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Examining the Within- and Between-Person Structure of a Short Form of the Positive and Negative Affect Schedule: A Multilevel and Dynamic Approach

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Increasing research uses intensive longitudinal designs to examine antecedents and consequences associated with dynamic affective processes. These studies often rely on the Positive and Negative Affect Schedule (PANAS) to measure affect. Studies assessing the structure of the PANAS are largely cross-sectional in nature and cannot always disentangle within-person variability from between-person differences in affect. A paucity of studies examines structural similarities and differences in affect at the between- and within-person levels, and few have done so with short-form versions of the PANAS. This study investigates the multilevel factor structure of the 10-item PANAS–short-form in a sample of young adults ($n = 272$) measured daily consecutively over 1 month. Additionally, dynamic relations between positive and negative affect, depressive symptoms, stress, and physical symptoms were examined. Results support a three factors within and two factors between multilevel structural model. Distinct dynamic relations were observed among positive affect, negative affect, stress, and physical symptoms at the within level. Positive and negative affect were correlated with depressive symptoms, stress, and physical symptoms at the between level. Findings indicate the need to disentangle structural components of positive and negative affect when conducting intensive longitudinal studies to examine correlates linked to dynamic affective processes.

Public Significance Statement

This study supports the multidimensional and multilevel structure of affect as dynamic processes assessed through a short-form version of the PANAS. This finding has implications for applied researchers interested in examining antecedents and consequences associated with between- and within-person differences in affect.

Keywords: multilevel confirmatory factor analysis, positive affect, negative affect, daily diary, dynamic structural equation modeling

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Research has paid considerable attention to the structure of affect in the psychological sciences (Brose et al., 2015, 2020; Eid & Diener, 1999). Cumulative evidence supports the distinction between two-factors (Bleidorn & Peters, 2011; Charles et al., 2019; Eisele et al., 2021; Jacobson et al., 2021; Wedderhoff et al., 2021; Wilhelm & Schoebi, 2007), although three-factor (Allan et al., 2015; Gaudreau et al., 2006; Killgore, 2000) and higher order (Mihić et al., 2014) structures have also been identified. Structural models of affect based on the circumplex model (Barrett & Russell, 1999; Brose et al., 2015) posit that affect varies along a two-dimensional space between valence (i.e., pleasant and unpleasant) and arousal (i.e., high activation and low activation). Hence, affect is prototypically a two-factor structure (i.e., positive [e.g., inspired, determined] and negative [e.g., shame, fear]). Watson and Tellegen (1985) assert that similarly valenced experiences (e.g., alert and attentive) are positively associated and that opposite dimensions

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(i.e., positive and negative) are independent. Empirical evidence of this assertion is mixed, often reporting bipolar (e.g., weak and negative) associations between unpleasant and pleasantly valenced experiences (Barrett & Russell, 1998, 1999; Tellegen et al., 1999). Inconsistencies regarding dimensional independence and bipolarity may be partly attributable to differences in response formats (e.g., frequency vs. intensity) and reporting timeframes (e.g., days vs. years; Barrett & Russell, 1999; Scott et al., 2020).

The conventional two-dimensional structural model has received empirical support primarily from between-person studies with cross-sectional designs (e.g., Sanmartín et al., 2018; Thompson, 2007; Watson et al., 1988). A growing body of research recognizes the need to assess affect as a complex dynamic process (see Brose et al., 2020), yet cross-sectional designs may not be well suited to disentangle within-person from between-person differences in affective dimensions. As such, researchers are increasingly using intensive longitudinal designs (e.g., ecological momentary assessment, daily diary assessment) to examine affective processes occurring within-persons at different time scales (e.g., moment-to-moment, day-to-day; Brose et al., 2015, 2020; Scott et al., 2020).

Extant studies examining within-person fluctuation in affective experiences have reported substantial individual differences in the association between affect and depressive symptoms (Merz & Roesch, 2011), physical symptoms, and stress (Rush & Hofer, 2014). Individuals reporting higher within-person levels of positive affect generally show lower within-person levels of depressive symptoms, physical symptoms, and stress (Merz & Roesch, 2011; Rush & Hofer, 2014). Conversely, those with higher within-person levels of negative affect report more depressive symptoms (Merz & Roesch, 2011), physical symptoms, and stress (Rush & Hofer, 2014). These findings are not always equivalent at the between-person level (Brose et al., 2015). For instance, Merz and Roesch (2011) found no significant association between positive affect and depressive symptoms at the between-person level. Rush and Hofer (2014) reported a null relation in the between-person association of negative affect and an aggregate measure of daily stressors. Clearly, studies should not assume convergence in observed associations across levels. There is substantive evidence to support the need to account for differences in processes occurring at the within- and between-person levels.

Increased longitudinal assessment of affective dynamics and processes is hindered by a paucity of psychometrically valid and sound measures of affect that accurately and reliably assess within-person differences in affective dimensions. Brose et al. (2020) highlight this issue in their meta-analysis of 50 empirical studies using longitudinal designs to examine within-person affective processes and associated outcomes. Most of the identified studies neglected to disentangle structural domains of affect varying within- and between-persons. Additionally, many of the studies examined within-person relations between affective processes and correlates using instruments validated only at the between-person level (Brose et al., 2020).

Between-person structural models often fail to translate to within-person domains. Several studies provide support for the two-factor model with inversely related dimensions at the within-person level (Bleidorn & Peters, 2011; Brose et al., 2015; Eisele et al., 2021; Merz & Roesch, 2011; Rush & Hofer, 2014). However, most of the studies supporting the two-factor structure at the within-level used long form instruments (e.g., the 20-item Positive and Negative Affect Schedule [PANAS]) to assess affect. Other studies using short-form versions of PANAS report superior fit of a three-factor model over the two-factor model at the within-person level. Among a sample of 293 adolescents followed daily over 2 weeks, for instance, Eadeh et al. (2020) found that the best-fitting model for the child version PANAS short-form included three-factors (PA, fear, distress) within- and two-factors (PA, NA) between persons. Wilhelm and Schoebi (2007) reported similar results in a sample of 187 adults assessed four times a day over 7 days using the Multidimensional Mood Questionnaire. Some studies suggest more complex within-person affective structures including models with four factors (Möwisch et al., 2019), five factors (Charles et al., 2019; Cranford et al., 2006), six factors (Leonhardt et al., 2016), and seven factors (Jacobson et al., 2021).

These studies demonstrate that the traditional two-factor structure of affect, based on the circumplex model (Barrett & Russell, 1999) and validated using cross-sectional designs, may not be equivalent at the within-person level (Brose et al., 2015; Scott et al., 2020). The structural complexity of affect likely varies as a function of differences in reporting time frames (e.g., moment-to-moment, day-to-day; Scott et al., 2020), response format (i.e., current vs. retrospective, frequency vs. intensity; Brose et al., 2015, 2020; Kuppens et al., 2010), and semantic differences across indicators (Barrett & Russell, 1999). The PANAS (Watson et al., 1988), for instance, uses high arousal (i.e., highly active) indicators of positive (e.g., alert, inspired, determined, attentive) and negative (e.g., hostility, shame, fear, nervousness) affect. These items may not capture the full range of valence and arousal (Brose et al., 2015). Measuring affect with other indicators (e.g., guilty, ashamed, jittery, scared) may alter the structural complexity of within-person affective dimensions. Additionally, Scott et al. (2020) findings show that affective processes vary when affective experiences are measured in the moment (e.g., how do you feel right now) or over the day (e.g., how did you feel today). Therefore, it is apparent that research should further examine differences in the within- and between-person structure of affect across different time scales and response formats.

Debate also exists regarding the interrelation between affective dimensions in between-person designs. Some evidence supports dimensional independence as hypothesized in the circumplex model (Jacobson et al., 2021; Rush & Hofer, 2014; Watson et al., 1988). However, research has also reported inverse (Allan et al., 2015; Bleidorn & Peters, 2011; Brose et al., 2015; Gaudreau et al., 2006) and positive (Jacobson et al., 2021; Merz & Roesch, 2011) relations among affective dimensions. Wedderhoff et al. (2021) used a meta-analytic structural equation modeling approach and found a moderate negative link ($r = -.22$) between the PA and NA factors. While this finding provides evidence for a moderate inverse relation between the positive and negative affective dimensions, there is evidence to show that the observed between-person structural components and dimensional bipolarity of affect may not extend to the within-person level (Brose et al., 2020; Eadeh et al., 2020).

Inconsistent findings in the different within- and between-person affective structural components indicate a continued need to examine affective domains at both levels. There are also several limitations to the literature examining within- and between-person affective structures. First, pertinent research has primarily used long-form versions of the PANAS or alternative measures of affect (Bleidorn & Peters, 2011; Brose et al., 2015; Jacobson et al., 2021). Studies employing intensive longitudinal designs often rely on shorter instruments to assess dynamic processes due to time limits. Except for Eadeh et al. (2020), no study has examined the validity of a short-form version of the PANAS at the within- and between-person level. Moreover, Eadeh et al.'s sample included adolescents ($M_{age} = 13.17$) with ($n = 156$) and without ($n = 137$) a diagnosis of attention-deficit/hyperactivity disorder. Hence, it remains unknown whether their findings are generalizable to non-clinical adult populations.

Second, extant research is also limited in their capacity to investigate affective structures over an extended period of time. Only three of the identified studies examined affective structures with more than 20 days of measures using daily diary designs (Brose et al., 2015; Cranford et al., 2006; Jacobson et al., 2021). Daily diary designs with fewer than 14 daily reports may not accurately capture day-to-day fluctuations in affective states (Eisele et al., 2021; Estabrook et al., 2012; Wang & Grimm, 2012). Thus, an important step in modeling affective structures is to use daily diary or other designs (e.g., ecological momentary assessment) extending beyond 2 weeks or 14 time points.

A third limitation involves the lack of validation of the multilevel structural components of affect. Affect is widely used as both a predictor and outcome variable in analyses examining dynamic relations, yet few studies have validated within- and between-person affective structural dimensions (Brose et al., 2020). As such, it is necessary to validate the within- and between-person structural dimensions of affect in relation to commonly examined correlates. Previous validation at both levels of analysis typically includes measures of depressive symptoms (Merz & Roesch, 2011), physical symptoms (Rush & Hofer, 2014), and stress (Brose et al., 2015; Rush & Hofer, 2014).

The Present Study

There is a substantive need to further examine within- and between-person affective structures. Future studies on dynamic affective processes and related outcomes should use valid, reliable, and efficient assessment instruments to accurately capture day-to-day fluctuations in affect. This study extends previous work on affect by disentangling the between- and within-person structure using a 10-item short-form PANAS (Thompson, 2007) in a sample of Canadian university students who participated in a month-long daily diary study. We used multilevel confirmatory factor analysis (MLCFA) to examine several alternative affective structures previously identified and supported in the literature. We also used dynamic structural equation modeling (DSEM) to explore the dynamic day-to-day relations between affective dimensions and several external criteria variables (i.e., depressive symptoms, stress, physical symptoms). Based on the literature, we expected that (a) a three-factor within-person and two-factor between-person model would be the best-fitting structure, and that (b) positive affect (PA) would be inversely related to negative affect (NA), depressive symptoms, stress, and physical symptoms, while NA would be positively linked to them at both within- and between-person levels.

Method

Participants

Participants were first-year undergraduate students ($N = 330$) attending a large Canadian university ($M_{age} = 18.15$ years, $SD = 1.30$, range 17–29, 72.1% female). Participants self-identified their ethnic background as Asian (53.9%), White (29.1%), Black (5.2%), Multiracial (4.5%), Aboriginal (0.9%), Latino or Hispanic (0.9%), or Other (5.5%). Participants were recruited from October to November 2019 to partake in a study that examined their psychological and behavioral adjustment during the transition to university. Participants first completed a baseline survey and subsequently took part in a 30-day daily diary survey. A total of 313 participants ($M_{age} = 18.13$ years, $SD = 1.31$, range 17–29, 72% female, 53% Asian, 30.3% White, 5% Black, 4.7% Multiracial, 0.7% Aboriginal, 1% Latino or Hispanic, 5.3% Other) took part in at least 1 day of the 30-day daily diary study, providing a total of 6,431 daily observations ($M = 21.43$ days, $SD = 9.65$). Among this sample, 41 participants provided five or fewer observations over the 30 days (a total of 77 observations). Clusters with fewer than five observations may not reliably detect within-person structures and can often lead to nonconvergence in the estimation (Asparouhov, 2020; Asparouhov & Muthén, 2022); as such, data from these participants were removed from further analyses. Participants had an open response window to complete the survey to accommodate unique schedules; however, surveys completed more than 24 hr from 7 p.m. the previous day were removed from the analysis to guarantee recall accuracy (34 observations). The final analytic sample included 273 participants (6,320 observations) measured over 30 days ($M = 23.24$ days, $SD = 9.50$, range 6–30). The final sample ($M_{age} = 18.12$, $SD = 1.30$, range 17–29, 73.5% female, 52.2% Asian, 32.4% White, 4.4% Black, 4% Multiracial, 0.7% Aboriginal, 0.7% Latino or Hispanic, 5.5% Other) is demographically comparable to the total sample.

Procedure

The procedure and instruments for this study were approved by the research ethics committee at the University of Alberta. This study was not preregistered. Data are available upon request to the corresponding author. We follow van Roekel et al. (2019) guidelines for reporting intensive longitudinal designs. The sample was recruited through online advertisements, on-campus posters, and short in-class presentations. All first-year undergraduate students who volunteered to participate were eligible for inclusion. The study consisted of two parts following recruitment and acquisition of informed consent. The first part included a 30–45 min long baseline survey developed using RedCap (Harris et al., 2019) and administered to participants via email. The baseline survey assessed various aspects of emotional and psychological health, peer and family relationships, and well-being and adjustment. The second part involved a signal-contingent 30-day daily diary survey. The first daily survey was emailed to participants 3 days following completion of the baseline survey. Surveys were sent by email at 7 p.m. each day and participants were instructed to complete the daily survey before going to sleep. Participants did not receive any training on the daily diary procedure before the study, nor did they receive any email reminders prior to the nightly 7 p.m. survey emails. Both the baseline survey and daily surveys could be completed on smartphones, tablets, or computer devices. However, information pertaining to the types of devices used to complete the surveys were not recorded. Most daily surveys were completed between 7 p.m. and 11:59 p.m. (75.81%) on the same day with the remaining completed the next day between 12 a.m. and 11:59 a.m. (22.43%) or between 12 p.m. and 6:59 p.m. (1.73%). Participants took an average of 9 min to complete daily surveys. Incentives included a $15 e-gift card for participants who completed the baseline survey and fewer than 20-days of the daily survey, and a $60 e-gift card for participants who completed the baseline survey and 20 or more days of the daily survey.

Measures

Positive and Negative Affect

Daily PA and NA were measured with a short form of the PANAS (Thompson, 2007), which is validated across cultures and countries in cross-sectional designs (Karim et al., 2011; Merz et al., 2013). Ten items were rated on a 5-point Likert scale (1 = *very slightly or not at all*, 2 = *a little*, 3 = *moderately*, 4 = *quite a bit*, 5 = *extremely*), with five items for PA (alert, inspired, determined, attentive, active) and NA (upset, hostile, ashamed, nervous, afraid), respectively. Participants indicated the extent to which they felt the way described by these items that day. Following recommended steps in Geldhof et al. (2014), both PA (α_b = .93, ω_b = .93, α_w = .73, ω_w = .74) and NA (α_b = .94, ω_b = .94, α_w = .72, ω_w = .73) demonstrated good internal consistency and reliability.

Depressive Symptoms

Depressive symptoms were measured at one time in the baseline survey using 17 items adapted from the Center for Epidemiological Studies Depression scale (Radloff, 1977). This abbreviated scale measures four dimensions of depressive symptoms including somatic activity ("my sleep was restless"), depressed affect ("I had trouble keeping my mind on what I was doing"), positive affect ("I felt I was just as good as other people"), and interpersonal relationships ("people were unfriendly"). Participants indicated how often the statements described them in the past year on a 4-point Likert scale (0 = *rarely or none*, 1 = *some or a little of the time*, 2 = *occasionally or a moderate amount of time*, 3 = *most or all of the time*). Items for positive affect were reverse coded. Items were averaged, with a higher score indicating higher levels of depressive symptoms. Cronbach's α for the scale was .92, and ω was .93.

Stress

A modified version of the College Chronic Life Stress Survey (Towbes & Cohen, 1996) was used to measure daily stress. A total of 17 items (Appendix) assessed a variety of daily stressors where participants responded to the prompt "Today, did you feel stressed, upset, or worried by the following events or experiences?" on a 3-point scale (0 = *no*, 1 = *just a little*, 2 = *a lot*). Scores were averaged with a higher score indicating higher levels of daily stress. Intraclass correlations (ICC = .34) indicated variation at both the within- and between-person levels. At the between level, Cronbach's α_b for the scale was .94, and ω_b was .95; at the within-level, Cronbach's α_w was .77, and ω_w was .78.

Physical Symptoms

Daily physical symptoms were measured with a checklist of day-to-day physical symptoms adopted from Larsen and Kasimatis (1991). This checklist measures four dimensions of relatively common physical symptoms including depression ("low energy/tired"), aches ("headache"), gastrointestinal problems ("nausea/upset stomach"), and upper respiratory issues ("sore throat"). Fifteen items (Appendix) were selected to measure relatively common physical symptoms in the present study. Participants indicated ("*Yes*" or "*No*") whether they experienced each symptom that day. Scores were averaged with higher scores indicating experiencing more daily physical symptoms. At the between level, Cronbach's α_b for the scale was .90 and ω_b was .91; at the within-level, Cronbach's α_w was .62 and ω_w was .62. ICC (.47) indicated substantial variance at both the within- and between-person level.

Analytic Plan

MLCFA and DSEM were used to examine the structure and relations of PA and NA at the within- and between-person levels. Analyses were estimated using M*plus* Version 8.6 (Muthén & Muthén, 1998–2019). Output and syntax are provided in the Supplemental Materials. First, ICCs for the ten items of PANAS were estimated to determine the appropriateness of multilevel modeling. ICCs were calculated as the proportion of variance from between-person (i.e., stable) differences and within-person variation across days which includes measurement error (Hamaker et al., 2021; Muthén, 1991; Scott et al., 2020). Next, a series of MLCFAs using robust maximum likelihood estimation were fit to determine the optimal structure of the PANAS at the within- and between-person levels. Previous literature has identified several structures: 1 factor within and 1 factor between (1w1b), 1 factor within and 2 factors between (1w2b), 2 factors within and 1 factor between (2w1b), 2 factors within and 2 factors between (2w2b), 2 factors within and 3 factors between (2w3b), 3 factors within and 2 factors between (3w2b), and 3 factors within and 3 factors between structure (3w3b). We used MLCFAs to examine each of these previously identified models. In line with prior works (Allan et al., 2015; Eadeh et al., 2020), we separated the NA dimension into fear and distress subdomains in all models with three factors at the within- and between-person levels. The fear subdimension was represented by two items (i.e., nervous, afraid) while the distress subdimension was reflective of three items (i.e., hostile, ashamed, upset). Each multi-level model included random means/intercepts to separate the within-person and between-person levels. The within-person factor structure, including the factor loadings, was assumed to be the same for each person (i.e., no random factor loadings or residual variances). This was done because of the relatively limited number of repeated measures in the current sample. For simplicity, we assume configural and metric invariance but not scalar invariance, that is, we assume equal loadings and factor structures for different persons but allow different people to have different means or intercepts (i.e., random means/intercepts). At the between-person level, affect represents an aggregate estimate over the 30-day daily surveys.

The best-fitting MLCFA model was determined based on a convergence of evidence from the literature, theory, model fit indices, and factor loadings. The residuals of content relevant items for positive affect (i.e., alert and attentive) and negative affect (i.e., nervous and afraid) were allowed to covary at both levels of analysis when possible (see Eadeh et al., 2020; Rush & Hofer, 2014). Cross-domain item-level residual covariances were not estimated. Positive and negative affect factor residuals were freely correlated in models with more than one latent factor. Model fit indices (Hu & Bentler, 1999) included the root-mean-square error of approximation

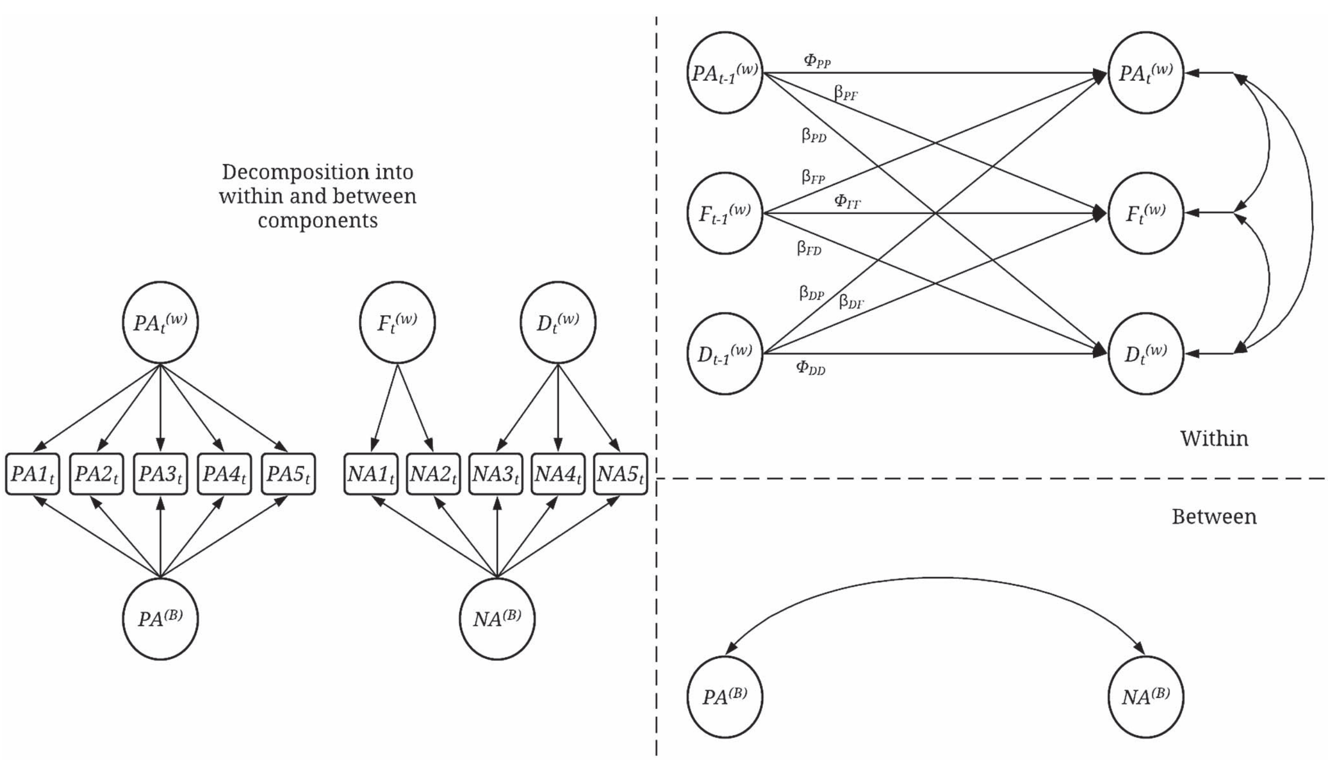
(RMSEA < .05), comparative fit index (CFI > .90), Tucker–Lewis index (TLI > .90), standardized root-mean-square residual (SRMR), Akaike information criterion, Bayesian information criterion (BIC), and the sample size adjusted BIC. Items with factor loadings below 0.30 were considered unrelated to the construct.

The best-fitting MLCFA model was further used to estimate a series of DSEMs, which is a multilevel and structural model ideal for intensive longitudinal data (Asparouhov et al., 2018). DSEM first decomposes variables of interest into within- and between-level components (left panel of Figure 1). Next, reciprocal relations between the within-level components are assessed by specifying lagged associations (i.e., autoregression [Φ] and cross-lagged [β] paths; top panel of Figure 1). DSEMs were estimated with the BAYES estimator in M*plus* using default priors. Model convergence was assessed using several diagnostic criteria including the Potential Scale Reduction statistic, trace plots, and autocorrelation plots (Hamaker et al., 2021). The DSEM model includes (by default) random means/intercepts to separate the within-person and between-person levels. As in the previous analyses (e.g., MLCFA), the factor structure was assumed to be the same for each person. We initially attempted to include random effects for the dynamic structure at the within-level (e.g., random autoregressive and cross-lagged effects), but this led to nonconvergence; thus, we decided to model fixed effects only. Output and syntax for all DSEMs are available in the Supplemental Material. Data are available upon request.

As shown in the top panel of Figure 1, $PA_t^{(w)}$, $F_t^{(w)}$, and $D_t^{(w)}$—which correspond to the best-fitting within-level latent factors of positive affect (PA), fear (*F*), and distress (*D*) identified in the MLCFA—were regressed onto their lagged counterparts of the previous day $PA_{t-1}^{(w)}$, $F_{t-1}^{(w)}$, $D_{t-1}^{(w)}$. At the between-level (bottom panel of Figure 1), PA and NA are represented by latent factors aggregated over 30 days, which is consistent with findings from the best-fitting MLCFA model. Here, PA and NA are correlated and indicate the association between the random intercepts of these components across persons.

Next, three DSEMs were estimated to examine the relations between PA, NA, depressive symptoms, stress, and physical symptoms as fixed effects at the within-level. Model 2 (Figure S1) includes the between-level covariate of depressive symptoms measured once at baseline. The between-level correlations estimate the association between the random intercepts of PA and NA with depressive symptoms. Models 3 (Figure S2) and 4 (Figure S3)

Figure 1
Model 1: DSEM



Note. Observed positive and negative affect items are decomposed into time-varying within-level components and time invariant between-level components. All parameters are fixed at the within-level with random effects at the between-level. $PA1_t$ = alert; $PA2_t$ = inspired; $PA3_t$ = determined; $PA4_t$ = attentive; $PA5_t$ = active; $NA1_t$ = nervous; $NA2_t$ = afraid; $NA3_t$ = hostile; $NA4_t$ = ashamed; $NA5_t$ = upset; *PA* = positive affect; *F* = fear subscale of negative affect; *D* = distress subscale of negative affect; *NA* = negative affect; Φ_{PP} = autoregression path from $PA_{t-1}^{(w)}$ to $PA_t^{(w)}$; β_{PF} = cross-lagged regression path from $PA_{t-1}^{(w)}$ to $F_t^{(w)}$; β_{PD} = cross-lagged regression path from $PA_{t-1}^{(w)}$ to $D_t^{(w)}$; Φ_{FF} = autoregression path from $F_{t-1}^{(w)}$ to $F_t^{(w)}$; β_{FP} = cross-lagged regression path from $F_{t-1}^{(w)}$ to $PA_t^{(w)}$; β_{FD} = cross-lagged regression path from $F_{t-1}^{(w)}$ to $D_t^{(w)}$; Φ_{DD} = autoregression path from $D_{t-1}^{(w)}$ to $D_t^{(w)}$; β_{DP} = cross-lagged regression path from $D_{t-1}^{(w)}$ to $PA_t^{(w)}$; β_{DF} = cross-lagged regression path from $D_{t-1}^{(w)}$ to $F_t^{(w)}$. DSEM = dynamic structural equation modeling.

includes stress and physical symptoms, respectively, as within- and between-level indicators by including them in both levels of the analysis. These models estimate reciprocal relations between PA, fear, distress, stress, and physical symptoms as fixed at the within-level, with correlations among the random intercepts estimated at the between-level which are aggregated over the 30-day survey period.

Results

Roughly, 49%–72% of the variation in the PANAS items were accounted for by day-to-day fluctuations at the within-person level (Table 1). Positive and negative affect items were generally significantly correlated with each other at the within- and between-person levels; however, not all cross-domain items were significantly correlated (e.g., upset and determined). ICCs for stress and physical symptoms (.34 and .47) indicated that these measures also showed a considerable amount of day-to-day variation at the within-person. Note that the within-person level variation includes both variation across levels and due to any measurement error.

Fit indices for the seven MLCFA models (Table 2) indicate that the best-fitting models were represented by a three-factor structure at the within-person level and a two- or three-factor structure at the between-person level (i.e., 3w2b and 3w3b). At the within-person level, positive affect was specified as a single latent factor while negative affect was divided into two separate latent factors: fear (*F*) and distress (*D*). As previously discussed, negative affect was divided into *F* and *D* subdimensions based on evidence from the previous literature estimating subdomains of negative affect at both levels of analysis (Eadeh et al., 2020). In all models, item loading patterns for the *F* (i.e., nervous, afraid) and *D* (i.e., hostile, ashamed, upset) subdimensions were consistent at the within- and between-person levels.

In the 3w2b model, positive and negative affect were estimated as latent factors at the between-person level. Negative affect was separated into the fear and distress factors at the between-person level for the 3w3b model. Difference in model fit and factor loadings between the 3w2b and 3w3b models was trivial; however, the *F* and *D* factors at the between-person level in the 3w3b model were highly correlated ($r = .93$, $p < .001$), indicating potential multicollinearity between these factors (see Eadeh et al., 2020). The between-level SRMR for the 3w2b model was also slightly better than the 3w3b model. The BIC indicated the 3w2b model as the more parsimonious model. Taken together, and considering previous empirical evidence, the 3w2b model was retained as the best-fitting model.

The 3w2b MLCFA model (Figure 2) showed that item loadings for the three latent factors ranged from .40 to .78 at the within-person level. Positive affect was significantly positively correlated with fear ($r = .25$, $p < .001$) but not with distress ($r = .01$, *ns*). Fear and distress were significantly and positively correlated ($r = .73$, $p < .001$). Omega (ω) estimates ranged from .65 to .73. Factor loadings for positive and negative affect were higher at the between-person level, ranging from .68 to .95 (Figure 2). Positive and negative affect were significantly and positively correlated ($r = .22$, $p < .001$) and demonstrated good reliability ($\omega_{PA} = 0.92$, $\omega_{NA} = 0.94$) at the between-person level. Residual correlations were significant and positive for the items alert and attentive at both levels ($r_w = .13, p < .001, r_b = .48, p < .001$), and for nervous and afraid ($r = .41$, $p < .001$).

Table 1
Variable Means, Percentages, Standard Deviations, ICCs, and Correlations for Positive and Negative Affect Items

Variable	*M*	*SD*	Range	ICC	Alert	Inspired	Determined	Attentive	Active	Upset	Hostile	Ashamed	Nervous	Afraid
Positive affect items														
Alert	1.91	1.12	1–5	0.51	—									
Inspired	2.00	1.15	1–5	0.45	0.23***/0.56***	—								
Determined	2.40	1.23	1–5	0.43	0.27***/0.64***	0.44***/0.83***	—							
Attentive	2.20	1.15	1–5	0.45	0.36***/0.77***	0.34***/0.74***	0.50***/0.84***	—						
Active	1.94	1.16	1–5	0.45	0.25***/0.56***	0.30***/0.69***	0.37***/0.74***	0.40***/0.73***	—					
Negative affect items														
Upset	1.80	1.10	1–5	0.28	0.11***/0.20**	−0.09**/0.12	−0.03/0.07	0.01/0.08	−0.02/0.04	—				
Hostile	1.37	0.78	1–5	0.38	0.19***/0.34***	0.01/0.26***	0.04*/0.20**	0.08***/0.22***	0.07**/0.21**	0.411***/0.73***	—			
Ashamed	1.58	0.98	1–5	0.42	0.12***/0.31***	0.01/0.24***	0.01/0.16*	0.03/0.19**	0.02/0.12	0.41***/0.82***	0.25***/0.77***	—		
Nervous	1.94	1.15	1–5	0.39	0.18***/0.19**	0.08***/0.16*	0.19***/0.17**	0.17***/0.16**	0.08***/0.04	0.30***/0.79***	0.17***/0.57***	0.34***/0.76***	—	
Afraid	1.58	1.00	1–5	0.41	0.16***/0.26***	0.03/0.25***	0.12***/0.21**	0.12***/0.21**	0.08***/0.19**	0.41***/0.78***	0.25***/0.71***	0.39***/0.82***	0.51***/0.83***	—
Depression	1.18	.61	0–3	—										
Stress	1.48	.30	0–2	.34										
Physical symptoms	.11	.15	0–1	.47										

Note. Within-level item correlations are shown on the left side of the slash. Between-level item correlations are shown on the right side of the slash. ICC = intraclass correlation coefficient; *SD* = standard deviation.
* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

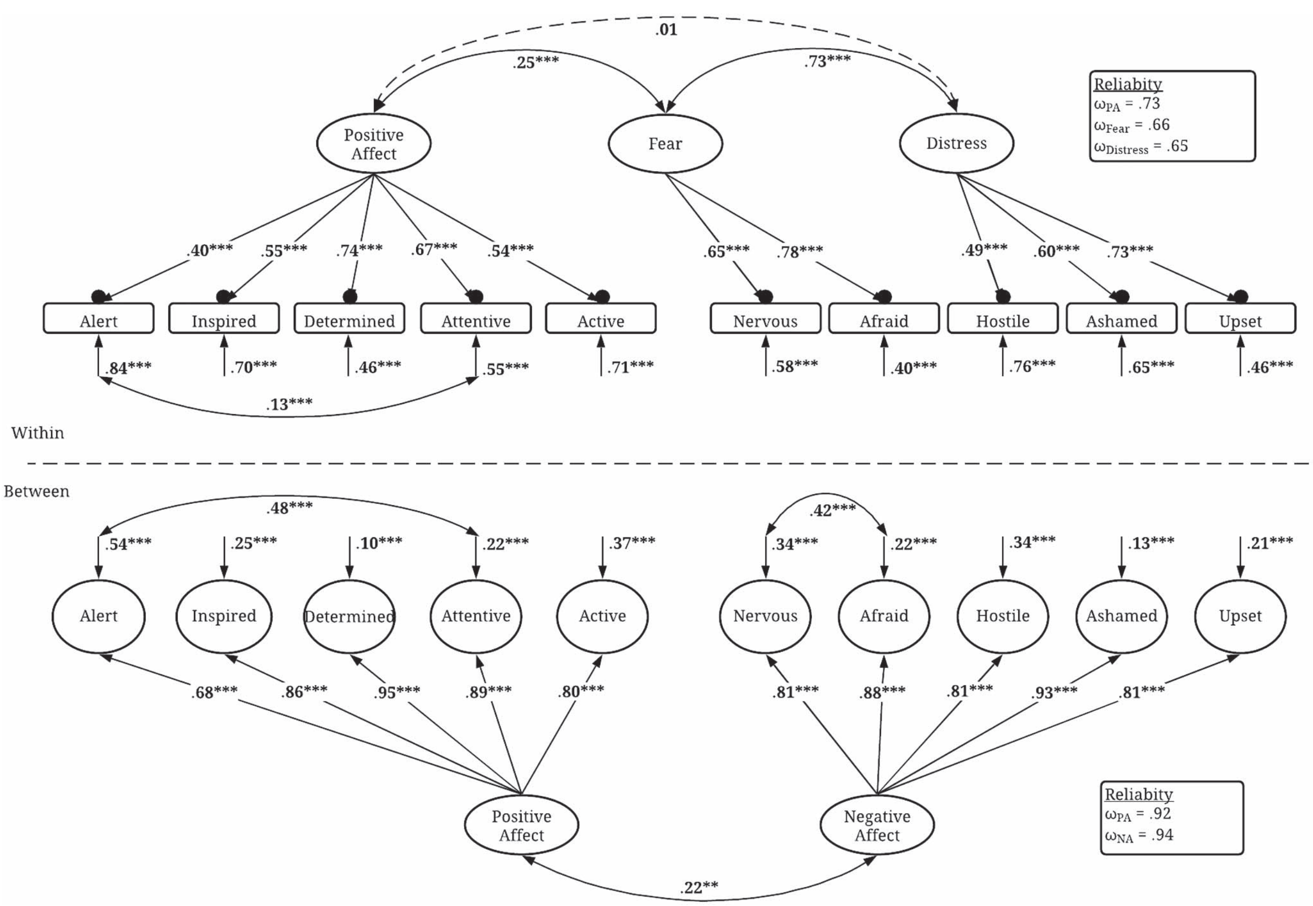
Table 2
Fit Indices for the Multilevel Confirmatory Factor Analyses of Young Adults PANAS

Model	AIC	Adjusted BIC	BIC	$SB\chi^2$	*df*	RMSEA	SRMR within/between	CFI	TLI
One factor within, one factor between	150554.45	150746.86	150918.45	3980.00	66	.10	0.14/0.25	.52	.35
One factor within, two factors between	149823.82	150019.78	150194.56	3432.77	65	.09	0.14/0.06	.56	.43
Two factors within, one factor between	147023.11	147222.08	147396.86	1330.84	65	.06	0.06/0.24	.85	.79
Two factors within, two factors between	146304.40	146503.92	146681.88	783.78	64	.04	0.06/0.06	.91	.88
Two factors within, three factors between	146303.38	146506.48	146687.61	775.73	63	.04	0.06/0.06	.91	.88
Three factors within, two factors between	**146108.28**	**146311.37**	**146492.51**	**638.24**	**63**	**.04**	**0.05/0.05**	**.93**	**.90**
Three factors within, three factors between	146108.01	146314.70	146499.00	631.84	62	.04	0.05/0.06	.93	.90

Note. All models were estimated with the MLR estimator. Bold indicates the retained model. PANAS = positive and negative affect schedule; AIC = Akaike information criterion; BIC = Bayesian information criterion; $SB\chi^2$ = Satorra–Bentler chi square; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual, CFI = comparative fit index; TLI = Tucker–Lewis index; MLR = robust maximum likelihood.

Standardized results from Model 1 of the DSEMs (Table 3) showed significant autoregressive estimates for positive affect (Φ_{PP} = .37, 95% CI [.32, .42]), distress (Φ_{DD} = .43, 95% CI [.33, .52]), and fear (Φ_{FF} = .53, 95% CI [.41, .63]). This suggests that if someone experienced relatively high levels of positive affect, distress, and fear compared to their average, they likely had relatively high levels of positive affect, distress, and fear, respectively, the next day. There were positive reciprocal relations

Figure 2
Multilevel CFA for Positive and Negative Affect



Note. Within-level results are presented above the dashed line while between-level results are below the dashed line. Only standardized estimates are shown. The model is estimated with the MLR estimator. Boxes show the ω (omega) reliability coefficients for the latent factors. CFA = confirmatory factor analysis; MLR = robust maximum likelihood; PA = positive affect; NA = negative affect.
* $p \le .050$. ** $p \le .010$. *** $p \le .001$.

Table 3

Model 1: DSEM Unstandardized and Standardized Point Estimates, Posterior Standard Deviations, and 95% Credible Intervals

Parameter	Unstandardized estimate [95% CI]	Posterior *SD*	*p* value	Standardized estimate [95% CI]	Posterior *SD*	*p* value
Within-level						
Φ_{PP}	.37 [.32, .42]	.02	<.001	.37 [.32, .42]	.02	<.001
β_{PF}	−.05 [−.13, .03]	.04	.118	−.03 [−.07, .02]	.02	.118
β_{PD}	.18 [.09, .30]	.05	<.001	.09 [.04, .13]	.02	<.001
Φ_{FF}	.53 [.41, .63]	.06	<.001	.53 [.41, .63]	.06	<.001
β_{FP}	−.06 [−.11, −.02]	.03	.002	−.12 [−.22, −.03]	.05	.002
β_{FD}	−.04 [−.14, .06]	.05	.200	−.03 [−.13, .06]	.05	.200
Φ_{DD}	.43 [.33, .52]	.05	<.001	.43 [.33, .52]	.05	<.001
β_{DP}	.10 [.06, .14]	.02	<.001	.21 [.12, .30]	.05	<.001
β_{DF}	−.06 [−.15, .03]	.05	.087	−.07 [−.16, .03]	.05	.087
$Corr_{PAF}$	.04 [.04, .05]	.01	<.001	.27 [.23, .31]	.02	<.001
$Corr_{PAD}$	−.01 [−.02, .01]	.01	.016	−.04 [−.09, .01]	.02	.016
$Corr_{FD}$	.27 [.25, .29]	.01	<.001	.78 [.75, .81]	.02	<.001
ζ_{PA}	.09 [.08, .10]	.01	<.001	.86 [.83, .89]	.02	<.001
ζ_{F}	.30 [.30, .34]	.02	<.001	.78 [.74, .82]	.02	<.001
ζ_{D}	.39 [.35, .43]	.02	<.001	.83 [.80, .86]	.02	<.001
Between-level						
$Corr_{PANA}$	.06 [.02, .10]	.02	.001	.22 [.09, .35]	.07	.001
Var_{PA}	.30 [.20, .41]	.05	<.001	—	—	—
Var_{NA}	.26 [.20, .34]	.03	<.001	—	—	—

Note. 95% CI = 95% credible interval; *PA* = positive affect; *F* = fear subscale of negative affect; *D* = distress subscale of negative affect; *NA* = negative affect; Φ_{PP} = autoregression path from $PA_{t-1}^{(w)}$ to $PA_t^{(w)}$; β_{PF} = cross-lagged regression path from $PA_{t-1}^{(w)}$ to $F_t^{(w)}$; β_{PD} = cross-lagged regression path from $PA_{t-1}^{(w)}$ to $D_t^{(w)}$; Φ_{FF} = autoregression path from $F_{t-1}^{(w)}$ to $F_t^{(w)}$; β_{FP} = cross-lagged regression path from $F_{t-1}^{(w)}$ to $PA_t^{(w)}$; β_{FD} = cross-lagged regression path from $F_{t-1}^{(w)}$ to $D_t^{(w)}$; Φ_{DD} = autoregression path from $D_{t-1}^{(w)}$ to $D_t^{(w)}$; β_{DP} = cross-lagged regression path from $D_{t-1}^{(w)}$ to $PA_t^{(w)}$; β_{DF} = cross-lagged regression path from $D_{t-1}^{(w)}$ to $F_t^{(w)}$; $Corr_{PAF}$ = correlation between *PA* and *F*; $Corr_{PAD}$ = correlation between *PA* and *D*; $Corr_{FD}$ = correlation between *D* and *F*; ζ_{PA} = residual variance of *PA*; ζ_F = residual variance of *F*; ζ_D = residual variance of *D*; $Corr_{PANA}$ = correlation between *PA* and *NA*; Var_{PA} = variance of *PA*; Var_{NA} = variance of *NA*; DSEM = dynamic structural equation modeling.

between positive affect and distress: persons that experienced relatively high levels of positive affect, compared to their average, tended to have relatively high levels of distress the next day (β_{PD} = .09, 95% CI [.04, .13]), and vice versa (β_{DP} = .21, 95% CI [.12, .30]). Participants who reported higher than their average levels of fear experienced lower than their average levels of positive affect the next day (β_{FP} = −.12, 95% CI [−.22, −.03]). There remained significant within-person correlations between the residuals of positive affect and fear (*r* = .27, 95% CI [.23, .31]) and between the residuals of fear and distress (*r* = .78, 95% CI [.75, .81]) on the same day after controlling for previous day's lagged effects. There was also a significant positive correlation between positive and negative affect (*r* = .22, 95% CI [.09, .35]) at the between-person level, indicating that people with higher average levels of positive affect also tended to report higher average levels of negative affect.

Depressive symptoms (Figure S1; Table S1), daily stress (Figure S2; Table S2), and daily physical symptoms (Figure S3; Table S3) were included in Models 2, 3, and 4 of the DSEMs, respectively. Standardized results show a significant and negative correlation between the random intercept of positive affect and depressive symptoms (*r* = −.21, 95% CI [−.33, −.09]), and a significant positive correlation between the random intercept of negative affect and depressive symptoms (*r* = .51, 95% CI [.40, .60]) at the between-person level. Thus, people with higher depressive symptoms over the past year, on average, tended to have lower average levels of positive affect and higher average levels of negative affect over the past month.

Stress demonstrated a moderate autoregression (Φ_{SS} = .48, 95% CI [.45, .51]) at the within-person level (Figure S2; Table S2). Persons with higher levels of stress, compared to their average, also tended to have higher than average levels of positive affect (β_{SP} = .06, 95% CI [.03, .10]), fear (β_{SF} = .08, 95% CI [.05, .11]) and distress (β_{SD} = .06, 95% CI [.03, .10]) on the next day. Positive affect was modestly linked with higher stress the next day (β_{PS} = .05, 95% CI [.01, .09]) such that individuals with higher than their average levels of positive affect also reported higher than their average levels of stress on the next day. On the same day, and controlling for previous day's lagged effect, residuals of daily stress was linked with the residuals for fear (*r* = .40, 95% CI [.36, .43]) and distress (*r* = .37, 95% CI [.34, .41]), but not with positive affect (*r* = −.01, 95% CI [−.04, .03]). There was a significant positive correlation between negative affect and stress (*r* = .79, 95% CI [.72, .84]) at the between-person level, such that persons with higher average levels of negative affect tended to also have higher average levels of stress.

Physical symptoms (Figure S3; Table S3) also demonstrated significant autoregression (Φ_{PSPS} = .32, 95% CI [.29, .35]). On the same day, and controlling for previous day's lagged effect, higher residuals of daily physical symptoms were correlated with higher fear (*r* = .30, 95% CI [.26, .33]) and distress (*r* = .27, 95% CI [.24, .30]). At the between-person level, there was a significant and positive correlation between higher average levels of physical symptoms and higher average levels of negative affect (*r* = .47, 95% CI [.35, .57]), but not with positive affect (*r* = −.02, 95% CI [−.20, .06]).

Discussion

This study compared the within- and between-person structure of a short-form version of the PANAS among Canadian undergraduates. The best-fitting affective structure was represented by three factors within- and two-factors between-person. This finding was consistent with our expectations and provides additional support for disentangling affective structures at both levels (Brose et al., 2020). Dynamic relations between affective domains were also examined. Evidence indicates a co-occurrence of positive and negative affective dimensions at the individual level. This finding further supports the need for considering distinct within- and between-person affective processes. Affective dimensions were linked with depressive symptoms, stress, and physical symptoms largely in the expected direction, demonstrating the utility of distinguishing within- from between-person affective structures when examining dynamic relations.

The modest direct link between PA and NA at the between-person level adds to a growing body of research supporting the bipolarity of dimensions across persons (Wedderhoff et al., 2021). The observed positive association is, nonetheless, inconsistent with the general literature (Eisele et al., 2021), though some studies have reported similar findings (Merz & Roesch, 2011; Wilhelm & Schoebi, 2007). A possible explanation, which aligns with findings from the within-persons analysis, is that the current sample of first-year undergraduate students have a high degree of overlap in affective experiences of opposite valence (Barford et al., 2020; Moeller et al., 2018). Specifically, young adults in transition periods (e.g., transitioning to university) may be experiencing co-occurring affective hyperarousal (e.g., anxiety and excitement). The overlap in experiences of opposite valence shows the association between aggregate measures of positive and negative affect at the between-person level. Future works should consider how the reporting frame (i.e., using an aggregate over 30 days compared to a global index assessed at one time only) may have influenced this observed positive association.

At the individual level, fear and distress were unique but coupled dimensions of NA and PA was a single factor. This three-factor within-person structure expands upon previous studies (Allan et al., 2015; Eadeh et al., 2020) and indicates a more nuanced NA subdomain occurring within persons. This finding also supports previous research reporting bipolar associations between PA and NA, but at the within-person level (Barrett & Russell, 1998). Future conceptualizations of the circumplex model should consider exploring the possibility of distinct domains of affect at the within-person level (Kuppens et al., 2010; Scott et al., 2020).

It is also possible that different within-person subdomains of NA (i.e., fear and distress) aid individual contextualization of daily situational experiences (Moeller et al., 2018). This is consistent with findings of a positive association between PA and fear within persons and implicates the role situational experiences likely have on affective valence (Barford et al., 2020; Moeller et al., 2018). For instance, our sample consisted of young adults beginning their college career. Young adults attending college may experience a mixture of fear (e.g., anxiety) and PA (e.g., alertness) due to their newly acquired college environment. Future studies will have to explore these relations across cohorts in different settings (e.g., adolescence vs. adulthood, high school vs. college), time scales (Scott et al., 2020), and response formats (Brose et al., 2015) to see if these relations change (see Diener & Emmons, 1984).

In addition to modeling the within- and between-person structure of affect, we also examined dynamic relations among affective domains and common correlates. This line of inquiry produced several novel findings that contribute to the current literature. First, we built on the MLCFA to show the intricate cross-day processes occurring among affective dimensions. Carryover effects were observed for PA, distress, and fear. Previous day's level of fear was linked to PA and reciprocal relations were observed between PA and distress. This evidence converges with our findings and previous literature (Barford et al., 2020; Brose et al., 2015; Moeller et al., 2018) to emphasize the co-occurrence of affective domains within persons.

We also show the ways in which individuals experience poignant responses to situational exposures (Brose et al., 2015). Specifically, higher daily stress was reciprocally linked with higher fear and distress. Higher daily physical symptoms were also linked with higher fear and distress on the same day. These findings are supported by the literature (Brose et al., 2015; Rush & Hofer, 2014). Unexpectedly (see Koval & Kuppens, 2012), however, individuals' daily stress was positively linked with PA. Considering our overall findings of high valence occurring within- and between-persons, it is plausible that the current participants experienced high stress and high PA simultaneously. Alternatively, these unexpected findings may be attributable to moderator variables not included in this model. It would be beneficial for future researchers to use this validated measure to examine potential covariates and moderators that may account for unique findings of the cross-day associations.

Between-persons, our findings showed that higher depressive symptoms over the past year were linked with higher NA and lower PA over the past month. Stress and physical symptoms were linked with higher NA and lower PA aggregated over 30 days. These findings are consistent with the previous literature (Brose et al., 2020; Koval & Kuppens, 2012; Rush & Hofer, 2014) and show that dynamic relations occurring within-persons did not necessarily translate to the between-person models. The between-person models were more homogenous and representative of findings from previous cross-sectional designs (see Brose et al., 2020). These findings highlight the importance of examining distinct affective structures at both levels of analysis to capture the full spectrum of affective dynamic relations. It is important to note, however, that PA, NA, stress, and physical symptoms were measured as an aggregate over 1 month at the between-person level while depressive symptoms represented a global measure over the past year. Aggregation of states does not necessarily reflect the global measure of traits assessed on different time frames. Future studies should be considerate of these types of response formats and reporting frames when disentangling within- from between-person associations.

Strengths, Limitations, and Future Directions

The present study has several notable strengths. Particularly, we examine within- and between-person affective structures over a 30-day period. This timescale provides us with more power to examine the within-person structure compared to previous studies (see Brose et al., 2020). We also used a short-form version of the PANAS that can be applied in future studies examining affective dynamic relations to reduce participant burden. Our findings add to a growing body of literature emphasizing the need to examine distinct within- and between-person affective structures and processes. Strengths bearing in mind, our findings should be considered in light of several limitations.

First, the present study employed a daily diary design to capture day-to-day affective fluctuations. Research is also increasingly examining moment-to-moment affective processes through ecological momentary assessments (e.g., Eisele et al., 2021). While the present study employed a longer time frame than most previous studies (i.e., 30 days compared to 14 or fewer days), it may not capture important fluctuations in affective dimensions occurring at micro-timescales (e.g., hours rather than days; see Scott et al., 2020). Affective processes are expected to demonstrate different dynamics and patterns at different timescales. Inability to examine these moment-to-moment fluctuations may explain some of our unexpected findings regarding the cross-day and within-day links between affective dimensions. Future works should examine affective dynamics by employing intensive longitudinal designs at multiple timescales to compare moment-to-moment and day-to-day affective structures.

Second, we used the short-form of the PANAS which consists of items with mostly high valence. Paired with the day-to-day timescale, it is possible that this measure did not capture more nuanced emotions and feelings. Future studies should consider comparing short- and long-form measures to examine the full spectrum of affect. This would include using measures that vary across valence (i.e., pleasant and unpleasant) and arousal (high activation and low activation), such as "happy" and "sad." Additionally, future work should compare differences in frequency (i.e., how often) and intensity (i.e., how much) of affective experiences. Comparing differences in reporting of valence, arousal, frequency, and intensity across different time scales would be a substantive leap forward in the literature examining the structure of affect.

The third limitation involves modeling random slopes in the autoregressive and cross-lagged paths at the within-level, representing between-person differences in their cross-day associations (Hamaker et al., 2021). The direct use of multiple indicators as opposed to composite scores in Bayesian estimation frequently led to nonconvergence issues that prevented us from investigating these random slopes. Future works should examine affective structures while including random slopes to further contextualize between-person differences in within-person associations. Additionally, it would be worthwhile to further investigate other potential differences in the within-person measurement structures among different persons. It is possible that within-person structures may differ from person to person, both in terms of factor loadings and the overall structural model. Studies investigating this issue provide supportive evidence that psychological measures may have unique factor structures and/or unique factor loadings in addition to unique means or intercepts across persons (Adolf et al., 2014; Hamaker et al., 2005).

Finally, the present study used a unique sample of first-year university students. While university students generally show comparable, if not slightly elevated, levels of subjective well-being, affect, stress, and depressive symptoms compared to the general population (Dalton & Hammen, 2018), it is possible that the current findings are not generalizable beyond these participants. Furthermore, the current sample was largely comprised of Asian, White, and female university students. It is important to be aware of diverse experiences that may influence exposure to life events that influence affect. Affective domains as well as depressive symptoms, stress, and physical symptoms may not be equivalent across ethnic groups or between sex. Future studies should consider examining affective relations among demographically diverse samples.

Conclusions

First year university students demonstrate distinct and meaningful affective structures at within- and between-person levels as assessed by a short-form version of the PANAS. Dynamic relations further highlighted the need to distinguish within- from between-person affective structures. Future research on affective dynamic relations should use rigorously validated instruments sensitive to both within- and between-person affective structures. Continued use of the PANAS for research in dynamic affective processes must be considerate of momentary changes in affect and must adequately capture these changes with structurally valid measurement instruments.

References

Adolf, J., Schuurman, N. K., Borkenau, P., Borsboom, D., & Dolan, C. V. (2014). Measurement invariance within and between individuals: A distinct problem in testing the equivalence of intra- and inter-individual model structures. *Frontiers in Psychology*, *5*, Article 883. https://doi.org/10.3389/fpsyg.2014.00883

Allan, N. P., Lonigan, C. J., & Phillips, B. M. (2015). Examining the factor structure and structural invariance of the PANAS across children, adolescents, and young adults. *Journal of Personality Assessment*, *97*(6), 616–625. https://doi.org/10.1080/00223891.2015.1038388

Asparouhov, T. (2020, May 28). *DSEM-CFA and factorial invariance* [Computer software]. Mplus Discussion. http://www.statmodel.com/discussion/messages/24588/28055.html?1601586370

Asparouhov, T., Hamaker, E. L., & Muthén, B. (2018). Dynamic structural equation models. *Structural Equation Modeling*, *25*(3), 359–388. https://doi.org/10.1080/10705511.2017.1406803

Asparouhov, T., & Muthén, B. (2022). *Practical aspects of dynamic structural equation models* (Technical Report; Version 2). Muthén & Muthén. http://www.statmodel.com/download/PDSEM.pdf

Barford, K. A., Koval, P., Kuppens, P., & Smillie, L. D. (2020). When good feelings turn mixed: Affective dynamics and big five trait predictors of mixed emotions in daily life. *European Journal of Personality*, *34*(3), 393–411. https://doi.org/10.1002/per.2264

Barrett, F. L., & Russell, J. A. (1998). Independence and bipolarity in the structure of current affect. *Journal of Personality and Social Psychology*, *74*(4), 967–984. https://doi.org/10.1037/0022-3514.74.4.967

Barrett, L. F., & Russell, J. A. (1999). The structure of current affect: Controversies and emerging consensus. *Current Directions in Psychological Science*, *8*(1), 10–14. https://doi.org/10.1111/1467-8721.00003

Bleidorn, W., & Peters, A. L. (2011). A multilevel multitrait–multimethod analysis of self–and peer–reported daily affective experiences. *European Journal of Personality*, *25*(5), 398–408. https://doi.org/10.1002/per.804

Brose, A., Schmiedek, F., Gerstorf, D., & Voelkle, M. C. (2020). The measurement of within-person affect variation. *Emotion*, *20*(4), 677–699. https://doi.org/10.1037/emo0000583

Brose, A., Voelkle, M. C., Lövdén, M., Lindenberger, U., & Schmiedek, F. (2015). Differences in the between-person and within-person structures of affect are a matter of degree. *European Journal of Personality*, *29*(1), 55–71. https://doi.org/10.1002/per.1961

Charles, S. T., Mogle, J., Leger, K. A., & Almeida, D. M. (2019). Age and the factor structure of emotional experience in adulthood. *The Journals of Gerontology: Series B*, *74*(3), 419–429. https://doi.org/10.1093/geronb/gbx116

Cranford, J. A., Shrout, P. E., Iida, M., Rafaeli, E., Yip, T., & Bolger, N. (2006). A procedure for evaluating sensitivity to within-person change: Can mood measures in diary studies detect change reliably? *Personality and Social Psychology Bulletin*, *32*(7), 917–929. https://doi.org/10.1177/0146167206287721

Dalton, E. D., & Hammen, C. L. (2018). Independent and relative effects of stress, depressive symptoms, and affect on college students' daily health behaviors. *Journal of Behavioral Medicine*, *41*(6), 863–874. https://doi.org/10.1007/s10865-018-9945-4

Diener, E., & Emmons, R. A. (1984). The independence of positive and negative affect. *Journal of Personality and Social Psychology*, *47*(5), 1105–1117. https://doi.org/10.1037/0022-3514.47.5.1105

Eadeh, H. M., Breaux, R., Langberg, J. M., Nikolas, M. A., & Becker, S. P. (2020). Multigroup multilevel structure of the child and parent versions of the Positive and Negative Affect Schedule (PANAS) in adolescents with and without ADHD. *Psychological Assessment*, *32*(4), 374–382. https://doi.org/10.1037/pas0000796

Eid, M., & Diener, E. (1999). Intraindividual variability in affect: Reliability, validity, and personality correlates. *Journal of Personality and Social Psychology*, *76*(4), 662–676. https://doi.org/10.1037/0022-3514.76.4.662

Eisele, G., Lafit, G., Vachon, H., Kuppens, P., Houben, M., Myin-Germeys, I., & Viechtbauer, W. (2021). Affective structure, measurement invariance, and reliability across different experience sampling protocols. *Journal of Research in Personality*, *92*, 1–11. https://doi.org/10.1016/j.jrp.2021.104094

Estabrook, R., Grimm, K. J., & Bowles, R. P. (2012). A Monte Carlo simulation study of the reliability of intraindividual variability. *Psychology and Aging*, *27*(3), 560–576. https://doi.org/10.1037/a0026669

Gaudreau, P., Sanchez, X., & Blondin, J. P. (2006). Positive and negative affective states in a performance-related setting: Testing the factorial structure of the PANAS across two samples of French–Canadian participants. *European Journal of Psychological Assessment*, *22*(4), 240–249. https://doi.org/10.1027/1015-5759.22.4.240

Geldhof, G. J., Preacher, K. J., & Zyphur, M. J. (2014). Reliability estimation in a multilevel confirmatory factor analysis framework. *Psychological Methods*, *19*(1), 72–91. https://doi.org/10.1037/a0032138

Hamaker, E. L., Asparouhov, T., & Muthén, B. (2021). Dynamic structural equation modeling as a combination of time series modeling, multilevel modeling, and structural equation modeling. In R. H. Hoyle (Ed.), *The handbook of structural equation modeling* (2nd ed., pp. 1–40). Guilford Press.

Hamaker, E. L., Dolan, C. V., & Molenaar, P. C. (2005). Statistical modeling of the individual: Rationale and application of multivariate stationary time series analysis. *Multivariate Behavioral Research*, *40*(2), 207–233. https://doi.org/10.1207/s15327906mbr4002_3

Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L., Delacqua, G., Delacqua, F., Kirby, J., Duda, S. N., & the REDCap Consortium. (2019). The REDCap consortium: Building an international community of software platform partners. *Journal of Biomedical Informatics*, *95*, Article 103208. https://doi.org/10.1016/j.jbi.2019.103208

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Jacobson, N. C., Evey, K. J., Wright, A. G., & Newman, M. G. (2021). Integration of discrete and global structures of affect across three large samples: Specific emotions within-persons and global affect between-persons. *Emotion*. Advance online publication. https://doi.org/10.1037/emo0001022

Karim, J., Weisz, R., & Rehman, S. U. (2011). International positive and negative affect schedule short-form (I-PANAS-SF): Testing for factorial invariance across cultures. *Procedia: Social and Behavioral Sciences*, *15*, 2016–2022. https://doi.org/10.1016/j.sbspro.2011.04.046

Killgore, W. D. S. (2000). Evidence for a third factor on the positive and negative affect schedule in a college student sample. *Perceptual and Motor Skills*, *90*(1), 147–152. https://doi.org/10.2466/pms.2000.90.1.147

Koval, P., & Kuppens, P. (2012). Changing emotion dynamics: Individual differences in the effect of anticipatory social stress on emotional inertia. *Emotion*, *12*(2), 256–267. https://doi.org/10.1037/a0024756

Kuppens, P., Oravecz, Z., & Tuerlinckx, F. (2010). Feelings change: Accounting for individual differences in the temporal dynamics of affect. *Journal of Personality and Social Psychology*, *99*(6), 1042–1060. https://doi.org/10.1037/a0020962

Larsen, R. J., & Kasimatis, M. (1991). Day-to-day physical symptoms: Individual differences in the occurrence, duration, and emotional concomitants of minor daily illnesses. *Journal of Personality*, *59*(3), 387–423. https://doi.org/10.1111/j.1467-6494.1991.tb00254.x

Leonhardt, A., Könen, T., Dirk, J., & Schmiedek, F. (2016). How differentiated do children experience affect? An investigation of the within- and between-person structure of children's affect. *Psychological Assessment*, *28*(5), 575–585. https://doi.org/10.1037/pas0000195

Merz, E. L., Malcarne, V. L., Roesch, S. C., Ko, C. M., Emerson, M., Roma, V. G., & Sadler, G. R. (2013). Psychometric properties of positive and negative affect schedule (PANAS) original and short forms in an African American community sample. *Journal of Affective Disorders*, *151*(3), 942–949. https://doi.org/10.1016/j.jad.2013.08.011

Merz, E. L., & Roesch, S. C. (2011). Modeling trait and state variation using multilevel factor analysis with PANAS daily diary data. *Journal of Research in Personality*, *45*(1), 2–9. https://doi.org/10.1016/j.jrp.2010.11.003

Mihić, L., Novović, Z., Čolović, P., & Smederevac, S. (2014). Serbian adaptation of the positive and negative affect schedule (PANAS): Its facets and second-order structure. *Psihologija*, *47*(4), 393–414. https://doi.org/10.2298/PSI1404393M

Moeller, J., Ivcevic, Z., Brackett, M. A., & White, A. E. (2018). Mixed emotions: Network analyses of intra-individual co-occurrences within and across situations. *Emotion*, *18*(8), 1106–1121. https://doi.org/10.1037/emo0000419

Möwisch, D., Schmiedek, F., Richter, D., & Brose, A. (2019). Capturing affective well-being in daily life with the day reconstruction method: A refined view on positive and negative affect. *Journal of Happiness Studies*, *20*(2), 641–663. https://doi.org/10.1007/s10902-018-9965-3

Muthén, B. O. (1991). Multilevel factor analysis of class and student achievement components. *Journal of Educational Measurement*, *28*(4), 338–354. https://doi.org/10.1111/j.1745-3984.1991.tb00363.x

Muthén, L. K., & Muthén, B. O. (1998–2019). *Mplus user's guide* (8th ed.).

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401. https://doi.org/10.1177/014662167700100306

Rush, J., & Hofer, S. M. (2014). Differences in within- and between-person factor structure of positive and negative affect: Analysis of two intensive measurement studies using multilevel structural equation modeling. *Psychological Assessment*, *26*(2), 462–473. https://doi.org/10.1037/a0035666

Sanmartín, R., Vicent, M., Gonzálvez, C., Inglés, C. J., Díaz-Herrero, Á., Granados, L., & García-Fernández, J. M. (2018). Positive and negative affect schedule-short form: Factorial invariance and optimistic and pessimistic affective profiles in Spanish children. *Frontiers in Psychology*, *9*, 1–10. https://doi.org/10.3389/fpsyg.2018.00392

Scott, S. B., Sliwinski, M. J., Zawadzki, M., Stawski, R. S., Kim, J., Marcusson-Clavertz, D., Lanza, S. T., Conroy, D. E., Buxton, O., Almeida, D. M., & Smyth, J. M. (2020). A coordinated analysis of variance in affect in daily life. *Assessment*, *27*(8), 1683–1698. https://doi.org/10.1177/1073191118799460

Tellegen, A., Watson, D., & Clark, L. A. (1999). On the dimensional and hierarchical structure of affect. *Psychological Science*, *10*(4), 297–303. https://doi.org/10.1111/1467-9280.00157

Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *Journal of Cross-Cultural Psychology*, *38*(2), 227–242. https://doi.org/10.1177/0022022106297301

Towbes, L. C., & Cohen, L. H. (1996). Chronic stress in the lives of college students: Scale development and prospective prediction of distress. *Journal of Youth and Adolescence*, *25*(2), 199–217. https://doi.org/10.1007/BF01537344

van Roekel, E., Keijsers, L., & Chung, J. M. (2019). A review of current ambulatory assessment studies in adolescent samples and practical recommendations. *Journal of Research on Adolescence*, *29*(3), 560–577. https://doi.org/10.1111/jora.12471

Wang, L. P., & Grimm, K. J. (2012). Investigating reliabilities of intraindividual variability indicators. *Multivariate Behavioral Research*, *47*(5), 771–802. https://doi.org/10.1080/00273171.2012.715842

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin*, *98*(2), 219–235. https://doi.org/10.1037/0033-2909.98.2.219

Wedderhoff, N., Gnambs, T., Wedderhoff, O., Burgard, T., & Bošnjak, M. (2021). On the structure of affect: A meta-analytic investigation of the dimensionality and the cross-national applicability of the positive and negative affect schedule (PANAS). *Zeitschrift für Psychologie mit Zeitschrift für Angewandte Psychologie*, *229*(1), 24–37. https://doi.org/10.1027/2151-2604/a000434

Wilhelm, P., & Schoebi, D. (2007). Assessing mood in daily life. *European Journal of Psychological Assessment*, *23*(4), 258–267. https://doi.org/10.1027/1015-5759.23.4.258

Appendix

Stress and Physical Symptoms Stems and Items

Measure	Item
Stress	Stem: Today did you feel stressed, upset, or worried by the following events or experiences?
	Homesick
	Diet
	Noisy dorm
	Missed distant friends
	Not having a romantic partner
	Parental pressure
	Not having friends
	Time management
	Studying
	Not enough exercise
	Conflict with parents
	Academic performance
	Didn't fit in
	Schoolwork overload
	Difficult class
	Concerns about your weight
	Not enough sleep
Physical symptoms	Stem: Did you experience any of the following symptoms today (check all that apply)?
	Headache
	Backache
	Dizziness
	Nausea/upset stomach
	Heart pounding (beating fast)
	Constipation/diarrhea
	Muscle soreness
	Fever or feeling cold
	Shortness of breath
	Tightness in chest
	Low energy/tired
	Poor appetite
	Congestion
	Sore throat
	Trembling/shaking

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