

**Week-to-Week Fluctuations in Autonomous Study Motivation:
Links to Need Fulfillment and Affective Well-Being**

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All data of this project are publicly available (<https://osf.io/bhq3p/>; Neubauer et al., 2021).

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Abstract

Autonomous motivation for self-set goals (pursuing goals for more intrinsic and less extrinsic reasons) has been linked to affective well-being. Using intensive longitudinal data, the present article examines the link between university students' autonomous study motivation with affective well-being and targets fulfillment of the basic psychological needs as a potential mediating factor of this association on the within-person and the between-person level.

University students in Germany (N = 488) completed an online questionnaire once a week over up to two semesters, indicating their weekly study motivation, need fulfillment, and affective well-being. Multilevel structural equation models were employed to target (a) the structure of autonomous study motivation and (b) the associations of autonomous study motivation with need fulfillment and affective well-being. Autonomous study motivation was associated with students' positive and negative affect on both levels. In line with predictions by self-determination theory, multilevel mediation models suggested indirect effects via need fulfillment on both levels. Results highlight the central role of autonomous study motivation and need fulfillment in university students' socio-emotional adjustment. A better understanding of this socioemotional adjustment of university students may be an important step for increasing overall study satisfaction and developing interventions to reduce study dropout.

Educational Impact and Implications Statement

The reasons why students pursue their studies have been suggested to directly affect students' fulfillment of their basic psychological needs which in turn affects well-being. Results of this study are in line with this assertion and highlight that the reasons for pursuing one's studies may be crucial to better understand students' socioemotional adjustment. This is an important step

toward maintaining and improving student mental health and developing interventions to reduce dropout and promote educational success in higher education.

Keywords: autonomous goal regulation, basic psychological needs, self-determination theory, ambulatory assessment, intensive longitudinal data

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Around 235 million students are enrolled in universities worldwide (UNESCO, 2022). In Germany, a majority of students who obtain a university entrance qualification enter tertiary education: Around 80% of those who obtained a university entrance qualification enrolled in an institute of higher education in 2020 (Autorengruppe Bildungsberichterstattung, 2022). Notably, not all of these students complete their degrees: About 27% dropout of their studies during their bachelor's study program¹ (Heublein et al., 2020). Reasons for dropout can be manifold and include, for example, performance and financial problems (Heublein et al., 2017), as well as family- or health-related reasons (Xenos et al., 2002). In addition, motivational factors also play a major role in the decision to leave higher education (e.g., Heublein et al., 2017). According to Heublein et al. (2017), only 70% of dropouts considered intrinsically motivated reasons important to pursue their studies, such as the desire for personal growth (compared to 80% of non-dropouts), while 55% considered extrinsic reasons important, such as the prospect of a high income (compared to 36% of non-dropouts). This suggests that the why of motivation (Deci & Ryan, 2000), that is, the reasons for pursuing a specific trajectory in higher education, might play a major role in whether or not students complete their education.

The aim of the present research is to target the ebbs and flows of one particular aspect of study motivation—the extent to which study-related tasks are pursued for autonomous reasons—and to investigate links of these fluctuations to students' affective well-being. Reduced well-being as a consequence of nonadaptive motivational states might be one relevant mechanism responsible for study dropout. The next sections are organized as follows: First, we will recur on self-determination theory (SDT; Ryan & Deci, 2017), which proposes autonomous motivation as a central element for adaptive goal motivation in a variety of settings. Next, we will review previous empirical research linking autonomous motivation to well-being and the fulfillment of

basic psychological needs. We will then test hypotheses derived from SDT on the association among autonomous motivation, need fulfillment, and affective well-being in an intensive longitudinal study with up to 30 weekly assessments in a sample of 488 university students.

Autonomous Motivation

SDT (Ryan & Deci, 2017) distinguishes between the what of goal pursuit, referring to goal content, and the why of pursuit, referring to the underlying motivation for a specific behavior (Deci & Ryan, 2000). Regarding the why of goal pursuit, organismic integration theory, one of the six mini-theories of SDT, postulates that the motivation for a behavior can be classified on a continuum that provides information about the underlying degree of autonomy. This continuum ranges from external motivation (the most controlled form of motivation) to intrinsic motivation (the most autonomous form of motivation). When individuals perform a behavior for external reasons, they act in response to external stimuli such as rewards or punishments. When acting for introjected reasons, they have taken in but not fully accepted the external controls. Individuals perform a behavior for identified reasons when they consider the behavior to be personally important. When acting for integrated reasons, the behavior is integrated into the personal value system and is considered a part of the self-concept. Last, a behavior is exhibited for intrinsic reasons if the behavior is done out of interest and fun. Hence, motivation for a given behavior can be understood as more or less autonomously regulated. The degree of autonomous (vs. controlled) motivation is often assessed by asking individuals to report their levels of either all or a selection of motivation forms (external, introjected, identified, integrated, and intrinsic) and combining these responses in a score representing the degree of relative autonomous motivation (e.g., Hope et al., 2019; Litalien et al., 2013; Sheldon et al., 2004).

The assumption of a continuous representation of autonomous motivation implies a quasi-simplex structure of motivation, in which adjacent factors on this continuum (e.g., external and introjected motivation; intrinsic and identified motivation) are more strongly positively correlated compared to nonadjacent factors (e.g., external and intrinsic motivation). A meta-analysis by Howard et al. (2017) yielded data consistent with this postulated structure: Using 486 different samples with a total of over 205,000 participants, Howard et al. (2017) examined the links among the various factors and how reliably they fit a predictable continuum-like pattern. Results largely indicated that intrinsic motivation correlated more strongly with identified and integrated motivation than with introjected and external motivation. External motivation also correlated strongly with its adjacent factor introjected motivation, but less strongly with integrated and identified motivation.

Prior psychometric work has targeted the structure of autonomous motivation primarily in cross-sectional studies (e.g., Litalien et al., 2017; Sheldon et al., 2017). However, autonomous motivation for a certain behavior likely varies within individuals across time: On some days, students might work for their classes for more intrinsic reasons (e.g., because they enjoy the contents of their studies), while on others, they might do so for more external reasons (e.g., because other people who are important to them, e.g., parents, friends, or lecturers, expect them to do so). In fact, results of a mobile diary study by Moilanen et al. (2020) suggested that university students' daily study motivation varied substantially from day to day. Hence, it is paramount to better understand the psychometric structure of autonomous motivation not only on the level of between-person differences (i.e., are some students more autonomously motivated than other students?) but also on the level of within-person differences (i.e., is a student more autonomously motivated at some moments/days/ weeks than at other moments/days/weeks?).

We will address this issue in the present work and examine the structure of autonomous study motivation on both the between-person level and the within-person (week-to-week) level. This is important because the structure of autonomous motivation on the within-person level cannot be inferred from cross-sectional data (e.g., Hamaker, 2012; Molenaar, 2004; Voelkle et al., 2014). Furthermore, within-person differences in autonomous motivation might be associated with fluctuations in relevant outcomes that give rise to long-term changes in psychological adjustment (Nesselrode, 1991; Neubauer, Brose, & Schmiedek, 2022), such as affective well-being. Within-person fluctuations were observed in related motivation constructs. For example, in a 1-year longitudinal study by Tamura et al. (2022), four postgraduate-level researchers were asked about key components in their motivational engagement process each evening. Within-person, day-to-day fluctuations were reported in both mastery-approach and performance-approach goals, as well as in mastery-avoidance and performance-avoidance goals. Neubauer, Schmidt, et al. (2022) examined children's academic goal orientation once per school day for four consecutive weeks and found that within-person fluctuations in academic goal orientation were related to academic success. Furthermore, specifically regarding university students' motivation, Ketonen et al. (2018) assessed educational goals and goal motivation in first-year university students during 14 days with five assessments per day. Results indicated that students' autonomous motivation (i.e., intrinsic and identified) and students' controlled motivation (i.e., introjected and external) varied from day to day. Additionally, students' motivation in the morning predicted academic emotions later during the day: While autonomous motivation in the morning was directly related to the later positive emotions interest, enthusiasm, activeness, and determination, controlled motivation in the morning was mainly associated with

later negative emotional states. These studies illustrate that within-person fluctuations observed in academic motivation are associated with affective and educational outcomes.

Association Between Autonomous Motivation and Well-Being

The degree to which a behavior is regulated for autonomous reasons has been hypothesized to relate to well-being (Ryan & Deci, 2017), a pattern that has been shown in various prior studies (e.g., Hope et al., 2019; Litalien et al., 2013; McDonough & Crocker, 2007; Perunovic et al., 2011; Vandercammen et al., 2014). For instance, longitudinal data suggest that autonomous motivation for self-set goals is associated with changes in affective well-being (e.g., Hope et al., 2019; Litalien et al., 2013). In a longitudinal study by Litalien et al. (2013) over a 2-year period and in a longitudinal study by Hope et al. (2019) over the course of one school year, higher autonomous motivation for self-set goals was associated with higher affective well-being at later measurement time points. Furthermore, using an experience sampling method, Perunovic et al. (2011) showed that participants with higher average intrinsic/identified motivation for goals they had worked on in the past 2 hr reported higher positive and lower negative affect. In contrast, participants with higher average introjected/external motivation reported higher negative affect but not lower positive affect. Similar findings were reported on the within-person level: Higher momentary average intrinsic/identified motivation for self-set goals was associated with higher positive and lower negative affect; higher momentary average introjected/external motivation for self-set goals with lower positive and higher negative affect (Perunovic et al., 2011). Vandercammen et al. (2014) also demonstrated in a daily diary study as well as in an experience sampling study that intrinsic and autonomous (i.e., intrinsic and identified) motivation were positively associated with positive affect and negatively associated with negative affect on the within-person level.

These studies provided important insights into the dynamic within-person association of intrinsic and extrinsic motivation with affective well-being; nevertheless, they did not specifically refer to autonomous study motivation. Only few studies considered the link of autonomous study motivation to students' well-being (e.g., Bailey & Phillips, 2016; Baker, 2004; Moilanen et al., 2020). For example, Bailey and Phillips (2016) reported cross-sectional associations between intrinsic and introjected motivation with positive affect (but not negative affect); external motivation was not related to either positive or negative affect. A study by Baker (2004) examined the relationships between students' motivation to succeed in college and psychological well-being (i.e., self-reported psychological distress), where neither intrinsic nor extrinsic (i.e., external, introjected, and identified) motivation was related to well-being. Overall, previous work on the links between autonomous study motivation and well-being is scarce and, to the best of our knowledge, has not been extended to the level of within-person fluctuations. In the present work, we aimed to examine whether autonomous study motivation is associated with well-being on both, the within- and the between-person level. In doing so, we focused on students' affective well-being, a central component of subjective well-being (e.g., Andrews & Withey, 1976; Diener, 1984). Furthermore, we will target a theoretically plausible psychological mechanism that might explain the link between autonomous study motivation and well-being: Fulfillment of the basic psychological needs for autonomy, competence, and relatedness (Ryan & Deci, 2017).

Need Fulfillment as Mediator of the Association Between Autonomous Motivation and Well-Being

Basic psychological needs theory, another of the six mini-theories of SDT, postulates that the fulfillment of three basic and universal psychological needs—the needs for autonomy,

competence, and relatedness—is a fundamental root of well-being (Ryan & Deci, 2017). The need for autonomy refers to the perception that one has control over one’s own actions. The need for competence can be satisfied by mastering one’s environment and having a sense of accomplishment. The need for relatedness is satisfied by feeling connected to others and experiencing close relationships. The positive link between the fulfillment of these needs and well-being has been suggested in a number of studies both on the within- and the between-person level (e.g., Dimmock et al., 2022; McDonough & Crocker, 2007; Reis et al., 2000; van der Kaap-Deeder et al., 2017). For example, Dimmock et al. (2022) used repeated surveys over 4 months to illustrate that the satisfaction of competence, the satisfaction of autonomy, and the satisfaction of relatedness were contemporaneously associated with mental well-being (i.e., hedonic and eudemonic aspects, positive affect, satisfying interpersonal relationships and positive functioning; see Tennant et al., 2007) on both, the within- and the between- person level.

In the present work, we build on SDT (specifically, basic psychological needs theory) and consider basic psychological need fulfillment as the mediator of the positive effect of autonomous motivation on well-being. While fulfillment of the three basic psychological needs has mostly been considered as a unidimensional construct (e.g., Hope et al., 2019), Vansteenkiste and Ryan (2013) emphasized the relevance of separating need fulfillment into need satisfaction and need frustration. The importance of this differentiated approach has been shown empirically in previous work: need satisfaction and need frustration were often differentially associated with well-being and ill-being (e.g., B. Chen et al., 2015; Neubauer, Kramer, & Schmiedek, 2022; Schmidt et al., 2020); furthermore, on the psychometric level, a six-factor model with differentiation of need satisfaction and need frustration for each of the three needs often fit the data best (e.g., Costa et al., 2018; Heissel et al., 2018; Neubauer & Voss, 2018). We will

consider this differentiation in the present work and predict, following Vansteenkiste and Ryan (2013), that need satisfaction is primarily associated with higher well-being (positive affect), whereas need frustration is primarily associated with higher ill-being (negative affect).

The Present Study

In the present study, we captured students' autonomous study motivation, fulfillment of basic psychological needs, and affective well-being each week over 15–30 weeks during the lecture period. We assessed autonomous study motivation with respect to the students' overall studies which allowed us to capture these motivational processes in a domain-general setting which is not tied to particular classes or majors. This intensive longitudinal design allows us to analyze (a) within-person fluctuations in autonomous study motivation and (b) between-person differences in mean levels of autonomous study motivation. With this approach, we pursued two goals: First, we examined the structure of autonomous study motivation, thus extending prior work by targeting these constructs on the between-person level and on the within-person level. Building on central assumptions of SDT and prior psychometric work (e.g., Howard et al., 2017; Sheldon et al., 2017), we expected that autonomous study motivation could be represented best by four factors² on the within- and the between- person level, respectively (Hypothesis 1). We further predicted that, in line with the quasi-simplex structure of autonomous motivation, there would be positive correlations between external and introjected motivation (Hypothesis 2a) and between intrinsic and identified motivation (Hypothesis 2b) on both levels.

Second, we tested hypotheses derived from SDT about the associations of autonomous study motivation with affective well-being and need fulfillment. Specifically, we expected that autonomous study motivation would be associated with higher positive affect (Hypothesis 3a) and lower negative affect (Hypothesis 3b). Additionally, in line with the claim of SDT that need

fulfillment mediates positive effects of autonomous study motivation on well-being, we expected higher autonomous study motivation to be associated with higher levels of need satisfaction, which in turn should be associated with higher levels of positive affect (Hypothesis 4a). Furthermore, we expected lower autonomous study motivation to be associated with higher levels of need frustration, which should again be associated with higher levels of negative affect (Hypothesis 4b). Given the central role of basic psychological needs for well-being as postulated by SDT, we further predicted that need fulfillment would fully mediate the associations of autonomous study motivation with positive and negative affect, respectively (Hypothesis 5). Using intensive longitudinal data provides the unique opportunity to test these hypotheses on both, the within-person level and the between-person level. We predicted to observe the pattern of associations as specified in all study hypotheses on both levels of analyses.

Method

We used data from a longitudinal project targeting psychological adaptation of university students who started their studies during the COVID-19 pandemic. This study combined elements of panel studies (with five repeated assessments every 3 months) with more intensive longitudinal assessments that included, on the one hand, 30 weekly assessments across two semesters and, on the other hand, an experience sampling part with six assessments per day across 14 days. For further information regarding the study procedure and additional constructs see the study protocol (<https://osf.io/2q4wz>; Neubauer & Kramer, 2022). The research was approved by the ethics committee of DIPF | Leibniz Institute for Research and Information in Education.

Transparency and Openness

All anonymized data of this project are publicly available ([https:// osf.io/bhq3p/](https://osf.io/bhq3p/); Neubauer et al., 2021). We further provide R and Mplus scripts for all analyses reported in the present research in the accompanying Open Science Framework (OSF) repository (<https://osf.io/xv75y/>). Sample size considerations can be found in the study protocol ([https://osf.io/2q4wz](https://osf.io/2q4wz;); Neubauer & Kramer, 2022), yet, a priori power analyses were not conducted for research questions of the present work. Descriptive statistical analyses were conducted using the open-source statistical program R (Version 4.2.1; R Core Team, 2022) running RStudio (Version 2022.7.1.554; RStudio Team, 2022). Multilevel models were conducted in Mplus for all hypotheses (Version 8.6; Muthén & Muthén, 1998–2017). This study was not preregistered.

Sample

The sample for this project was recruited in two waves. The first recruitment phase lasted from March 18, 2021 to April 11, 2021. Because the target sample size³ of $N = 500$ was not reached at the end of the first recruitment wave, additional participants were recruited in a second recruitment phase at the beginning of the following winter semester. Hence, the first recruitment phase was placed directly before the start of the summer semester in Germany, and the second recruitment phase was conducted directly before the start of the winter semester in Germany. In both phases, participants were recruited through advertisements on social media platforms and by information distributed via university administrations and student bodies at various universities across Germany. In the first recruitment phase, inclusion criteria were that participants (a) had obtained their university entrance qualification in 2019 or 2020 and (b) were enrolled at a university in Germany in the summer semester 2021 in their first or second semester. In the second recruitment phase, participants had to (a) have obtained their university

entrance qualification in 2020 or 2021 and (b) be enrolled at a university in Germany in the winter semester 2021/2022 in their first semester.

Overall, 374 participants completed the baseline questionnaire in the summer semester (recruitment Phase 1; further referred to as starting sample) and 145 participants completed the baseline questionnaire in the winter semester (recruitment Phase 2; further referred to as refreshment sample). Additionally, there were 18 participants who participated at least partially in at least one weekly assessment but who did not complete the baseline questionnaire. Of these 537 total participants, we excluded those who did not have at least one response on one of the relevant variables (weekly autonomous study motivation, need fulfillment, and affective well-being; $n = 49$). This resulted in a final sample of $N = 488$ students between the ages of 17 and 42 ($M=19.66$, $SD=1.69$; $n=19$ without any information) who participated in the weekly surveys for the present analyses. Of these, 361 students were in the starting sample and 127 in the refreshment sample. A total of 366 women participated in the study (75%), 96 men (20%) and four nonbinary participants (1%); $n = 22$ participants did not specify their gender. Furthermore, 434 of the participants were born in Germany and 36 in another country; 384 indicated German as their native language, 57 German and an additional language, and 29 participants indicated a language other than German as their native language. Regarding study majors, 10% ($n=48$) of participants reported studying medicine in the summer semester of 2021, 9% ($n=44$) reported studying psychology, business psychology, or applied psychology, and another 9% ($n = 43$) reported various forms of education majors (e.g., elementary school teaching or high school teaching). Furthermore, 37 participants (8%) indicated law; other majors with multiple nominations included biology or biological sciences (6%, $n = 30$) and computer science (3%, $n = 15$).

The remaining majors were indicated less than 15 times each, for example, pharmacy, mathematics, and physics.⁴

Procedure

Overall, the study consisted of three study parts: (a) A panel part with five online questionnaires across 1 year, (b) an intensive longitudinal part with 15–30 weekly questionnaires in the summer and the winter semester, and (c) an experience sampling part with six questionnaires per day for seven consecutive days in 2 weeks. For the present study, only the first assessment of the panel part (the baseline questionnaire) and data from the weekly questionnaires were used and only these parts are described in the following. Details of the other study parts can be found in the study protocol (<https://osf.io/2q4wz>; Neubauer & Kramer, 2022). The link to the first assessment of the panel part (the baseline questionnaire) was sent to the participants via email directly after their registration and could be completed until April 11, 2021, for the starting sample and until October 20, 2021, for the refreshment sample, respectively. Weekly questionnaires (study part 2) were sent from April 16, 2021, to July 23, 2021, for the starting sample, and from October 21, 2021, to February 18, 2022, for the starting sample and the refreshment sample (no weekly questionnaires were sent between December 20 and January 9). Students who started participating in the summer semester could thus complete up to 30 questionnaires (15 in the summer semester and 15 in the winter semester); students who started participating in the winter semester could complete up to 15 questionnaires (all in the winter semester). Weekly online questionnaires were sent via email every Friday at 3:00 p.m. and could be completed at any point from that moment on until the following Sunday 11:45 p.m. All questionnaires were completed online via the platform SoSci Survey (Leiner, 2021).

As reimbursement, participants entered lotteries for each completed assessment in study parts one and two. Specifically, among all participants who completed the baseline questionnaire, 100 retail vouchers of €25 each were raffled. In study part two, 50 retail vouchers of €10 each were raffled each week. In addition, to uphold study compliance and reduce dropouts, participants were informed in the 11th week (June 25) that all participants who completed all questionnaires in Weeks 11–15 would receive an additional €10 voucher. A total of 5,989 (at least partially) completed weekly questionnaires are available for the analyses in the present manuscript.

Relative to the total number of possible weekly questionnaires $(10,935)^5$ this corresponds to a compliance rate of 55%.⁶

Measurement Instruments

In this section, only relevant measures for the present analyses are reported.

Questionnaire length varied between 70 and 107 items per week. Questionnaires varied in length because some items (none of the items relevant to the present research) were not assessed every week (for more information including a complete overview of all assessed constructs in this project see codebook; <https://osf.io/csfgw>; Neubauer, Kramer, & Soenens, 2022).

Baseline Assessment

Big Five Personality Traits. The Big Five personality traits were measured using the short version of the Big Five Inventory (Rammstedt & John, 2005). A total of 21 items assessed the personality traits agreeableness (four items), conscientiousness (four items), extraversion (four items), neuroticism (four items), and openness to experience (five items). Overall, 22 participants (5%) had missing values on the Big Five personality traits agreeableness, conscientiousness, extraversion, neuroticism, and openness to experience. Internal consistencies (McDonald's ω) in the present sample were agreeableness: $\omega = .53$,

conscientiousness: $\omega = .69$, extraversion: $\omega = .77$, neuroticism: $\omega = .71$, and openness: $\omega = .73$.

We controlled for the Big Five personality traits on the between-person level given their associations with need fulfillment and well-being shown in prior studies (e.g., Neubauer & Voss, 2016; Steel et al., 2008).

Weekly Assessments

Study Motivation. Participants were instructed to think about all study-related tasks (e.g., attending lectures, working on assignments, and reading literature) they had completed in the past week and to rate, why they completed these tasks. To that end, they were asked to rate 12 items describing different reasons on a 7-point Likert scale from not at all to very much. These items were adapted from the Self-Regulation Questionnaire (Ryan & Connell, 1989; Sheldon et al., 2017). All items started with the question stem “I was working for my studies this week...” followed by three items capturing external motivation (e.g., “... because important people (e.g., parents, friends, lecturers) expected me to do this.”), three items capturing introjected motivation (e.g., “... because I would have felt bad if I had not done this.”), three items capturing identified motivation (e.g., “... because the contents of my studies were personally important to me.”), and three items capturing intrinsic motivation (e.g., “... because I found the contents of my studies exciting.”). For each week and each person, the three items of each subscale were averaged and a score of autonomous motivation was created as a weighted average between the four subscales. Following, for example, Litalien et al. (2013) and Milyavskaya and Koestner (2011), we computed the relative autonomy index for autonomous study motivation as $2 \times \text{Intrinsic Motivation} + 1 \times \text{Identified Motivation} - 1 \times \text{Introjected Motivation} - 2 \times \text{External Motivation}$. Hence, positive values indicated relatively autonomous motivation, negative values indicated relatively controlled motivation. Internal consistencies

(estimated as multilevel McDonald's ω ; Geldhof et al., 2014) were $\omega_{\text{within}} = .53/\omega_{\text{between}} = .92$ for external motivation, $\omega_{\text{within}} = .55/\omega_{\text{between}} = .72$ for introjected motivation, $\omega_{\text{within}} = .72/\omega_{\text{between}} = .84$ for identified motivation, and $\omega_{\text{within}} = .86/\omega_{\text{between}} = .99$ for intrinsic motivation.

Affective Well-Being. Items assessing affective well-being were chosen to capture the four quadrants of the affect circumplex (Russell, 1980). For this purpose, positive affect was surveyed with four items: “happy” and “cheerful” for high arousal positive affect and “relaxed” and “balanced” for low arousal positive affect. Furthermore, four items were included to capture negative affect: “afraid” and “angry” for high arousal negative affect, “worried” for moderate negative affect, and “sad” for low arousal negative affect. Participants were asked how much they experienced the feelings in the past week on a 7-point Likert scale ranging from not at all to very much. Internal consistencies were acceptable for both scales with positive affect $\omega_{\text{within}} = .80/\omega_{\text{between}} = .91$ and negative affect $\omega_{\text{within}} = .68/\omega_{\text{between}} = .91$.

Need Fulfillment. We used the 18-item Balanced Measure of Psychological Needs Scale (German instructions and items: Neubauer & Voss, 2016; English instructions and items: Sheldon & Hilpert, 2012) to capture basic psychological need fulfillment. This instrument measures satisfaction of the three needs for autonomy, competence, and relatedness with three items each. The remaining nine items capture frustration of the three needs (also with three items per need). Participants were instructed to read all statements carefully and indicate to what extent they agreed with them, referring to the past week. Responses were given on a 7-point Likert scale ranging from completely disagree to completely agree. Internal consistencies in the present sample were $\omega_{\text{within}} = .63/\omega_{\text{between}} = .81$ for autonomy satisfaction, $\omega_{\text{within}} = .53/\omega_{\text{between}} = .82$ for autonomy frustration, $\omega_{\text{within}} = .81/\omega_{\text{between}} = .97$ for competence

satisfaction, $\omega_{\text{within}} = .67/\omega_{\text{between}} = .93$ for competence frustration, $\omega_{\text{within}} = .83/\omega_{\text{between}} = .98$ for relatedness satisfaction, and $\omega_{\text{within}} = .69/\omega_{\text{between}} = .95$ for relatedness frustration. A six-factor model estimated in multilevel confirmatory factor analysis with factors autonomy satisfaction, autonomy frustration, competence satisfaction, competence frustration, relatedness satisfaction, and relatedness frustration yielded acceptable model fit, comparative fit index (CFI)=0.95, root-mean-square error of approximation (RMSEA) = 0.03, standardized root-mean-square residual (SRMR): SRMR_{within} = 0.04 and SRMR_{between} = 0.06.

Data Analysis

Hypotheses 1 + 2: Structure of Autonomous Study Motivation

We used the robust maximum likelihood estimator to test the first and the second hypothesis. The four factors external, introjected, identified, and intrinsic motivation were defined by three items each. Thus, a total of 12 items capturing autonomous study motivation were used in a two-level confirmatory factor analysis (Level 1 = repeated measures, Level 2 = individuals), with four correlated factors on both levels. The first hypothesis was evaluated based on model fit indices and model comparisons. We evaluated model fit as acceptable if the CFI was larger than 0.90, the RMSEA was smaller than 0.08 and if the SRMR was smaller than 0.08. Regarding model comparisons, the fit of a two-factor model and the fit of a one-factor model was compared against the fit of the four-factor model. In the one-factor model, all items are loaded on one common factor on both levels. In the two-factor model, the items capturing external and introjected motivation loaded on one factor, while the items capturing intrinsic and identified motivation loaded on a second factor on each level. The fits of these two models were compared to the fit of the four-factor model using the Bayesian information criterion (BIC), the CFI, the RMSEA, and the SRMR. Specifically, the four-factor model was accepted if (a) the BIC

was smaller for the four-factor model than for the other two models, (b) the RMSEA of the four-factor model was not larger than 0.02 compared to the RMSEA of the other two models, (c) the CFI of the four-factor model was not smaller than 0.01 compared to the CFI of the other two models, and (d) the SRMR of the four-factor model was not larger than 0.03 compared to the SRMR of the others two models.⁷ Because there were two SRMR comparisons, one for each level, criterion (d) was considered met if it was met for at least one SRMR comparison. The four-factor model was chosen over the two alternative models if at least three of the four criteria (a)–(d) were met. The first hypothesis was considered supported, if three conditions were applied: (a) Model fit of the four-factor model was considered acceptable, (b) the four-factor model was preferred over the two-factor model, and (c) the four-factor model was preferred over the one-factor model.

The second hypothesis was evaluated based on factor correlations. The four specified correlations were examined using two-sided tests with an α level of .05.

Hypotheses 3–5: Autonomous Study Motivation, Need Fulfillment, and Affective Well-Being

We used multilevel structural equation modeling to test the third, fourth, and fifth hypotheses. Two different two-level models were estimated: In the first model, autonomous study motivation was added as a predictor, and positive and negative affect as outcomes. This regression model was estimated on the within-person level and the between-person level. Random slopes were estimated for the within-person effects (autonomous motivation predicting positive affect and negative affect, respectively); covariances among random intercepts and random slopes on Level 2 were estimated. On both levels, the residual covariances between positive and negative affect were estimated. The third hypothesis was evaluated based on the regression coefficients of autonomous study motivation predicting positive and negative affect

on both levels. We extended the model established to test the third hypothesis in a second model in which need satisfaction and need frustration were added as mediator variables, and the residual covariance between need satisfaction and need frustration was added on each level. Directed paths were added from autonomous study motivation to the two mediators (need satisfaction and need frustration), and from the two mediators to positive and negative affect. This regression model with one predictor, two parallel mediators, and two outcomes was estimated on both levels. Four indirect effect estimates and two total effect estimates were computed per level. Again, random slopes were estimated for all within-person effects. Additionally, covariances were estimated among random intercepts and random slopes on Level 2. The fourth hypothesis was evaluated based on the indirect effect of autonomous study motivation on positive affect mediated by need satisfaction, and the indirect effect of autonomous study motivation on negative affect mediated by need frustration, respectively. To test the fifth hypothesis, the direct effect estimates of autonomous study motivation on positive affect and negative affect from the model established in Hypothesis 4 were examined. For hypotheses testing 3–5, we used the Bayes estimator, which allows for latent person-mean centering of the predictors as testing random slopes in the model. We used Mplus default priors and two Markov Chain Monte Carlo (MCMC) chains with 5,000 iterations, and a thinning factor of 10. We considered parameters to be statistically significantly different from zero if their 95% credible interval did not contain zero. Reported estimates are medians of the posterior parameter distributions and their 95% credible intervals. Unstandardized coefficients are reported as b , standardized coefficients as β .

Covariates

In all multilevel regression models (Hypotheses 3–5), we included the following set of covariates: On the between-person level, we included the Big Five personality traits and a dichotomous variable coding the sample (0 = starting sample, 1 = refreshment sample). Directed paths were added from each of these observed covariates (a) to positive and negative affect (Hypothesis 3) and (b) to positive and negative affect, as well as to need satisfaction and need frustration (Hypotheses 4 and 5). On the within-person level, we controlled for potential time trends with three variables. The first variable, semester, was a dichotomous variable coding the semester (0=summer semester, Weeks 1–15; 1=winter semester, Weeks 16–30). The second variable, week, coded weeks within each semester and was coded from 0 (first week of the semester) to 1 (last week of the semester) in 1/14 increments. The third variable, week squared, was the square of the variable week and was included to account for possible quadratic time trends. Directed paths were added to positive and negative affect, as well as to need satisfaction and need frustration. Effects of all covariates were added as fixed effects.

Results

Descriptive statistics for all key variables (autonomous study motivation, need satisfaction, need frustration, positive affect, and negative affect) can be found in Table 1. A correlation table including all variables can be found in Table S2 in the online supplemental materials. Intraclass correlations (ICCs; see Table 1) showed that variations in key variables were due to both within- and between- person variation, with ICCs ranging from 0.47 to 0.66. For autonomous study motivation, within-person variance was 10.03 and between-person variance 19.40. For need satisfaction and need frustration, within-person variance was very similar: Need satisfaction had a within-person variance of 0.66 and need frustration a within-person variance of 0.64; on the between-person level, the variance estimate for need satisfaction

was 0.67 and for need frustration 0.88. Finally, within-person variance was 0.89 for positive affect and between-person variance was 0.80; negative affect varied 0.98 on the within-person level and 1.13 on the between-person level (Table 1). Thus, we can conclude that all variables showed variance on both the within- and the between-person level. Graphical representations of time trends of the key variables can be found in Figures S1–S5 in the online supplemental materials. As can be seen in the graphs, autonomous study motivation decreased during the summer semester (Weeks 0–14), then increased at the beginning of the winter semester (Weeks 14–15), and decreased again across the winter semester (Weeks 15–30; Figure S1 in the online supplemental materials). Need satisfaction increased during the summer semester and remained relatively stable during the winter semester (Figure S2 in the online supplemental materials). Need frustration increased slightly over the two semesters (Figure S3 in the online supplemental materials). Positive affect remained relatively stable during the summer semester (until Week 15), and decreased across the winter semester (Weeks 15–30; Figure S4 in the online supplemental materials). Last, negative affect initially decreased in the summer semester (until Week 9), and then increased across the winter semester (Figure S5 in the online supplemental materials).

Measurement Model for Autonomous Motivation

The specified four-factor model yielded acceptable model fit according to our criteria: CFI = 0.93, RMSEA = 0.04, SRMR_{within} = 0.04, and SRMR_{between} = 0.13 (see Table 2). The BIC of the four-factor model was smaller than the BIC of the specified one- and two-factor models.⁸ Furthermore, all fit indices favored the four-factor model over the alternative models (see Table 2). Hence, according to our decision criteria, we considered the first hypothesis as supported by the data.

In our second hypothesis, we predicted positive correlations between the factors intrinsic and identified as well as between the factors external and introjected motivation on the within- and the between-person level. As shown in Table 3, the correlations between the latent factors intrinsic and identified motivation were very large, $r_{\text{within}} = .94$ ($p < .01$) and $r_{\text{between}} = .97$ ($p < .01$). Correlations between external and introjected motivation were smaller, but also statistically significant, $r_{\text{within}} = .23$ ($p < .01$) and $r_{\text{between}} = .59$ ($p < .01$).

Association Between Autonomous Motivation and Affective Well-Being

The two MCMC chains converged successfully (Potential Scale Reduction [PSR] = 1.001) and we did not identify any irregularities when inspecting the trace plots and the autoregression plots. As predicted by our third research hypothesis, autonomous study motivation positively predicted positive affect on the within-person level, $b = .10$, 95% credible interval [0.09, 0.11], $\beta = .33$ [0.30, 0.36], and on the between-person level, $b = .08$ [0.06, 0.10], $\beta = .44$ [0.35, 0.52]. Moreover, autonomous study motivation was negatively associated with negative affect on the within-person level, $b = -.08$ [-0.09, -0.07], $\beta = -.25$ [-0.27, -0.22], and on the between-person level, $b = -.09$ [-0.11, -0.07], $\beta = -.41$ [-0.50, -0.32], respectively.

Need Fulfillment as Mediator of the Association Between Autonomous Motivation and Affective Well-Being

Figure 1 shows the standardized path coefficients of the specified multilevel mediation model. Again, we did not identify any irregularities within the graphical inspection of the trace- and the autoregressive plots. The maximum PSR was 1.001, indicating that the MCMC chains converged successfully. As hypothesized, there was a statistically meaningful indirect effect of autonomous study motivation on positive affect through need satisfaction on the within-person level, $ab = .04$, 95% credible interval [0.03, 0.05] and on the between-person level, $ab = .07$

[0.05, 0.08]. Furthermore, there was a statistically significant indirect effect of autonomous study motivation on negative affect through need frustration on both levels: within-person level, $ab = -.04 [-0.05, -0.03]$, and between-person level, $ab = -.09 [-0.11, -0.07]$. After mediators were included on the within-person level, direct effects of autonomous study motivation on positive affect, $b = .04 [0.03, 0.05]$, $\beta = .12 [0.09, 0.15]$ and on negative affect, $b = -.02 [-0.03, -0.01]$, $\beta = -.06 [-0.09, -0.03]$, remained significant. On the between-person level, the direct effects of autonomous study motivation on positive affect, $b = -.01 [-0.02, 0.01]$, $\beta = -.03 [-0.12, 0.07]$ and on negative affect, $b = .02 [-0.01, 0.04]$, $\beta = .07 [-0.03, 0.16]$, were no longer statistically significant.

Sensitivity Analyses

We conducted sensitivity analyses to examine whether the pattern of results regarding the links among autonomous study motivation, need fulfillment, and affective well-being would change (a) when excluding $n = 16$ students in the starting sample who were not in their first or second semester in the summer semester of 2021,⁹ (b) when calculating autonomous study motivation as $1 \times \text{Intrinsic Motivation} + 1 \times \text{Identified Motivation} - 1 \times \text{Introjected Motivation} - 1 \times \text{External Motivation}$ (e.g., Hope et al., 2019; Sheldon et al., 2004), and (c) when excluding $n=156$ students who completed less than 30% of weekly questionnaires. Last, we conducted further sensitivity analyses in which we used residual dynamic structural equation models to account for autocorrelations among the residuals. The pattern of reported results did not change in any of these sensitivity analyses (see the online supplemental materials: sensitivity analyses for details).

Discussion

Why students work on tasks related to their studies may be a critical predictor of their long-term engagement and consequently their successful degree completion. The data of the present study show that autonomous study motivation shows meaningful within-person variation from week to week. We targeted both the internal structure of autonomous study motivations as well as its associations with week-to-week fluctuations in fulfillment of basic psychological needs and affective well-being.

Structure of Autonomous Motivation

Previous research supported the prediction of a continuous representation of autonomous motivation on the between-person level, implying a quasi-simplex structure of motivation in which adjacent factors on the continuum (e.g., external and introjected motivation; intrinsic and identified motivation) are positively correlated (e.g., Howard et al., 2017; Litalien et al., 2017; Sheldon et al., 2017). We examined the structure of autonomous study motivation on the within-person level and the between-person level using intensive longitudinal data which is crucial to understand the ebbs and flows of autonomous study motivation as well as their antecedents and consequences.

Results were in line with the predicted four-factor structure and the postulated quasi-simplex pattern of autonomous study motivation on both the within-person and the between-person level. The adjacent factors external and introjected motivation as well as intrinsic and identified motivation were positively correlated on both levels. Thus, in weeks in which students reported higher intrinsic study motivation, students also reported higher identified study motivation. Additionally, in weeks in which students reported higher external motivation, they also reported higher introjected motivation. On the between-person level, those students who

reported higher intrinsic motivation also reported higher identified motivation, while students who reported higher external motivation also reported higher introjected motivation.

When inspecting the correlation pattern among all four subfacets of autonomous motivation (see Table 3), there were some differences between the within-person level and the between-person level: For example, intrinsic and introjected motivation were significantly positively correlated on the within-person level, whereas no statistically significant correlation was identified on the between-person level. Intrinsic and external motivation correlated significantly negatively on the between-person level, while no statistical significance was reached on the within-person level. So, for instance, students who reported on average more intrinsic study motivation, reported on average lower external study motivation, but a week in which a student reported higher than usual intrinsic study motivation was not necessarily a week in which this student reported lower than usual external study motivation. Thus, our results extend results reported in previous research (e.g., Howard et al., 2017; Litalien et al., 2017; Sheldon et al., 2017) regarding the overall structure of autonomous motivation to both, the between-person level and the within-person, week-to-week level. Results also demonstrate, however, that there may be more or less subtle differences between the within-person measurement structure and the between-person measurement structure as evidenced by the slightly distinct intercorrelation pattern of the subscales across levels. These results emphasize the necessity to target psychometric issues on all levels of analyses because measurement structure on one level cannot be used to infer the measurement structure on other levels of analyses (e.g., Hamaker, 2012; Molenaar, 2004; Voelkle et al., 2014).

Associations Between Autonomous Motivation and Affective Well-Being

According to SDT (Ryan & Deci, 2017) and prior empirical research (e.g., Hope et al., 2019; Litalien et al., 2013; Perunovic et al., 2011), autonomous motivation is positively associated with individuals' well-being. To the best of our knowledge, no prior study focused on the link between autonomous study motivation and affective well-being on both the within- and the between-person level using intensive longitudinal data. Our findings are in line with SDT's prediction: Results indicated that autonomous study motivation was associated with positive and negative affect. On the within-person level, this means that students reported both higher positive affect and lower negative affect in weeks in which they reported higher autonomous study motivation than they did on average. On the between-person level, students with higher autonomous study motivation reported higher affective well-being than students with lower autonomous study motivation. These findings stand partially in contrast to results reported in prior studies (e.g., Bailey & Phillips, 2016), which identified correlations of intrinsic and introjected motivation with positive but not negative affect, whereas external motivation was not related to either positive or negative affect. These differences may be due to various reasons: For example, while Bailey and Phillips (2016) used separate factor scores for each motivation type and examined their correlations with affective well-being, we calculated an index of autonomous motivation that provided information about whether a student was more or less autonomously motivated. Additionally, students referred to their reasons for studying in Bailey and Phillips' study (2016). In the present study, students were not asked for what reasons they were studying, but why they completed tasks and assignments for their studies in the past week. It is conceivable that the reasons for which students pursue their studies in general and the reasons why they completed tasks for their studies in the past week may differ. For example, students may study because they are interested in the subject (e.g., because they are interested in

psychology). In contrast, they may have completed assignments for their studies in the previous week solely because they are required to pass an exam that is part of the course of study (e.g., they are not interested in statistics, but passing the statistics course is a prerequisite for studying psychology).

Need Fulfillment as Mediator of the Association Between Autonomous Motivation and Affective Well-Being

In examining the links among autonomous study motivation, need fulfillment, and affective well-being, we considered suggestions by Vansteenkiste and Ryan (2013) and further researchers (e.g., B. Chen et al., 2015; Neubauer, Kramer, & Schmiedek, 2022; Schmidt et al., 2020) who emphasized the relevance of separating need satisfaction from need frustration. Results regarding the links among autonomous study motivation, need fulfillment, and affective well-being were in line with predictions by SDT (Ryan & Deci, 2017): Weekly fluctuations in autonomous study motivation were related to (a) need satisfaction, which in turn was related to positive affect, and related to (b) need frustration, which in turn was related to negative affect. This pattern was observed both, on the between-person level and the within-person level. These results are in line with ideas of a “bright path” of need fulfillment (positive inputs relate to well-being via need satisfaction) and a “dark path” of need fulfillment (negative inputs relate to ill-being via need frustration; Vansteenkiste & Ryan, 2013). Between-person results were consistent with results by Hope et al. (2019), in which higher autonomous motivation for self-set goals was associated with higher need satisfaction 2 months later, which in turn was associated with higher affective well-being 3 months later. On the between-person level, our results were in line with full mediation, while partial mediation was identified on the within-person level. Potentially, this remaining direct effect of autonomous motivation could either be

mediated by other variables such as sustained effort and goal attainment as suggested by the self-concordance model (Sheldon & Elliot, 1999) or in fact, directly relate to affective well-being on the weekly level. Such an effect that is not mediated by need fulfillment poses a challenge to basic psychological needs theory, which emphasizes the crucial role of need fulfillment for well-being. Notably, these direct effects were rather small, however, and might indicate that such direct effects of autonomous motivation are small and/or transient.

It is important to add here that our model was built on the theoretical prediction by SDT, which suggests a mediating role for need fulfillment. We note that some prior studies have tested models assuming different causal directions (e.g., Hope et al., 2019; McDonough & Crocker, 2007; Milyavskaya & Koestner, 2011; Vandercammen et al., 2014). For example, based on cross-sectional results, Milyavskaya and Koestner (2011) suggested that the effect of need satisfaction on well-being (operationalized as vitality and affective well-being) was partially mediated by autonomous motivation. In the study of Vandercammen et al. (2014), the links between the three basic psychological needs and intrinsic motivation were partially mediated by positive and negative affect. Taken together, there has been some inconsistency in these prior studies with regard to the assumed direction of the effects among autonomous motivation, need fulfillment, and well-being. Potentially, the link between autonomous motivation and need fulfillment is reciprocal across time (e.g., Hope et al., 2019), with positive experiences (need fulfillment) derived from autonomously regulated goal pursuit fueling the internalization of motivation and thereby fostering autonomous motivation. Future research might target this question, for instance using measurement-burst designs (Sliwinski, 2008), which could allow to better understand the reciprocal links among autonomous motivation, need fulfillment, and well-

being, as well as their downstream consequences for long- term socioemotional adjustment and academic achievement.

The present study was built on premises derived from SDT and aligns with similar work in this area (e.g., Hope et al., 2019; Litalien et al., 2013; Ryan & Deci, 2017), but these findings also have implications for other theoretical approaches to motivation in educational settings. For instance, achievement goal theory (e.g., Elliot & Thrash, 2001) also emphasizes that the reasons for a particular behavior (e.g., improving one's skills and developing competence vs. demonstrating competence) are an important predictor of motivational processes and attainment (e.g., Schwinger et al., 2016). Achievement goals in educational contexts have also been shown to vary within individuals and to be linked to emotional experiences (e.g., Goetz et al., 2016) as well as perceived experiences of competence (Neubauer, Schmidt et al., 2022). Future research is needed to disentangle the unique roles of achievement goals and autonomous study motivation for week-to-week fluctuations in affective well- being. Combining these theoretical perspectives could aid in further improving our understanding of the antecedents of study satisfaction, dropout intentions, and degree completion in tertiary education.

Limitations

A number of limitations of the present research need to be considered. First, the links among autonomous study motivation, need fulfillment and affective well-being were based on contemporaneous associations, which does not allow for an unambiguous interpretation of causal effects. As discussed above, alternative, possibly reciprocal, directions of effects are also possible. Second, autonomous motivation was specifically examined in relation to study-related tasks and assignments, whereas need fulfillment and affective well-being were examined in a domain-general fashion. Week-to-week fluctuations in need fulfillment and affective well-being

are related to multiple causes, at least some of which are unrelated to individuals' study-related tasks and assignments. Future studies may capture need fulfillment and affective well-being specifically related to studying to match the level of generality between the predictor and the outcomes. Third, results were based on a predominantly female convenience sample of university students in Germany, and the study was conducted in the midst of the COVID-19 pandemic. Building on SDT's universality claim, it might be suspected that a similar pattern of results can also be observed in other samples and time periods, but this generalizability needs to be put to a test before it can be assumed. Last, internal consistencies (McDonald's ω) were low for some of the constructs on the within-person level. However, this indicator is built on the assumption of a reflective measurement model, which may not be perfectly suitable for intensive longitudinal data. Other approaches for estimating the reliability of time-varying constructs (e.g., Dejonckheere et al., 2022) can help gain further insight into the psychometric properties of the scales.

Conclusion

Students varied from week to week in their autonomous study motivation, that is, students were more autonomously motivated in some weeks than in other weeks. In weeks, in which students studied for more autonomously motivated reasons, they reported higher need fulfillment and higher affective well-being. Additionally, students differed in their autonomous study motivation, that is, some students were more autonomously motivated on average than others were. Students who reported higher autonomous study motivation also reported higher need fulfillment and higher affective well-being. The present findings suggest that autonomous study motivation may be crucial to better understand socioemotional adjustment in university students which is in turn an important step toward not only protecting and improving university

students' mental health, but also developing interventions for reducing student dropout and fostering educational attainment in tertiary education.

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Table 1

Descriptive Statistics for Autonomous Study Motivation, Need Satisfaction, Need Frustration, Positive Affect, and Negative Affect

Number	Variable	<i>M</i>	Var _b , Var _w	Range	ICC	Correlation				
						1	2	3	4	5
1	NS	4.70	0.67, 0.66	1-7	.50	—	-.35	.53	-.34	.31
2	NF	3.03	0.88, 0.64	1-7	.58	-.49	—	-.44	.48	-.33
3	PA	4.39	0.80, 0.89	1-7	.47	.77	-.55	—	-.57	.34
4	NA	3.10	1.13, 0.98	1-7	.54	-.47	.76	-.65	—	-.24
5	MOT	4.27	19.40, 10.03	-16.00-18.00	.66	.55	-.63	.47	-.43	—

Note. N = 488. Within-person correlations are shown above the diagonal. Between-person correlations are shown below the diagonal. NS = need satisfaction; NF = need frustration; PA = positive affect; NA = negative affect; MOT = autonomous study motivation; Mean = overall mean for all 5,878 observations; Var_b, Var_w = variance between, variance within; ICC = intraclass correlation.

Table 2

Autonomous Study Motivation: Model Comparison of a Four-Factor Model With a Two- and a One-Factor Model

Factor	BIC	CFI	RMSEA	SRMR	
				Within	Between
1	210,316.965	0.80	0.07	0.08	0.19
2	208,640.960	0.87	0.06	0.07	0.18
4	207,136.082	0.93	0.04	0.04	0.13

Note. N = 486. For the one-factor model, convergence could only be achieved after setting the factor variances to one and freeing the factor loadings of the first item per factor. BIC = Bayesian information criterion; CFI = comparative fit index; RMSEA=root-mean-square error of approximation; SRMR= standardized root-mean-square residual.

Table 3

Autonomous Study Motivation: Factor Correlations Among External, Introjected, Identified, and Intrinsic Motivation

Motivation	External	Introjected	Identified	Intrinsic
External	—	.23**	.09	.01
Introjected	.59**	—	.76**	.56**
Identified	-.20**	.25	—	.94**
Intrinsic	-.20**	.21	.97**	—

Note. N = 486. Within-person correlations are shown above the diagonal. Between-person correlations are shown below the diagonal.

**p,.01.

Figure 1

Mediation Model: Predicting Affective Well-Being From Autonomous Study Motivation and Need Fulfillment

