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Adolescent Psychological Adaptation: The Impact of Daily Levels and Instability in Psychological Need Satisfaction and Frustration

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ABSTRACT

Introduction: Psychological need satisfaction and frustration are distinct processes that have unique effects on adolescents' psychological adaptation. Beyond their average levels, psychological satisfaction and frustration exhibit meaningful daily instability that is expected to have implications for adolescents' psychological adaptation. However, research directly examining both average levels and instability in psychological need satisfaction and frustration is rare.

Methods: A sample of 107 adolescents (ages 11–18; 38.3% female; 64.5% White/European American) across the United States was recruited via an online survey during 2020–2023. Using a 30-day diary and long-term design, this study aimed to capture both the level and instability of psychological need satisfaction and frustration, and their implications for adolescents' psychological adaptation (indicated by emotion regulation, resiliency, mental health, and self-esteem) 6 months later.

Results: Psychological need satisfaction and frustration played distinct roles in adolescents' psychological adaptation: levels of autonomy and relatedness satisfaction, as well as levels of competence frustration, consistently predict overall adolescent psychological adaptation 6 months later. Beyond levels, instability in autonomy frustration predicted adolescents' emotion regulation, resiliency, and mental health; instability in relatedness frustration predicted adolescents' mental health.

Conclusions: Results emphasized the importance of simultaneously considering the differential roles of satisfaction and frustration in each psychological need. Also, findings highlighted the necessity of considering the dynamic nature of psychological needs.

1 | Introduction

Successful psychological adaptation during adolescence lays the foundation for long-term outcomes in adulthood, including better educational and career success, reduced risk-taking behaviors, and improved physical and mental health (Blakemore 2019; Masten et al. 2010). Each psychological need (i.e., autonomy, competence, and relatedness) is considered a robust and important predictor of adolescents' psychological adaptation (Chacón-Cuberos et al. 2021; Chen et al. 2015). However, little is known about how daily fluctuations in psychological need satisfaction and frustration impact adolescents' adaptation over time. We

aimed to examine how the level and instability of three psychological needs prospectively link to adolescents' psychological adaptation.

2 | Psychological Adaptation During Adolescence

Psychological adaptation in adolescence is a dynamic process through which adolescents navigate challenges to achieve positive psychological well-being (Compas et al. 2001; Livneh and Martz 2014). To capture both the navigation process and the achievement of successful psychological adaptation, this study focused on four indicators: emotion regulation, resiliency, mental health, and self-esteem.

Emotion regulation and resiliency are two indicators reflecting the navigation process of adolescent psychological adaption (Cracco et al. 2017; Masten 2014). Emotion regulation, defined as the ability to recognize, understand, and manage emotions effectively, is particularly important for dealing with intense emotional fluctuations during adolescence (Zimmermann and Iwanski 2014). Adolescents with greater emotion regulation are better able to align their behavior with both social and personal goals, allowing them to maintain emotional stability, navigate stress effectively, and ultimately achieve positive well-being (Zeman et al. 2006). Resiliency, defined as the general psychological capacity to adapt to previous adverse experiences, is critical for maintaining positive development during adolescence, a developmental period marked by numerous stressors and setbacks (Smith et al. 2008). Resilient adolescents can navigate stressors and continue progressing toward their goals despite obstacles, thereby enhancing their coping abilities and maintaining psychological well-being (Luthar et al. 2000; Masten 2014).

Mental health and self-esteem are two indicators reflecting the achievement of successful psychological adaption during adolescence (Feldman 2010; Steca et al. 2011). Mental health, conceptualized as the absence of psychological distress and the presence of overall psychological well-being (Berwick et al. 1991), is a critical hallmark of successful psychological adaptations for adolescents who are in a development stage with increased vulnerability to mental disorders (Blakemore 2019). Self-esteem, closely tied to identity formation, represents an individual's sense of self-worth and value (Gecas and Schwalbe 1986). Given its considerable variability during adolescence, high self-esteem is a crucial indicator of successful psychological adaptation – specifically, maintaining a positive self-image even when facing challenges (Orth and Robins 2014).

Overall, adolescent successful psychological adaptation is marked by the ways in which adolescents regulate their emotions, possess resiliency, maintain mental health, and develop healthy self-esteem.

3 | Three Psychological Needs in Self-Determination Theory

According to self-determination theory, autonomy, competence, and relatedness are three fundamental psychological needs whose satisfaction results in optimal psychological adaptation (Deci and Ryan 2000). Both the theoretical framework and empirical findings highlight the importance of exploring these needs separately. Theoretically, self-determination theory proposes that each need has distinct meanings and functions separately. Specifically, autonomy refers to experiences of self-ownership, psychological freedom, and volition. Adolescents with the satisfaction of autonomy tend to experience the freedom to be themselves and make decisions based on their own interests and values. Competence involves experiences of mastery and being effective. Competent adolescents are likely to feel capable of performing tasks and achieving desired outcomes. Relatedness encompasses experiences of trust and closeness with important others. Adolescents with high levels of relatedness satisfaction have a sense of belonging and meaningful social bonds (Ryan and Deci 2017).

Empirically, research has demonstrated that a model with three separate need factors fits the data significantly better than a model with one general need factor, providing evidence for the distinctiveness of these constructs (Sheldon and Hilpert 2012). Moreover, numerous longitudinal, cross-sectional, and meta-analysis studies have consistently shown that the satisfaction of each psychological need differentially contributes to different aspects of positive psychological adaptation during adolescence (e.g., Chen et al. 2015; Wang et al. 2019). For instance, autonomy satisfaction and relatedness satisfaction predict adolescent life satisfaction, while competence satisfaction does not (Nishimura and Suzuki 2016). Taken together, examining the three needs separately, rather than combining them into a single measure, provides a clearer understanding of their distinct contributions to adolescent outcomes, prevents masking unique patterns of influence, and enhances the ability to design targeted interventions.

4 | Psychological Need Satisfaction (Frustration) and Adolescent Psychological Adaptation

As outlined in the dual-process model of self-determination theory, need satisfaction and need frustration are asymmetrically distinct processes (Ryan and Deci 2000; Vansteenkiste et al. 2020). Need satisfaction varies quantitatively from fulfilled (high level) to lacking (low level), whereas need frustration occurs when psychological needs are actively thwarted, representing a qualitative difference from the quantitative range. Specifically, autonomy frustration arises not merely from a lack of personal volition in behaviors (i.e., low autonomy satisfaction) but from external pressures or coercion, pushing individuals in unwanted directions. Competence frustration is marked by feelings of failure and helplessness, extending beyond a simple lack of achievement and mastery (i.e., low competence satisfaction). Similarly, relatedness frustration is not about lacking deep connections with others (i.e., low relatedness satisfaction), but about feelings of rejection, exclusion, and isolation by significant others.

Moreover, need satisfaction and need frustration have distinct and asymmetrical impacts on adolescent psychological adaptation. As previous studies have shown, need satisfaction (often referred to as the "bright side") promotes adaptive outcomes

(e.g., life satisfaction, vitality; Chen et al. 2015), while need frustration (the "dark side") is associated with maladaptive outcomes, such as heightened negative emotions and depression (Chen et al. 2015; Schmidt et al. 2020). Moreover, there is an asymmetrical relationship between need satisfaction and frustration. That is, high levels of need satisfaction do not preclude the presence of frustration, but high levels of frustration inherently involve low satisfaction (Vansteenkiste et al. 2020). Need frustration is not only associated with adjustment difficulties but also with reduced adaptation, such that experiences of need frustration diminish feelings of vitality, positive emotions, life satisfaction, and academic engagement (Buzzai et al. 2021; Chen et al. 2015; van der Kaap-Deeder et al. 2016).

Overall, considering the qualitative distinction between need satisfaction and frustration, it is critical to incorporate both constructs of each psychological need to simultaneously evaluate their importance for adolescent psychological adaptation (Buzzai et al. 2021; Nishimura and Suzuki 2016; Schmidt et al. 2020). Each psychological need satisfaction is expected to support higher levels of adolescents' psychological adaptation, whereas need frustration is likely to undermine it.

4.1 | Daily Dynamics of Psychological Need Satisfaction/Frustration: Levels and Instability

Beyond the overall level of psychological need satisfaction and frustration, it is also important to investigate their daily dynamics. Because adolescents may feel more satisfied or frustrated with their psychological needs on some days than other days, and these daily fluctuations have been shown to impact various aspects of adolescent development (Heppner et al. 2008; Laporte et al. 2022). To better capture this dynamic nature, instability—a dynamic indicator reflecting the frequency and degree of daily fluctuations over time (Ong and Ram 2016)—is an important index to consider. For example, two individuals with the same average level of psychological need satisfaction/frustration can display completely different trajectories: one with high instability experiences substantial daily ups and downs, while the other with low instability maintains a relatively stable level around their average.

Building on previous research highlighting the negative implications of instability in relevant psychological constructs (e.g., positive affect, feeling loved), we expect that high instability in psychological need satisfaction/frustration would also be a risk factor for adolescent psychological adaptation (Ong and Ram 2016; Xia et al. 2024). Fluctuations in psychological need satisfaction/frustration lead to an unstable perception of themselves and their surroundings. Such uncertainty may elicit a sense of insecurity and additional cognitive loads, which interfere with their appraisals and deplete their cognitive resources, contributing to adolescents' maladaptation (Baumeister et al. 2007; Bowlby 1988). Considering adolescence is a period marked by dramatic changes, frequent fluctuations in psychological need/frustration can further exacerbate adolescents' sense of unpredictability about their lives and future. The combination of developmental flux and instability in need satisfaction/frustration can create a highly challenging environment that hinders adolescents' ability to cope effectively, thereby undermining their psychological adaptation (Lippold et al. 2016).

Overall, beyond the levels of psychological need satisfaction and frustration, instability in psychological needs is expected to have additional negative implications for adolescent psychological adaptation.

5 | The Current Study

In summary, both theoretical and empirical perspectives support that autonomy, competence, and relatedness are independent constructs, making it essential to investigate their associations with adolescents' adaptation separately (Ryan and Deci 2017; Sheldon and Hilpert 2012). Moreover, the dual-process model of self-determination theory (Ryan and Deci 2000; Vansteenkiste et al. 2020) suggests that psychological need satisfaction and frustration are distinct constructs that should be considered simultaneously. Furthermore, meaningful day-to-day variability in psychological needs may have implications for adolescent psychological adaptation in addition to the effects of the average level of each psychological need. Therefore, this study used a baseline (T1), 30-day diary, and 6-month follow-up (T2) longitudinal design to investigate how the level and instability of satisfaction and frustration for each psychological need (autonomy, relatedness, and competence, separately) would be prospectively associated with adolescent psychological adaptation (emotion regulation, resiliency, mental health, and self-esteem) over 6 months.

Drawing from the dual-process model of self-determination theory and above reviewed research, we proposed two general hypotheses regarding these associations: (H1) the satisfaction of each psychological need would be positively associated with adolescent psychological adaptation, whereas frustration would be negatively associated with adaptation; and (H2) low instability in both satisfaction and frustration would predict better adolescent psychological adaptation. Given the novelty of this study, the differential effects of each need satisfaction and frustration (including both their levels and instability) on adaptation are exploratory.

6 | Methods

6.1 | Participants and Procedures

The study sample is from the FEELING project, a longitudinal online project investigating the effects of family dynamics on adolescent well-being. Ethical approval was granted by the University of Alabama (IRB #20-11-4083). Participant recruitment was conducted through a multi-channel approach including local flyers, online newsletters, dedicated research registry platforms (e.g., ResearchMatch), social media advertisements (e.g., Facebook), and participant referrals throughout the United States. Eligible families met four criteria: (1) an adolescent in middle or high school; (2) internet or cellular data access; (3) English fluency; and (4) informed consent.

Strict screening ensured data reliability, including telephone interviews, cross-verification, demographic and response consistency checks, and attention checks. Participation was entirely voluntary and compensated with virtual gift cards corresponding to the amount completed.

After establishing family eligibility and receiving consent from participants, both adolescents and their parents received their baseline surveys (T1), daily surveys, and 6-month follow-up surveys (T2) separately. Daily surveys were sent each night to adolescents and their two parents for 30 consecutive days. Participants were instructed to independently complete the survey each night before going to bed. This study focused on adolescent participants. A total of 107 adolescents ($Mean_{age} = 14.75$, $SD_{age} = 1.58$, $Range_{age} = 11–18$) completed the baseline survey and successfully enrolled in the daily portion of the study. During the 30-day daily assessment, participants completed an average of 15.41 days ($SD_{age} = 8.61$) and achieved a high completion rate of 88.60%, representing 2844 completed daily surveys out of the total possible 3210 occasions (where possible occasions = 107 participants x 30 days). And 88.79% of them ($n = 95$) completed the 6-month follow-up assessment. The missing data are consistent with being Missing Completely at Random (MCAR) (using the MissMech package in R, $p = 0.35$). This suggests that the missing values are unrelated to observed or unobserved data and thus unlikely to introduce bias into the analysis (Jamshidian et al. 2014). Multiple imputation (MI) was further used in analyses to account for the missingness in the between-person variables.

Adolescents self-identified as female (38.3%), male (58.9%), and 2.8% preferred not to answer. Adolescents reported their race as White/European American (64.5%), African American/Black (29.9%), Hispanic/Latino (4.7%), and Asian American (5.6%), with some reporting multiple ethnicities (4.7%). Their family annual household incomes range from less than $10,000 (0.9%) to more than $150,000 (11.2%) (median in the range of $80,000–89,999).

7 | Measures

7.1 | Daily Psychological Need Satisfaction/Frustration

During the 30-day diary assessments, adolescents reported on one item of satisfaction and frustration of each psychological need respectively on a daily basis. Responses were reported on a slider scale of 0–10 (in 0.1 increments), ranging from 0 (not at all true) to 10 (very true). A higher score indicated that adolescents experienced higher levels of need satisfaction or frustration on that day. As a single-item assessment, their reliability estimates could not be computed.

Autonomy. The autonomy need satisfaction was measured with the item "You were doing what interests you today." Adolescents also reported on autonomy need frustration with the item "You had to do thing against your will today" (Sheldon and Hilpert 2012).

Competence. The competence need satisfaction was measured with the item "You successfully completed difficult tasks today." Adolescents also reported on competence need frustration with the item "You experienced some kind of failure today" (Sheldon and Hilpert 2012).

Relatedness. The relatedness need satisfaction was measured with the item "You felt close and connected to other people today." Adolescents also reported on relatedness need frustration with the item "You were lonely today" (Sheldon and Hilpert 2012).

7.2 | General Psychological Adaptation

At both T1 (baseline) and T2 (6 months later), adolescents reported emotion regulation, resiliency, mental health, and self-esteem as described below.

Emotion Regulation. Adolescent reported emotion regulation using the Difficulties in Emotion Regulation Scale (Gratz and Roemer 2003; Hamby and Banyard 2015), including two items on emotional awareness (e.g., "I am aware of my feelings") and four items on emotional regulation (e.g., "I have difficulty making sense of my feelings"). Adolescents rated six items on a Likert scale ranging from 1 (not true about me) to 4 (mostly true about me). After reversing the scores for four items, all scores were averaged, with higher scores indicating greater emotion regulation skills. The scale demonstrated high internal consistency (Cronbach's $alpha_{baseline} = 0.78$; Cronbach's $alpha_{6\text{-month}} = 0.87$).

Resiliency. Adolescents reported resiliency using the 6-item Brief Resilience Scale (Smith et al. 2008). The scale includes items such as "I tend to bounce back quickly after hard times." Items were rated on a scale from 1 (strongly disagree) to 5 (strongly agree). Resiliency scores were calculated by averaging all items, with higher scores reflecting greater resiliency. In this sample, the scale had good reliability (Cronbach's $alpha_{baseline} = 0.84$; Cronbach's $alpha_{6\text{-month}} = 0.88$).

Mental health. Adolescents assessed their mental health using the Mental Health Inventory (Berwick et al. 1991) by rating five items (e.g., "Been a happy person") on a Likert scale from 1 (none of time) to 7 (all of the time). All scores were averaged such that higher scores indicated better mental health. In this sample, the items showed good reliability (Cronbach's $alpha_{baseline} = 0.70$; Cronbach's $alpha_{6\text{-month}} = 0.82$).

Self-esteem. Adolescents reported self-esteem using the 10-item Self-esteem Scale (Robins et al. 2001) on a 4-point scale, ranging from 1 (*strongly agree*) to 4 (*strongly disagree*). The sample item is "On the whole, I am satisfied with myself." The overall score for each adolescent was calculated by the average of all items, with higher scores indicating greater self-esteem. In this sample, the scale exhibited good reliability (Cronbach's $alpha_{baseline} = 0.86$; Cronbach's $alpha_{6\text{-month}} = 0.86$).

7.3 | Covariates

To control for the possible impact of demographic factors, two covariates from the baseline assessment were included as control variables: (1) adolescent's gender (0 = female, 1 = male) and (2) adolescent's age (in years).

7.4 | Analytic Plan

Data checking and preparation. We first calculated the intraclass correlation coefficient (ICC) to test whether there is meaningful daily variability (20% as acceptable level; Bolger and Laurenceau 2013). The ICC derived from the ratio of between-person to total variance (the sum of between- and within-person variance), indicated the proportion of variance in psychological need satisfaction/frustration attributable to between-person differences versus within-person differences (Bolger and Laurenceau 2013).

The next step was to compute the *level* and *instability* of daily variables for each adolescent across study days. *Level* refers to the within-person mean of a daily variable across days, representing the individual's overall level, which was calculated by grouping the daily data by individual and computing the average score of each daily variable across all days for each adolescent ($\text{Mean}_i = \frac{\sum X_{i,t}}{t_i}$, where Mean_i represents the average value of X for individual i over t_i time points). *Instability* refers to day-to-day fluctuations, capturing both the range of variability and temporal dependency. The mean square successive difference (MSSD; Wang et al. 2012) was used to calculate the instability score, given by the formula: $\text{MSSD}_i = \frac{\sum(X_{i,t} - X_{i,t-1})^2}{t_i - 1}$, where $X_{i,t}$ represents the daily variable score for individual i at day t, and t_i is the total number of days for individual i. This formula calculates the average of the squared differences over days for each daily variable per adolescent.

The newly calculated level and instability scores for six daily variables (i.e., satisfaction of three needs and frustration of three needs) were added as 12 new variables at between-individual levels and combined with baseline and 6-month follow-up assessments to create a longitudinal dataset for the main analyses.

Main analyses. Data analysis was conducted using R version 4.3.2. We first computed descriptive statistics and correlations for all used variables. Next, we conducted 12 parallel sets of linear regression models (3 psychological needs × 4 psychological adaption indicators) to investigate whether the levels and instability of each daily psychological need satisfaction and frustration would predict adolescent psychological adaptation (i.e., emotion regulation, resiliency, mental health, and self-esteem) 6 months later, after controlling for demographic covariates (adolescent age and gender) and the psychological adaptation level at the baseline. Variance inflation factor (VIF) analysis was used to detect any potential multicollinearity issue.

Sensitivity analyses. Given that conducting multiple parallel regression models may increase the risk of false discoveries, we applied the Benjamini-Hochberg (B-H) correction to assess the robustness of our findings.

8 | Results

Figure 1 shows the day-to-day fluctuations of satisfaction and frustration of three psychological needs. ICC of these six daily variables ranged from 45.82% (autonomy need frustration) to 62.30% (relatedness need satisfaction), which exceeded the acceptable level of ICC (i.e., less than 80% ICC or at least 20% within-person variance) for meaningful within-person variability (Bolger and Laurenceau 2013). Thus, it is meaningful to examine the daily instability of psychological need satisfaction and frustration.

Table 1 presents the descriptive statistics and correlations for the key variables in this study. The correlations between each psychological adaptation indicator at T1 and T2 were in the range of 0.49 to 0.79, indicating that adolescent psychological

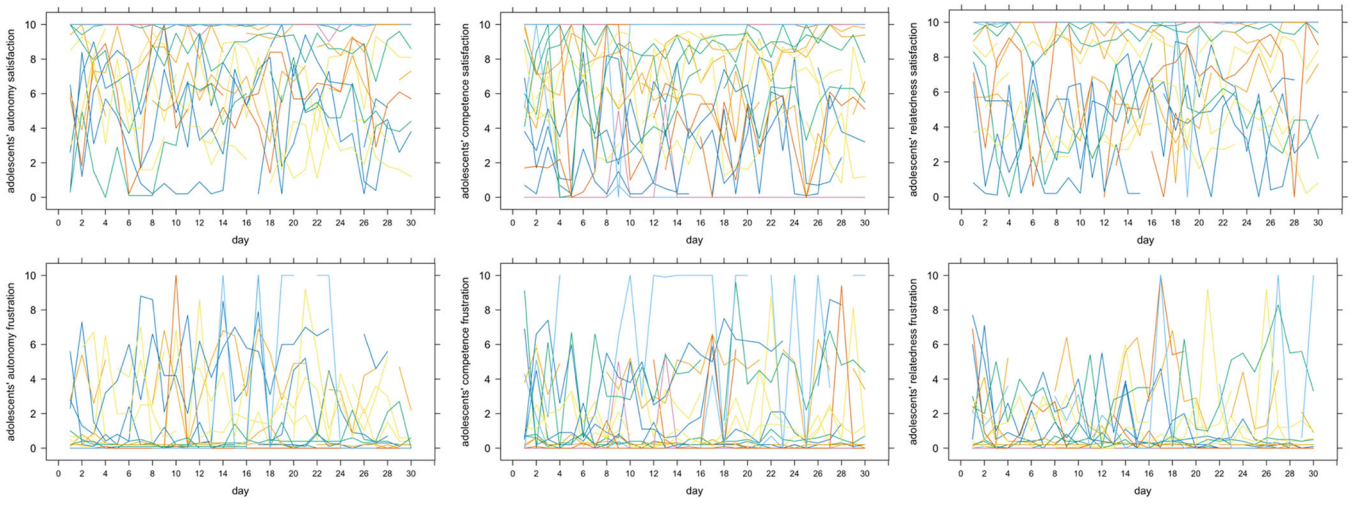

FIGURE 1 | Day-to-day fluctuations in adolescent psychological need satisfaction and frustration. *Note:* Top-left: autonomy satisfaction; top-middle: competence satisfaction; top-right: relatedness satisfaction; bottom-left: autonomy frustration; bottom-middle: competence frustration; bottom-right: relatedness frustration. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1 | Means, standard deviations, and correlations.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Gender	—																					
2. Age	0.15	—																				
3. T1 ER	**0.23**	**0.26**	—																			
4. T1 Resiliency	**0.28**	0.10	**0.72**	—																		
5. T1 Mental Health	**0.31**	0.13	**0.62**	**0.57**	—																	
6. T1 Self-esteem	**0.21**	0.11	**0.72**	**0.57**	**0.63**	—																
7. AS Level	**0.34**	0.12	**0.45**	**0.39**	**0.56**	**0.52**	—															
8. AF Level	0.01	−0.07	**−0.36**	**−0.28**	**−0.39**	**−0.40**	**−0.42**	—														
9. CS Level	**0.38**	0.12	−0.04	−0.03	**0.23**	0.01	**0.34**	−0.02	—													
10. CF Level	0.04	−0.15	**−0.40**	**−0.38**	**−0.42**	**−0.54**	**−0.34**	**0.64**	0.03	—												
11. RS Level	**0.31**	0.16	**0.48**	**0.40**	**0.56**	**0.53**	**0.92**	**−0.48**	**0.34**	**−0.37**	—											
12. RF Level	0.04	−0.13	**−0.40**	**−0.27**	**−0.49**	**−0.54**	**−0.30**	**0.68**	−0.01	**0.72**	**−0.34**	—										
13. AS Instability	−0.16	−0.10	**−0.36**	**−0.21**	**−0.33**	**−0.40**	**−0.51**	**0.29**	−0.14	**0.40**	**−0.47**	**0.41**	—									
14. AF Instability	0.09	0.05	**−0.30**	−0.16	−0.13	**−0.29**	−0.07	**0.47**	0.15	**0.44**	−0.18	**0.44**	**0.26**	—								
15. CS Instability	0.05	0.02	−0.20	**−0.26**	**−0.32**	**−0.24**	−0.16	0.15	**−0.22**	**0.32**	−0.18	**0.35**	**0.44**	**0.32**	—							
16. CF Instability	0.03	−0.10	**−0.34**	**−0.26**	**−0.29**	**−0.33**	−0.10	**0.33**	−0.09	**0.61**	−0.19	**0.52**	**0.35**	**0.56**	**0.41**	—						
17. RS Instability	−0.05	−0.02	**−0.29**	−0.11	**−0.23**	**−0.27**	**−0.32**	0.20	−0.18	**0.31**	**−0.40**	**0.31**	**0.72**	**0.27**	**0.37**	**0.61**	—					
18. RF Instability	0.12	−0.09	**−0.26**	−0.15	**−0.27**	**−0.33**	−0.17	**0.52**	0.06	**0.59**	**−0.21**	**0.70**	**0.35**	**0.57**	**0.28**	**0.62**	**0.46**	—				
19. T2 ER	**0.28**	**0.25**	**0.62**	**0.54**	**0.66**	**0.67**	**0.70**	**−0.50**	0.18	**−0.59**	**0.73**	**−0.50**	**−0.49**	**−0.34**	**−0.29**	**−0.36**	**−0.34**	**−0.34**	—			
20. T2 Resiliency	0.18	0.12	**0.50**	**0.49**	**0.46**	**0.54**	**0.61**	**−0.51**	0.07	**−0.51**	**0.66**	**−0.44**	**−0.47**	**−0.44**	**−0.26**	**−0.35**	**−0.42**	**−0.34**	**0.72**	—		
21. T2 Mental Health	**0.28**	**0.24**	**0.50**	**0.49**	**0.68**	**0.59**	**0.63**	**−0.49**	0.17	**−0.66**	**0.66**	**−0.58**	**−0.53**	**−0.36**	**−0.37**	**−0.42**	**−0.32**	**−0.39**	**0.81**	**0.63**	—	
22. T2 Self-esteem	0.18	0.18	**0.55**	**0.50**	**0.50**	**0.79**	**0.56**	**−0.40**	0.08	**−0.61**	**0.58**	**−0.55**	**−0.50**	**−0.34**	**−0.30**	**−0.43**	**−0.34**	**−0.38**	**0.75**	**0.66**	**0.71**	—

(Continues)

TABLE 1 | (Continued)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mean	0.62	14.79	3.60	3.47	4.60	3.16	7.42	1.80	5.64	2.13	7.58	1.47	4.70	6.93	8.63	7.59	5.17	5.33	3.89	3.71	4.74	3.14
SD	0.49	1.54	0.78	0.88	0.78	0.56	2.21	1.82	2.72	2.12	2.16	1.69	5.66	7.07	7.41	9.34	7.15	6.50	0.91	0.89	0.93	0.58
Skewness	−0.49	−0.50	0.08	0.04	−0.26	−0.52	−0.38	1.12	−0.35	0.83	−0.42	1.68	2.16	1.22	1.50	2.16	3.35	1.56	−0.48	0.09	−0.27	−0.75
Kurtosis	1.24	3.30	2.31	2.56	2.67	2.57	2.00	3.66	2.32	2.60	1.90	5.80	9.36	4.17	6.31	8.65	19.41	4.87	2.45	1.73	2.25	2.75

Note: Statistically significant correlations are highlighted in bold and underlined ($p < 0.05$). Gender = adolescent gender, Age = adolescent age, T1 = baseline assessment, T2 = 6-month follow-up assessment, ER = emotion regulation, AS = autonomy satisfaction, AF = autonomy frustration, RS = Relatedness satisfaction, RF = relatedness frustration, CS = competence satisfaction, CF = competence frustration, SD = standard deviation.

adaptation indicators were generally stable over time. For each psychological need, the correlations between their levels of need satisfaction and frustration ranged from −0.42 to 0.03, and the correlations between their instability of need satisfaction and frustration ranged from 0.26 to 0.46. The wide range of these correlation magnitudes, including some positive correlations between satisfaction and frustration of the same need, supported the notion that satisfaction and frustration of the same psychological need are distinct constructs. The levels of each need satisfaction were significantly negatively associated with their respective instability, with correlations ranging from −0.51 to −0.22. In contrast, the levels of each need frustration were significantly positively correlated with their instability, with correlations ranging from 0.47 to 0.70.

Table 2 presents 12 parallel regression models (three psychological needs × four psychological adaptation indicators). The VIF for all models fell below the multicollinearity threshold of 5 (Belsley et al. 2005), ranging from 1.07 to 3.06, indicating the appropriateness of including these predictors simultaneously. For the autonomy need, the level of satisfaction significantly predicted higher levels of adolescent emotion regulation ($b = 0.23$, $p < 0.001$), resiliency ($b = 0.16$, $p < 0.001$), mental health ($b = 0.14$, $p = 0.001$), and self-esteem ($b = 0.06$, $p = 0.003$) 6-month later after controlling for their baseline level. Instability in autonomy need frustration significantly predicted lower levels of adolescent emotion regulation ($b = -0.03$, $p < 0.001$), resiliency ($b = -0.04$, $p < 0.001$), and mental health ($b = -0.03$, $p = 0.001$) 6-month later after controlling for their baseline level. All other autonomy need indicators were not significant.

For the competence need, the level of frustration significantly predicted lower levels of adolescent emotion regulation ($b = -0.20$, $p < 0.001$), resiliency ($b = -0.18$, $p < 0.001$), mental health ($b = -0.19$, $p < 0.001$), and self-esteem ($b = -0.06$, $p = 0.009$) 6-month later after controlling for their baseline level. All other competence need indicators were not significant.

For the relatedness need, the level of satisfaction significantly predicted higher levels of adolescent emotion regulation ($b = 0.24$, $p < 0.001$), resiliency ($b = 0.15$, $p < 0.001$), mental health ($b = 0.20$, $p < 0.001$), and self-esteem ($b = 0.06$, $p = 0.002$) 6-month later after controlling for their baseline level. Instability in relatedness frustration significantly predicted lower levels of adolescent mental health ($b = -0.03$, $p = 0.029$) 6 months later after controlling for their baseline level. All other relatedness need indicators were not significant.

Sensitivity analyses revealed similar patterns (see Table S1), with the only change being that higher instability in relatedness frustration became marginally significantly associated with lower adolescent mental health ($p = 0.057$) after B-H correction.

9 | Discussion

Building on the dual-process model of self-determination theory, our research investigates how daily levels and instability in

TABLE 2 | Multiple regressions of daily psychological need satisfaction and frustration predicting adolescent psychological adaptation.

	Emotion regulation	Resiliency	Mental health	Self-esteem
Autonomy	*b* (SE)	*b* (SE)	*b* (SE)	*b* (SE)
Intercept	0.64 (0.59)	1.55 (0.67)*	1.51 (0.64)*	0.85 (0.38)*
Gender	0.07 (0.12)	−0.05 (0.13)	0.03 (0.12)	−0.06 (0.07)
Age	0.06 (0.04)	0.06 (0.04)	0.06 (0.04)	0.03 (0.02)
T1 outcome	0.23 (0.08)**	0.15 (0.08)	0.35 (0.08)***	0.48 (0.07)***
AS level	0.23 (0.03)***	0.16 (0.04)***	0.14 (0.04)***	0.06 (0.02)**
AS instability	0.00 (0.01)	−0.01 (0.01)	−0.02 (0.01)	−0.01 (0.01)
AF level	−0.03 (0.04)	−0.06 (0.04)	−0.04 (0.04)	−0.00 (0.02)
AF instability	−0.03 (0.01)***	−0.04 (0.01)***	−0.03 (0.01)**	−0.01 (0.01)
R^2	66.83%	55.71%	66.94%	67.09%
Competence	*b* (SE)	*b* (SE)	*b* (SE)	*b* (SE)
Intercept	2.29 (0.65)***	2.57 (0.78)**	2.59 (0.69)***	1.26 (0.42)**
Gender	0.23 (0.14)	0.13 (0.17)	0.22 (0.14)	0.04 (0.08)
Age	0.01 (0.04)	0.04 (0.05)	0.04 (0.04)	0.02 (0.02)
T1 outcome	0.41 (0.10)***	0.23 (0.09)*	0.41 (0.08)***	0.53 (0.07)***
CS level	0.05 (0.03)	0.01 (0.03)	0.01 (0.02)	0.01 (0.01)
CS instability	−0.01 (0.01)	−0.00 (0.01)	−0.01 (0.01)	−0.00 (0.01)
CF level	−0.20 (0.04)***	−0.18 (0.04)***	−0.19 (0.04)***	−0.06 (0.02)**
CF instability	0.01 (0.01)	−0.00 (0.01)	−0.01 (0.01)	−0.00 (0.00)
R^2	57.14%	39.16%	62.96%	63.69%
Relatedness	*b* (SE)	*b* (SE)	*b* (SE)	*b* (SE)
Intercept	0.50 (0.56)	1.32 (0.70)	1.63 (0.61)**	0.82 (0.38)*
Gender	0.11 (0.12)	−0.03 (0.14)	0.14 (0.12)	−0.01 (0.07)
Age	0.04 (0.04)	0.06 (0.04)	0.05 (0.03)	0.03 (0.02)
T1 outcome	0.27 (0.08)**	0.17 (0.08)*	0.24 (0.08)**	0.48 (0.07)***
RS lLevel	0.24 (0.03)***	0.15 (0.04)***	0.20 (0.03)***	0.06 (0.02)**
RS instability	0.01 (0.01)	−0.02 (0.01)	0.01 (0.01)	−0.00 (0.01)
RF level	−0.03 (0.05)	−0.06 (0.06)	−0.06 (0.05)	0.01 (0.03)
RF instability	−0.02 (0.01)	−0.01 (0.02)	−0.03 (0.01)*	−0.01 (0.01)
R^2	67.79%	47.39%	69.35%	66.13%

Note: Gender = adolescent gender, Age = adolescent age, T1 = baseline assessment, AS = Autonomy satisfaction, AF = autonomy frustration, CS = competence satisfaction, CF = competence frustration, RS = Relatedness satisfaction, RF = relatedness frustration, SE = standard error. Each regression outcome was assessed at T2 (six months later than T1).
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

the satisfaction and frustration of autonomy, competence, and relatedness needs impact adolescents' long-term psychological adaptation, as indicated by emotion regulation, resiliency, mental health, and self-esteem. This study significantly extends our understanding of the dual sides and dynamic features of each psychological need over time, contributing to both theoretical and practical advances in adolescent psychological adaptation.

9.1 | Psychological Need Satisfaction and Frustration for Adolescent Psychological Adaptation

The results partly support the first hypothesis. Results indicate that the level of autonomy satisfaction, but not frustration, was associated with adolescents' psychological adaptation. This aligns with previous findings showing the benefits of need

satisfaction for positive outcomes. One possible explanation is that autonomy satisfaction supports volitional functioning, which, according to the self-determination theory, is important for improved self-esteem and mental health (Chen et al. 2024; Deci and Ryan 1987; Soenens et al. 2007). Additionally, it is possible that autonomy satisfaction fosters intrinsic motivation, which supports emotion regulation and resiliency (Vansteenkiste et al. 2020). Our findings provide direct evidence that autonomy satisfaction supports adaptation, even when controlling for frustration, helping adolescents navigate transitions.

Similarly, the level of relatedness satisfaction, but not frustration, was positively associated with adolescents' psychological adaptation. This finding is consistent with previous studies demonstrating the stronger predictive effect of relatedness satisfaction (than frustration) on academic performance and relationship satisfaction (Buzzai et al. 2021; Vanhee et al. 2016), and further extends to broader psychological adaption outcomes. Based on self-determination theory and attachment theory, high levels of relatedness satisfaction provide adolescents with a sense of security and emotional resources essential for better psychological adaptation (Bowlby 1988; Ryan and Deci 2017). Notably, relatedness satisfaction exerts a significant effect on adolescents' psychological adaptation even when relatedness frustration is present. The possible explanation is that while relatedness frustration may arise as adolescents navigate changing relationships, strong connections in other areas can help maintain effective coping and well-being (Masten 2018).

Interestingly, the competence frustration level, rather than competence satisfaction, matters more for adolescents' psychological adaptation. One possible explanation is that adolescence is a crucial period for self-concept formation, during which individuals are highly sensitive to negative feedback about their capabilities (Ford et al. 2023; Heffer and Willoughby 2020). Repeated setbacks may lead adolescents to internalize these failures, undermining self-efficacy and self-worth and increasing vulnerability to negative outcomes like depressive symptoms (Liu et al. 2024). Alternatively, competence frustration may cause adolescents to withdraw from challenges, fostering hopelessness and passive engagement (Earl et al. 2017). This avoidance approach limits opportunities to build crucial coping skills for psychological adaptation. As one of the first empirical studies to directly identify the greater impact of competence frustration over its satisfaction, our findings highlight the importance of reducing competence frustration to support positive psychological adaptation.

Overall, within each psychological need, satisfaction and frustration have distinct effects on adolescents' psychological adaptation, supporting the dual-process model of self-determination theory. Psychological need satisfaction and frustration are not simply two ends of a single continuum, but rather distinct constructs that can coexist. Future research should simultaneously consider the differential roles of satisfaction and frustration in study designs. Additionally, incorporating all psychological needs into a single model to evaluate their combined and interactive effects could further clarify each need's unique contribution and their interplay in influencing adolescent adaptation.

9.2 | The Role of Instability in Psychological Need Satisfaction and Frustration

The results partially support the second hypothesis, which posits that beyond levels of psychological need satisfaction and frustration, their low instability predicts better adolescent psychological adaptation. Three out of four models indicate that instability in autonomy frustration (but not its satisfaction) negatively predicts adolescents' psychological adaptation. Adolescents may be more sensitive to daily changes in autonomy frustration than satisfaction, amplifying their impact. Consistent with prior research (van der Kaap-Deeder et al. 2016), our results show lower ICCs for autonomy frustration than satisfaction, indicating greater day-to-day variation. Interestingly, instability in autonomy frustration is more influential than overall levels in predicting adolescents' psychological adaptation. It is possible that unpredictable autonomy frustration may disrupt control, security, and stress regulation more than consistently high frustration (Baumeister et al. 2007; Bowlby 1988), making adolescents vulnerable to external pressures and hindering adaptive stability (Soenens et al. 2009). Moreover, such fluctuations can impair self-discover, preventing adolescents from internalizing their beliefs and leading to low self-esteem and mental health (Soenens et al. 2007).

Our findings partially support the second hypothesis on relatedness. As expected, instability in relatedness frustration predicts mental health, supporting self-determination theory's emphasis on stable social connections for well-being (Deci and Ryan 2008). However, this association became less pronounced (i.e., marginally significant) after the B-H correction, suggesting that instability in relatedness frustration is not a robust predictor. Furthermore, this instability did not predict emotion regulation, resiliency, or self-esteem, consistent with research showing that instability in positive relatedness primarily predicted interpersonal rather than intrapersonal outcomes (Xia et al. 2024). It is possible that instability in relatedness frustration may primarily affect adolescents' perceptions of competence or trust in relationships more than intrapersonal factors. As a first-time finding, further replication and mechanism analysis are needed to confirm this result.

It is worth noting that the instability of competence need did not significantly predict any psychological adaptation outcomes. One possible explanation is that adolescents might expect and adapt to some degree of variability in their competence experiences as they navigate new challenges and roles (Steinberg and Morris 2001). Future research should further investigate this study question to disentangle the nuances, including the possibility of inverse U-shaped relationships between instability and adaptation, as emotion research suggests that both excessive rigidity and instability predict poor outcomes (Houben et al. 2015). Additionally, it would be valuable to examine the conditions under which psychological need instability has a greater impact on adolescent adaptation, such as exploring whether instability in competence frustration is more harmful when frustration levels are high.

9.3 | Strengths and Limitations

Our study is one of the first to assess the daily dynamics of psychological need satisfaction and frustration simultaneously and to examine their implications for the long-term psychological adaptation of adolescents across multiple indicators. This study includes the following strengths: (1) By simultaneously assessing need satisfaction and frustration, this study provides direct evidence of their distinct constructs and differential impacts on adolescent adaptation. (2) By examining both levels and instability of psychological needs, this study demonstrates how daily fluctuations shape adolescent psychological adaptation beyond their average levels across days, highlighting the necessity of including the dynamic dimensions of psychological needs. (3) By using a daily-nested-within-longitudinal design, this study explores how daily dynamics predict long-term psychological adaptation and ensures result robustness by controlling for baseline outcomes. (4) The innovative dynamic index (i.e., MSSD) provides a robust method to accurately capture the real-time dynamics of psychological needs, overcoming the limitations of similar dynamic indicators that omit changes from day to day and are susceptible to systematic trends (e.g., Intraindividual Standard Deviation [ISD]).

While this study provides valuable insights, several limitations and directions for future research should be considered. First, single-item measures for psychological need satisfaction and frustration may not fully capture their complexity or adequately differentiate between the needs. This limitation could lead to a high correlation between distinct psychological needs, particularly between autonomy and relatedness satisfaction ($r = 0.92$). The high correlation suggests that the current measures of autonomy and relatedness satisfaction may not sufficiently distinguish between the two constructs empirically, despite their theoretical distinction and face validity. Future studies employing multidimensional scales to replicate these findings would enhance confidence in our results. Second, despite substantial daily observations ($N = 2844$), future studies might benefit from a larger and more diverse between-person sample to complement our current sample ($N = 107$). Third, incorporating additional adaptation indicators, such as academic performance and physical health outcomes, could extend our findings. Lastly, we tested the linear association between psychological need instability and adolescents' adaptation; future work would benefit from examining potential U-shaped relationships to provide deeper insights.

9.4 | Implications

This study yields significant implications for both theory and practice. Theoretically, our findings strongly validate the dual-process model of self-determination theory (Ryan and Deci 2000). The differential effects observed for need satisfaction and frustration underscore the importance of treating these constructs as distinct in future research, rather than as mere opposites on a single continuum. Moreover, the impact of instability in autonomy frustration highlights the role of stability in psychological needs for effective psychological adaptation. Future studies should consider both overall levels and daily fluctuations in psychological need satisfaction and frustration. Practically, interventions should prioritize supporting adolescents' autonomy satisfaction, fostering positive relationships, and reducing competence frustration. Additionally, it is beneficial to create consistent and predictable environments, as stability in autonomy frustration plays a crucial role in adolescents' psychological adaptation.

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Ethics Statement

All procedures performed in this study involving human subjects were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All procedures performed in the study involving human participants were approved by the Institutional Review Board at the University of Alabama (IRB#20-11-4083).

Consent

Informed consent/assent was obtained from all participants included in the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.