self-reported burnout items. Longitudinal and experimental studies are needed to distinguish these possibilities.

The significant contribution of thought persistence also aligns with the finding that rumination mediates the relationship between academic stress and burnout, with a moderating effect of neuroticism (Zuo et al., 2024). High levels of thought persistence may be understood as a behavioral index related to this ruminative tendency—that is, the inability to disengage from a particular thought topic, which may in turn drain cognitive and emotional resources needed for self-regulation and academic task completion. From a Self-Regulatory Executive Function (S-REF) perspective, this pattern is consistent with the idea that metacognitive dysfunction—in this case, the inability to adaptively shift thought focus—may be linked to higher academic burnout through reduced self-regulatory capacity, although this pathway was not tested here (Sapancı, 2023; Wells & Matthews, 1996).

Conversely, entropy showed the opposite pattern of relationship, with higher variability and flexibility of thought topics, lower levels of burnout and higher reported academic efficacy. This finding is consistent with the idea in studies of spontaneous thought dynamics that more flexible shifting of thought topics reflects more adaptive cognitive processes, including exploratory functions and memory optimization (Mildner & Tamir, 2024). In the context of psychopathology, thoughts that are "stuck" on a particular pattern or topic (stuck thought) have been associated with maladaptive processes, whereas thoughts that flow flexibly between topics tend to reflect healthier cognitive regulation capacities. However, the independent contribution of entropy was no longer significant in the combined logistic regression model, indicating that its association with lower burnout is largely shared with RNT and thought persistence rather than independent of them. It should also be noted that entropy, as computed here, is a statistical property of topic transitions and is not equivalent to cognitive flexibility as a psychological construct (for example, set-shifting ability); its interpretation as flexibility remains a hypothesis that requires convergent evidence from established flexibility measures.

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The findings regarding self-focus revealed an interesting pattern: although it correlated significantly with all burnout dimensions in the bivariate analysis and showed significant differences between risk groups, its contribution became insignificant after RNT and thought persistence were simultaneously entered into the model. This pattern suggests that self-focus may overlap substantially with the RNT process, given that rumination involves self-focused attention and negative emotional experiences (Ehring & Watkins, 2008), so that its shared variance is largely absorbed by the RNT and persistence indicators; the present data cannot determine whether self-focus is a component of RNT or merely a correlate of it. These findings provide an important nuance for future research: of the four indicators of spontaneous thought dynamics tested, RNT and persistence appear to be the more informative candidate markers, while self-focus may add little beyond them.

Consistent with the correlational pattern, students classified as high-risk showed higher RNT, thought persistence, and self-focus and lower entropy than low-risk students, with large effect sizes for RNT, persistence, and self-focus and a moderate effect size for entropy. Because the risk groups were defined from MBI-SS scores collected at the same time, these differences describe how the groups differ at a single time point and do not show that thought dynamics precede or cause burnout. In addition, the risk classification depends on the cut-off criteria used (see Methods), so the magnitude of the group differences may vary with the classification approach.

The composite marker of spontaneous thought dynamics showed high discrimination in this sample (AUC = 0.864, in the range described as excellent by Hosmer et al., 2013), which suggests potential practical relevance. This estimate was obtained in the same sample used to build the model, without external validation, and may therefore be optimistic. These findings align with machine learning-based research in psychology students showing that burnout risk profiles can be accurately identified through a combination of psychological variables, including psychological well-being, distress, and sleep quality (Pereira et al., 2025). This study extends these findings by suggesting that thought process dynamics—which can be measured relatively briefly through a thought-sampling task—may offer comparable, and potentially more economical, discrimination than longer psychological instrument batteries, although this comparison was not tested directly. This suggests a potential, yet to be validated, role for digital process-based tools (Martens et al., 2026; Valentine et al., 2024). Before any institutional or clinical screening use can be recommended, external validation in independent samples and prospective, longitudinal studies are necessary.

Several limitations should be acknowledged. First, the cross-sectional design precludes causal and temporal inferences, and the associations may be bidirectional, because exhaustion may itself impair cognitive control and thereby increase repetitive negative thinking. Second, participants were recruited through convenience sampling using an online survey, which may limit representativeness and generalizability beyond similar student populations. Third, burnout risk status was derived from self-report scores and cut-offs, and the thought-dynamics indicators, stress, and sleep were obtained in the same online session, so shared method variance and

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common state influences may have inflated the associations; sleep was assessed with a single item on duration. Fourth, the AUC was estimated in the same sample without cross-validation, and the number of high-risk cases (n = 60) limits the number of predictors that can be reliably included in the logistic model (Peduzzi et al., 1996). Fifth, further evidence is needed on the reliability and validity of the thought-sampling indicators. Future research should therefore use longitudinal or ecological momentary assessment designs, larger and more diverse student samples, and external validation and replication before these indicators are considered for screening or intervention purposes.

CONCLUSIONS

This study found that indicators of spontaneous thought dynamics (repetitive negative thinking [RNT], thought persistence, entropy, and self-focus) were systematically associated with academic burnout among university students. RNT and thought persistence showed the strongest associations across burnout dimensions, whereas entropy was negatively associated with burnout. In the multiple regression model, the four indicators together with stress, sleep duration, age, and gender accounted for 76.2% of the variance in total burnout (R^2 = .762), and a composite thought-dynamics score discriminated high-risk from low-risk students with an AUC of .864 in this sample. These results identify spontaneous thought dynamics as potential transdiagnostic markers of burnout risk. Because the design was cross-sectional and the sample was a convenience sample, however, they do not establish causal or temporal relationships.

Theoretically, the findings extend the transdiagnostic RNT framework from mood and anxiety disorders to academic burnout and highlight the value of examining how thoughts unfold over time, and not only what they contain. Practically, the findings point to a potential application: brief, process-based assessments of thought dynamics could complement conventional self-report instruments in the early identification of students at risk and in guiding counseling and mental health services in higher education. This should be regarded as a potential application rather than an established screening tool.

Future research should test these findings with longitudinal or ecological momentary assessment designs, larger and more diverse student samples, and external validation and replication before screening or intervention tools are developed.

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