Journals of Gerontology: Psychological Sciences
cite as: J Gerontol B Psychol Sci Soc Sci, 2018, Vol. 73, No. 1, 100–112
doi:10.1093/geronb/gbw159
Advance Access publication December 24, 2016

Special issue: Methodological Innovations: Special Article

Intrinsic Emotional Fluctuation in Daily Negative Affect across Adulthood

Yin Liu,[1] Lauren R. Bangerter,[2] Michael J. Rovine,[3] Steven H. Zarit,[4] and David M. Almeida[1,4]

[1]Center for Healthy Aging, The Pennsylvania State University, State College. [2]Robert D. and Patricia E. Kern Center for the Science of Healthcare Delivery, Care Experiences Program, Mayo Clinic, Rochester, Minnesota. [3]Human Development and Quantitative Methods Division, Graduate School of Education, University of Pennsylvania, Philadelphia. [4]Department of Human Development and Family Studies, The Pennsylvania State University, State College.

Correspondence should be addressed to Yin Liu, PhD, Center for Healthy Aging, 422 Biobehavioral Health Building, The Pennsylvania State University, University Park, PA 16802. E-mail: yul183@psu.edu

Received April 20, 2016; Editorial Decision date November 16, 2016

Decision Editor: Deborah Carr, PhD

Abstract

Objectives: The study explored daily negative affect (NA) fluctuation, its associations with age, and its developmental characteristics.
Method: The sample (n = 790) was drawn from the Midlife Development in the United States; participants completed two 8-day daily diaries 10 years apart. Multilevel models were estimated within each diary component, where two single daily NA (depression and nervousness) and daily NA diversity were predicted separately by daily stressor exposures, physical health symptoms, age, gender, education, and neuroticism. The variances of within-person residual were output for single NA and NA diversity as intrinsic emotion fluctuation (IEF) within each diary component (i.e., controlled for within- and between-person contextual factors). Then multilevel growth models were fit to explore the developmental characteristics of day-to-day IEF across 10 years.
Results: At the daily level, older age was associated with less IEF in depression and nervousness. Over time, IEF in depression decreased. Additionally, IEF in NA diversity increased for older participants longitudinally.
Discussion: IEF represents a new conceptualization of midlife individuals' daily emotional ups and downs, specifically, the intrinsic within-person volatility of emotions. The magnitude of IEF and its longitudinal dynamics may have implications for health and well-being of middle-aged adults.

Keywords: Growth curve—Intrinsic emotion fluctuation—Midlife—Multilevel heterogeneous model—Negative affect

People's daily lives are entwined with emotional experiences. Daily emotions are an essential part of people's daily well-being, both in terms of the level or amount of emotions and day-to-day fluctuation in emotions. Both of these dimensions are core components of daily emotion and may have implications for health and well-being over time (Carstensen et al., 2011; Eid & Diener, 1999). Most research on daily emotions, however, has focused on the level of emotions, rather than on their fluctuation. Another aspect is the mix or diversity of emotions experienced in response to daily events. Most daily research has focused on single items or types of emotion, rather than examining the diversity of emotions comprehensively. These aspects of emotions can vary within persons over short and long periods of time as well as between persons. Drawing on the Midlife Development in the United States (MIDUS) study, the current research examines these aspects of emotions using data from two diary studies conducted 10 years apart on daily emotions and experiences (mean age was about 47 versus 55 years in each daily component). The data allow for consideration of age effect on fluctuations and diversity of daily emotions cross-sectionally and longitudinally. Focusing on daily negative affect (NA), this paper explores two important but overlooked perspectives to daily emotions: diversity, and intrinsic emotion fluctuation (IEF) and its developmental characteristics.

Daily NA Diversity

The first perspective, diversity, looks at multiple daily NA comprehensively. Similar to other common indicators of emotional complexity (Grühn, Lumley, Diehl, & Labouvie-Vief, 2013), daily NA diversity considers a mixture of NA items and is operationalized uniquely in the current study. A Simpson's diversity index (Simpson, 1949) was used to calculate a day-to-day measure of the range and distribution of an individual's daily NA diversity. Uniquely, the index considers both NA intensity and frequency as a number of negative emotions were experienced naturally in daily lives. The Simpson's diversity index is a well-established measure to quantify biodiversity within an ecological system (Hill, 1973). Its application in affect research, however, has not been used.

As with single daily NA such as depressive symptoms, daily NA diversity can be measured by both the level using means and the fluctuation using variances. Although the mean level has been applied mostly to study one single emotion at a time, Quoidbach and colleagues (2014) did use a similar approach based on a multitude of affect items to examine the mean level of emotional diversity. The authors coined the measure as "Emodiversity" and showed that in women, younger age and better psychological and physical health were associated with higher levels of emotional diversity (Quoidbach et al., 2014).

Daily NA Fluctuation

There are two common measurement approaches to daily emotions: (i) the level or intensity of NA and (ii) the fluctuation or change in intensity and frequency of NA. Daily NA fluctuation provides an additional perspective that accounts for individuals' emotional lability. Unlike viewing mean-level daily NA across days, assessing daily NA fluctuation allows for a more comprehensive assessment of the naturally occurring ebb and flow of daily NA (for a review, see Röcke & Brose, 2013). Fluctuation has been applied mostly in studying a single NA at a time. Some fluctuations in NA may signal healthy and better emotional regulation (Kuppens, Allen, & Sheeber, 2010). No studies have examined fluctuations in NA diversity derived from multiple daily negative emotions. Fluctuations in daily NA diversity are variations in amount of diversity from day to day. They can be calculated by variation scores, which are applicable to a single NA or NA diversity. Like fluctuations in single NA, more fluctuations in NA diversity may have positive or negative associations with emotional well-being and health (Carstensen et al., 2011).

One common way to operationalize daily NA fluctuation is using a variability measure such as within-person standard deviation (i*SD*) scores (Grühn et al., 2013; Röcke, Li, & Smith, 2009). The i*SD* score is the sum of differences between each individual score on one sampling occasion and the mean for all scores across all sampling occasions (Riediger & Rauers, 2014). Although i*SD* is easy to calculate, there is some question as to whether i*SD* makes an adequate measure of within-person fluctuations in daily NA. First, as a summary score of variability, i*SD* is not corrected for its dependency on mean values. Using i*SD*, it is not possible to tell whether a large test-retest correlation coefficient is due to small measurement error or the fact that affective instability is truly small.

Second, i*SD* may be theoretically limited as a measure of within-person affective variability. Two important dimensions of within-person emotional variability are affective intensity and frequency (Larsen, 1987). Using i*SD*, one can only index the average intensity of mood changes, the frequency of changes are, however, ignored. Additionally, Larsen (1987) observed that people's mood may be consistently variable over repeated sampling occasions. These mood fluctuations may be due to reactivity to subtle contextual stimuli and contingencies, which could be predicted partially by stressor exposures. However, it is also possible that emotionally labile individuals are predisposed to such malleability, regardless of situational cues. Using i*SD*, one can only quantify the overall affective variability without controlling for contextual factors. This emotional fluctuation which occurs intrinsically, regardless of contextual or external cues, cannot be properly measured using i*SD* and has largely been neglected in the past research.

Intrinsic Emotion Fluctuation in Daily NA

Expanding on this notion that daily fluctuations in emotions are not entirely due to external circumstances, it is probable that intrinsic individual characteristics are also at play. Because self-reported affective variability has been proposed as a trait (Baumeister, 1991), high affective variations that could occur as random fluctuations in the daily context may masquerade true underlying individual characteristics and associations. In this case, i*SD* can be a misleading index on daily NA fluctuation. Another approach, multilevel models with heterogeneous variance (also known as dispersion models; Hoffman, 2007; Raudenbush & Bryk, 2002) can be powerful and parsimonious in modeling within-person fluctuation in daily NA as a personality trait, controlling for levels of daily NA and contextual associations.

This modeling approach takes into account one's general level of daily NA, and the fluctuation is operationalized as the Level 1 (within-person) model residual of daily affect, after considering the average associations between daily NA and daily events, and individual characteristics such as neuroticism, gender, and education. The resulting within-person residual, which is defined as intrinsic emotion fluctuation (IEF), is the unexplained Level 1 variance that was left after controlling for all the within- and between-person covariates of the multilevel models (Liu, Kim, Almeida, & Zarit, 2015). Although IEF is conceptually similar to i*SD*, the difference is that IEF is model based, whereas i*SD* is calculated directly by subtracting personal means from the raw affect scores. As a variability indicator, IEF, therefore, can be superior to i*SD* in that it controls for the mean levels of daily emotions as well as the many potential environmental cues that could induce high affective reactivity (Charles, Piazza, Luong, & Almeida, 2009).

In multilevel modeling of daily emotions, within-person fluctuation in NA across days has usually been treated as error after the predictors of levels of daily NA are estimated. These within-person errors are usually assumed to be invariant or homogeneous across individuals. However, they may be of direct interest as a source of individual differences, and there may be heterogeneous associations between within-person errors and between-person characteristics (Hoffman, 2007). For example, Hoffman (2007) found that within-person fluctuations of self-reported affect were differentially associated with individuals' cognitive ability. In other words, there were greater within-person fluctuations in both negative and positive affect in individuals with poorer cognitive functioning.

Thus far, IEF has only been applied to study a single NA, such as daily depressive symptoms and anger (Liu et al., 2015). IEF along with its unique modeling approach has not been applied to examine daily NA diversity. Specifically, if within-person fluctuation in daily NA is a trait, IEF in daily NA diversity derived from multilevel models with heterogeneous within-person variance may also show stable individual differences and associations over the course of days. Similar to levels of a single emotion, IEF may also change developmentally, within persons, as people age. Very few studies have examined the developmental characteristics of IEF in either a single NA or NA diversity. It is not clear what the trajectories of IEF in daily NA are or whether the trajectories vary depending on some individual characteristics.

Negative Affect: Nervousness and Depression

Although NA is usually operationalized as one single dimension, the multifactorial structure of NA provides an alternative perspective on the specific types of negative emotions. Two discrete negative emotions that derived from factor analysis are nervousness and depressive symptoms (Lovibond & Lovibond, 1995). Compared with other types of negative emotions such as guilt, nervousness and depressive symptoms tend to be more frequently experienced, and thus more fluctuating in daily life. Nervousness and feelings of bad mood (i.e., depression) tend to be at the core of one's daily NA.

Nervousness is conceptualized as one narrow component of anxiety (Spielberger, 2010). Similar to anxiety, nervousness can have a trait and state distinction. Trait nervousness is a more stable personality characteristic that distinguishes individual differences. State nervousness reflects an emotional state that is more reactive to daily contingencies and situations (Watson & Tellegen, 1985). Given our research interest in affective fluctuation, the current study focused on state nervousness. In terms of degrees of emotional activation or arousal, nervousness is high in reactivity to daily stressors (Lovibond & Lovibond, 1995; Watson & Tellegen, 1985). In contrast to state nervousness, state depression is less reactive and more stable (Lovibond & Lovibond, 1995). Additionally, depression usually falls under the Pleasantness–Unpleasantness dimension of mood, whereas nervousness is categorized in the Arousal or Activation dimension, two consistently emerging dimensions of mood (Watson & Tellegen, 1985). In the current study, fluctuations in nervousness and depression were compared for their associations with age and other individual characteristics.

The Associations Between Affective Well-Being and Age, and Other Individual Characteristics

Converging evidence from the literature suggests that older people may have more diverse emotions and less fluctuation as they age. Labouvie-Vief, Hakim-Larson, DeVoe, and Schoeberlein (1989) argued that increased complexity in cognition, which is associated with aging, is accompanied by more diverse emotional responses and better emotional regulation in coping with actual or anticipated life events. Carstensen, Fung, and Charles (2003) and Carstensen and colleagues (2011) have bridged findings from daily studies and traditional longitudinal studies on emotional well-being based on the socioemotional selectivity theory (SST; Carstensen et al., 2003). Specifically, SST denotes that emotions are expected to be more complex as people age. Also, older people tend to have more stable emotional experiences with less fluctuations, and this decreasing fluctuations over time has been associated with better emotional experience (Carstensen et al., 2011; Röcke et al., 2009). However, it is not clear whether there are age differences in fluctuation in daily NA diversity. Further, the literature is also limited regarding age effects on the developmental trajectory of fluctuation in daily NA diversity over time. Potential age effects on NA diversity in the daily as well as longitudinal settings were explored in the study.

Charles and colleagues (2009) have suggested that although older people are likely to avoid stressors strategically in their daily lives, they can have a similar affective reactivity as younger persons when they are actually encountering stressors. Therefore, when studying daily affective fluctuation and its association with age and daily stressors, it is important to consider one's general levels of affect as well as daily contextual factors. Within-person fluctuation in daily NA has been linked to negative events (Röcke et al., 2009), stressor reactivity (Piazza, Charles, Sliwinski, Mogle, & Almeida, 2013), perceived stress (Watson, 1988), gender and education (Liu et al., 2015), and neuroticism (Kokkonen & Pulkkinen, 2001; Watson & Pennebaker, 1989). These characteristics were considered as covariates in the study.

The Present Study

Röcke & Brose (2013) suggest that to capture the whole range of one's emotions, it is important to consider both stable and dynamic emotional components. Specifically, it is integral to identify to what degree emotions fluctuate and remain stable across time, and the developmental course of such affective dynamics. Such studies will need to rely on both daily components and traditional longitudinal components. The current study utilized a nested repeated measures design with two daily diary components spaced 10 years apart. The first purpose for conducting the study was to assess associations between levels of daily NA diversity and age (i.e., the fixed effects), and associations between IEF in daily NA and age (i.e., the random effects) within each daily component. The second purpose was to examine developmental trajectories of IEF in daily NA and the associations with age over 10 years. Based on SST and previous studies, there are four hypotheses guiding the inquiry in the daily and longitudinal context:

Hypothesis 1. In the daily context, older age will be associated with a more diverse NA experience with more mixed NA states.

Hypothesis 2. In the daily context, older age will be associated with less IEF in depressive symptoms and nervousness.

Hypothesis 3. In the daily context, older age will be associated with greater IEF in NA diversity.

Hypothesis 4. In the longitudinal context, IEF in depressive symptoms and nervousness are expected to decrease over time for older people, whereas IEF in NA diversity is expected to increase over time for older people.

Method

Participants and Procedure

Participants are drawn from the National Study of Daily Experiences (NSDE), the daily diary substudy of the MIDUS study. Participation entailed completion of two daily diary data collections (each consisting of eight consecutive nightly telephone interviews) that were gathered 10 years apart. MIDUS I recruited participants (N = 7,108; aged 24–74 years) in 1994–1995 using random digit dialing protocol of telephone numbers. In 1996 and 1997, a randomly chosen subset of MIDUS I participants completed the NSDE study, where participants had an average of 7.3 interview days (SD = 1.05, range = 2–8 days). Of the 1,843 MIDUS I respondents that researchers attempted to contact for the NSDE, 1,483 agreed to participate, yielding a response rate of 81%.

The second daily component of the NSDE included 2,022 participants who were recruited in 2004–2005. During the 8 interview days of the second daily component (average number of days was 8), participants reported similar information on demographics and emotional well-being as in the original NSDE. The sample for the present study included 790 participants who completed at least two diary days in both daily components of the MIDUS daily studies. Demographics and daily experiences are presented in Table 1.

Measures

Daily negative affect

Daily NA was measured within each daily component. In the first daily component, daily NA was assessed every day using 10 items (0 = *none of the time*, 4 = *all the time*) from the Nonspecific Psychological Distress Scale (Almeida & Kessler, 1998). Factor analysis was conducted

Table 1. Demographic Characteristics of Participants (n = 790)

Characteristics of participants in daily component 1	Mean (SD) or n (%)	Range
Age	46.73 (12.48)	24–74
Female	442 (56%)	1 (0 = male)
Education	7.08 (2.37)	1–12
Total household income	55,503.76 (47897.56)	0–3,00,000
White	722 (91.4%)	
Neuroticism	2.18 (0.64)	1–4
Daily experiences in daily component 1		
Stressor exposure	0.57 (0.46)	0–3.86
Average physical symptom severity	1.28 (0.28)	1–4.6
Daily experiences in daily component 2		
Stressor exposure	0.52 (0.45)	0–3
Average physical symptom severity	1.82 (1.88)	1–9.70

and it revealed three components of daily NA: depressive symptoms, nervousness, and lethargy, which were moderately correlated (rho ranged from .51 to .62). The depressive symptoms subscale included five items (α = .79): feeling depressed, worthless, hopeless, so nervous that nothing could calm you down, and so sad that nothing could cheer you up. The nervousness subscale included three items (α = .72): feeling nervous, restless or fidgety, so restless that you could not sit still. The lethargic subscale was dropped from the current study (two items, α = .60), because it was not followed up in the second diary component. In the second diary component, the same method with factor analysis was used to assess daily NA. Both the depressive symptoms (α = .74) and the nervousness subscales (α = .72) had satisfactory reliability.

For comparison purposes, only common items and subscales across daily components were considered in the current study. Confirmatory factor analyses (CFA) were conducted within each daily component to test the structure of NA based on exploratory factor analysis. In fitting those models, dependency across persons was ignored and longitudinal invariance was assumed. Because of the large sample size (n = 790), the chi-square statistic for the model within each daily component did not show satisfactory fit (Bentler & Bonett, 1980). The CFA in daily component 1 had χ^2 = 363.5, df = 32, p = .000, root mean square error of approximation (RMSEA) = .115, Comparative Fit Index (CFI) = .856. The CFA in daily component 2 had χ^2 = 528.2, df = 74, p = .000, RMSEA = .088, CFI = .866.

The Simpson's diversity index (Simpson, 1949) was calculated to measure daily NA diversity. The measure was based on self-reported frequency and the corresponding intensity of each of the NA items across days. It was calculated within each daily diary component based on all NA items from the factor analysis. The following formula was used:

$$\Psi = \sum_{i=1}^{n} P_i^2$$

where n is the sum of raw response scores across NA items within a day, i is the specific daily NA item, and P_i is the proportion of n made up of the ith NA item. There are four steps to calculate the daily Simpson's diversity index:

Step 1. Divide the raw response score on a specific NA item (i.e., 4 = *all of the time*, 0 = *none of the time*) by the total sum of raw response scores across NA items. This yields P_1.

Step 2. Multiply this proportion by itself: $P_1 \times P_1$.

Step 3. Repeat this for each specific NA item an individual experienced within a day.

Step 4. Sum all the ($P_i \times P_i$) products and $1 - \Psi$ gives the Simpson's diversity index.

A greater Simpson's index indicated a more diverse and complex experience of daily NA, whereas a smaller coefficient indicated a simpler daily NA experience.

Daily stressor exposure

Daily stressor exposures have been found to have close associations with daily NA (Almeida & Horn, 2004). Daily stressor exposures were assessed using the Daily Inventory of Stressful Events (DISE; Almeida, Wethington, & Kessler, 2002). The DISE includes seven questions probing whether certain types of daily stressor happened within the past 24 hours (1 = *yes*, 0 = *no*). Participants were asked whether they had an argument or disagreement, whether they avoided a disagreement, whether anything happened at work/school/home that most people would consider stressful, whether they experienced any discrimination, and whether anything happened to a friend that was stressful for them. The sum of all stressor exposures on a specific day was calculated for each participant.

Other covariates

Other variables that have been related to daily NA were included as covariates within each daily component. Age, gender (1 = *female*), and highest level of education completed (1 = *no school/some grade school*, 12 = *professional degrees such as PhD, MD, JD*) were considered. Additionally, neuroticism (four items on a 4-point scale with α = .32 in daily component 1 and α = .27 in daily component 2, higher scores indicated greater neuroticism; Lachman & Weaver, 1997) and daily physical symptoms such as headache, fever, and chest pain (18 symptoms on a 5-point scale and α = .36 in daily component 1, and 18 symptoms on a 10-point scale and α = .58 in daily component 2, higher scores indicated greater severity; Charles & Almeida, 2006) were considered as covariates of daily NA.

Analytical Strategy

Cross-sectional and longitudinal analyses were conducted to test hypotheses on age differences and developmental changes in various aspects of daily NA. First, multilevel models were estimated within each daily component cross-sectionally. Then multilevel growth models were estimated across the two daily components to examine longitudinal developmental trajectories for IEF in daily NA over 10 years. The multilevel growth models also tested how these differential trajectories were associated with age and other individual characteristics such as gender and education.

Cross-Sectional Analysis Within Each Daily Component

To test Hypothesis 1, cross-sectional analyses within each daily component examined the average association (i.e., the fixed effects) between age and daily NA diversity. To test Hypotheses 2 and 3, cross-sectional analyses within each daily component examined the heterogeneous associations (i.e., the random effects) between age and IEF in depression, nervousness, and NA diversity, respectively. A series of multilevel models with common and heterogeneous within-person residuals were fit to estimate the magnitude of average and differential associations between daily NA and covariates, following standard model fitting procedures (Hoffman, 2007; Raudenbush & Bryk, 2002). Each aspect of daily NA was modeled as a separate outcome. The potential day of the week and day in the study effects were evaluated to determine the need to include them as fixed or/and random effects. Although the day/time did not have significant fixed effects, the random intercept + AR(1) model had the best model fit for nearly all homogeneous models except for NA diversity in daily component 2. Thus, the AR(1) structure was modeled in all subsequent residual variance models by adding linear and quadratic time effects in addition to the key predictor.

Multilevel model with homogeneous within-person residual was fit at first, where daily physical symptoms and stressor exposures were modeled as within-person covariates of daily NA diversity at the within-person level. In the between-person level, participants' average stressor exposures and average physical symptoms across days were the covariates, along with age, gender, education, and neuroticism.

Hypotheses 1 to 3 were tested by the multilevel models with within-person heterogeneous residual, where the assumption on homogeneous within-person errors was relaxed to allow it to differ across individuals depending on individual characteristics (Hoffman, 2007). In multilevel models with heterogeneous Level 1 variance, a scale parameter that is the random intercept of the Level 1 variance was not estimated. Such parameter allows associations with the mean (i.e., location) and variance (i.e., scale) of individual NA outcomes. The models are specified as mixed-effects location-scale models (Hedeker, Mermelstein, & Demirtas, 2008). As the random scale effect is the model-based test of heterogeneity, the location-scale models were attempted in Proc NLmixed initially. However, these models failed to converge. Studies applying multilevel models with heterogeneous variances have not uniformly tested such random scale effects (Hedeker & Mermelstein, 2007; Hoffman, 2007). Also, the literature is not clear on whether such effects necessitate the model building process. Thus, tests of heterogeneity were conducted as follows.

Specifically, the within-person residual term in the common-variance model, $\sigma^2_{i\varepsilon}$, was allowed to vary across individuals as a function of between-person covariates of average stressor exposures, average physical symptoms, age, gender, education, and neuroticism:

$$\sigma^2_{i\varepsilon} = \alpha_0 * \exp\left(a_1 \times \text{Between-person covariate}_i\right)$$

where α_0 indicates the expected IEF in daily NA for the prototypical individual and α_1 indicates the extent to which that IEF in daily NA differed in relation to the corresponding between-person covariate. The log (exponential) structure of the model accommodated the fact that IEF cannot go below zero (Hoffman, 2007). Given the complexity of the model, the linear effects of these covariates on IEF in daily NA were tested one at a time (Hedeker, Mermelstein, Berbaum, & Campbell, 2009).

Longitudinal Analysis Across Daily Components

The variance of the within-person residual term in the multilevel model within each daily component, σ^2_i, was first output and saved for each aspect of daily NA. (Because Hypothesis 4 was focused on developmental trajectory of the extent of daily fluctuation in NA, a random effect from daily multilevel models, daily data were not combined for the growth model over 10 years.) To examine the change in IEF in daily NA across the two daily components and over time (Hypothesis 4), the variances were then modeled using unconditional growth curves with linear time as the solo within-person predictor to examine the longitudinal trajectory. To test Hypothesis 4, between-person covariates were added into the Level 2 model to examine their associations with trajectories of IEF in each aspect of daily NA.

Results

Table 2 presents the fixed-effect estimates for age on NA diversity (top part) and the random-effect estimates for IEF in daily NA associated with covariates (bottom part) as pertain to each hypothesis.

Hypothesis 1: The Fixed Effect of Age on NA Diversity

Hypothesis 1 was supported in the first daily component as suggested by the significant fixed effect for age ($\beta = 0.018$, $p = .001$). Specifically, older age was associated with greater daily NA diversity. In the second daily component 10 years later, Hypothesis 1 was not supported. The model showed that there was no significant association between age and NA diversity ($\beta = -0.003$, $p > .05$).

Hypotheses 2 and 3: The Random Effect of Age on IEF in Daily NA

Hypothesis 2 was supported in the first daily component. Specifically, the heterogeneous model showed that after controlling for the fixed effect, older age was associated with less IEF in daily depressive symptoms ($\alpha_1 = -0.129$, $p < .001$) and nervousness ($\alpha_1 = -0.174$, $p < .001$). However, Hypothesis 3 was not supported in the first daily component, as the heterogeneous model showed that older age was associated with less IEF in NA diversity ($\alpha_1 = -0.061$, $p < .001$).

Additional findings in the first daily component are the following. After controlling for the fixed effect of

Table 2. Parameter Estimates for Multilevel Models With Homogeneous and Heterogeneous Within-Person Variance in Daily Bursts

	Daily Component 1			Daily Component 2		
	Depressive symptoms	Nervousness	NA diversity[b]	Depressive symptoms	Nervousness	NA diversity[c]
Parameter	Estimate (*SE*)	Estimate (*SE*)	Estimate (*SE*)	Estimate (*SE*)	Estimate (*SE*)	Estimate (*SE*)
Fixed effect						
Intercept			0.234 (0.058)***			0.709 (0.007)***
Daily stressor exposures			–0.061 (0.008)***			–0.018 (0.008)*
Daily physical symptoms			–0.079 (0.021)***			–0.014 (0.004)**
Average daily stressor exposures			–0.096 (0.015)***			–0.039 (0.016)*
Average daily physical symptoms			–0.122 (0.024)***			0.003 (0.003)
Age			0.018 (0.005)***			–0.003 (0.005)
Education			–0.002 (0.003)			–0.006 (0.003)*
Female			–0.011 (0.013)			–0.018 (0.013)
Neuroticism			0.052 (0.011)***			–0.007 (0.011)
Random effect						
VAR (Int), $\sigma^2_{\upsilon 0}$			0.017 (0.005)***			0.016 (0.002)***
COV (Int, Stressor slope)			0.001 (0.001)			–0.009 (0.002)***
VAR (Stressor slope), $\sigma^2_{\upsilon 1}$			0.004 (0.002)*			0.004 (0.002)*
COV (Int, Symptom slope)			–0.004 (0.004)			–0.002 (0.001)**
COV (Stressor slope, Symptom slope)			0.007 (0.004)			0.001 (0.000)*
VAR (Symptom slope), $\sigma^2_{\upsilon 2}$			0.023 (0.012)*			0.112 (0.002)***
Residual, σ^2_{ε}			0.135 (0.007)***			0.110 (0.002)***
REML deviance			4,351.7			4,018.1
Heterogeneous within-person variance[a], $\sigma^2_{i\varepsilon}$						
Age	–0.129 (0.017)***	–0.174 (0.018)***	–0.061 (0.016)***	–0.094 (0.019)***	–0.080 (0.018)***	0.057 (0.016)***
Average daily stressor exposures	1.607 (0.056)***	1.074 (0.052)***	1.172 (0.049)***	1.158 (0.062)***	1.073 (0.056)***	–0.238 (0.054)***
Average daily physical symptoms	3.172 (0.090)***	1.797 (0.084)***	0.204 (0.078)**	0.469 (0.015)***	0.279 (0.014)***	–0.057 (0.012)***
Gender	0.654 (0.044)***	0.338 (0.044)***	0.099 (0.041)*	0.586 (0.047)***	0.291 (0.045)***	0.040 (0.042)
Education	–0.072 (0.009)***	–0.062 (0.009)***	0.020 (0.009)*	–0.044 (0.010)***	0.021 (0.009)*	0.012 (0.009)
Neuroticism	1.306 (0.039)***	0.624 (0.035)***	0.101 (0.033)**	1.294 (0.041)***	0.690 (0.037)***	–0.158 (0.035)***

Notes: NA = negative affect; REML = restricted maximum likelihood. Total participants were $n = 790$. All covariates were concurrent measures. Within-person covariates were person-mean centered; Between-person covariates were grand-mean centered.

[a]Multilevel models with heterogeneous within-person variance controlled for day in the study effects, except for the NA diversity model in diary Burst 2. Linear and quadratic time effects not reported because of the space limitation. [b]The fixed effects presented were from the heterogeneous within-person variance model with age as covariate. This model had the lowest BIC compared with other heterogeneous within-person variance models. [c]The fixed effects presented were from the heterogeneous within-person variance model with average daily health symptoms as covariate. This model had the lowest BIC compared with other heterogeneous within-person variance models.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

within-person stressor exposures, greater daily stressor exposures were associated with greater IEF in all aspects of daily NA including depressed affect ($\alpha_1 = 1.607$, $p < .001$), nervousness ($\alpha_1 = 1.074$, $p < .001$), and NA diversity ($\alpha_1 = 1.172$, $p < .001$). Similarly, after controlling for the fixed effect of within-person physical symptoms, more severe physical symptoms were associated with greater IEF in all aspects of daily NA including depressed affect ($\alpha_1 = 3.172$, $p < .001$), nervousness ($\alpha_1 = 1.797$, $p < .001$), and NA diversity ($\alpha_1 = 0.204$, $p = .009$). Being female and being neurotic were associated with greater IEF in all aspects of daily NA; better education was associated with less IEF in daily depression and nervousness but greater IEF in NA diversity.

In the second daily component, Hypothesis 2 was supported. Specifically, after controlling for the fixed effect of age on daily NA, older age was associated with less IEF in depressive symptoms ($\alpha_1 = -0.094$, $p < .001$) and nervousness ($\alpha_1 = -0.080$, $p < .001$). Hypothesis 3 was supported in the second daily component. Specifically, the heterogeneous model showed that older age was associated with greater IEF in NA diversity ($\alpha_1 = 0.057$, $p < .001$), after controlling for the average association between age and NA diversity.

Additional findings in the second daily component on associations between stressor exposures, physical symptoms, demographic characteristics, and IEF in daily NA were largely similar to what were observed in the first daily component. An exception was the associations between stressor exposures, physical symptoms, and IEF in NA diversity. Specifically, greater stressor exposures and more severe physical symptoms were associated with greater IEF in depressive symptoms and nervousness, but less IEF in NA diversity. Further, being female was associated with greater IEF in depression and nervousness; being more neurotic was associated with greater IEF in depression and nervousness but less IEF in NA diversity; better education was associated with greater IEF in nervousness and NA diversity but less IEF in depression.

Hypothesis 4: Developmental Trajectories of IEF in Daily NA and Associations

Developmental change in IEF of daily NA was estimated using growth models fit to each aspect of daily NA based on the two daily components 10 years apart. Unconditional models showed differential trajectories of IEF. Specifically, IEF in depressive symptoms decreased, whereas IEF in nervousness and IEF in NA diversity remained stable. Model estimates from unconditional models are presented in Table 3. To test Hypothesis 4, between-person covariates (i.e., average daily stressor exposures and physical symptoms, age, gender, education, and neuroticism) measured in the first daily component were added as covariates into the unconditional models, and estimates are presented in Table 4. Developmental trajectories of IEF in daily NA remained the same after controlling for covariates. Specifically, IEF in depression decreased over time ($\beta = -0.001$, $p = .005$), whereas IEF in nervousness ($\beta = -0.000$, $p > .05$) and IEF in NA diversity ($\beta = 0.001$, $p > .05$) remained stable. Further, Hypothesis 4 was partially supported. Specifically, there was an age effect for the trajectory of IEF in NA diversity only. Although older people tended to have less IEF in NA diversity on average ($\beta = -0.012$, $p = .0001$), the trajectory was increasing for IEF in NA diversity among old people over the years ($\beta = 0.001$, $p = .0003$).

Several alternative models were explored to see whether there were interaction effects between developmental trajectories of IEF in daily NA and other demographic characteristics such as gender and education. For the trajectory of IEF in depressive symptoms, there was a borderline gender difference over time; women tended to have a steeper decrease than men ($\beta = -0.001$, $p = .06$). For the trajectory of IEF in nervousness, although the general trend was nonsignificant, there was an education effect; the better educated tended to have increasing IEF in nervousness over time ($\beta = 0.001$, $p = .02$). A summary of findings are presented in Table 5.

Table 3. Parameter Estimates for Unconditional Longitudinal Growth Curve Models Across Time

	Depressive symptoms	Nervousness	NA diversity
Parameter	Estimate (*SE*)	Estimate (*SE*)	Estimate (*SE*)
Fixed effects			
Intercept	0.024 (0.002)***	0.090 (0.005)***	0.106 (0.003)***
Linear time	−0.001 (0.000)**	−0.000 (0.001)	0.001 (0.001)
Random effects			
Intercept VAR	0.000 (0.000)***	0.004 (0.001)***	0.000 (0.000)*
Residual VAR	0.003 (0.000)***	0.019 (0.001)***	0.006 (0.000)***
−2LL	−4,365.4	−1,365.5	−3,234.8
AIC, BIC	−4,361.4, −4,352.0	−1,361.5, −1,352.1	−3,230.8, −3,221.5

Notes: AIC = Akaike information criterion; BIC = Bayesian information criterion; IEF = intrinsic emotion fluctuation; NA = negative affect. Total participants were $n = 790$. Outcomes were IEF in depressive symptoms, nervousness, and NA diversity, respectively.
$^{*}p < .05$. $^{***}p < .001$.

Table 4. Parameter Estimates for Longitudinal Growth Curve Models Across Time With Covariates

Parameter	Depressive symptoms	Nervousness	NA diversity
	Estimate (*SE*)	Estimate (*SE*)	Estimate (*SE*)
Fixed effects			
Intercept	−0.025 (0.006)***	−0.039 (0.016)*	0.116 (0.008)***
Linear time	−0.001 (0.000)**	−0.001 (0.001)	0.001 (0.000)
Average daily stressor exposures	0.018 (0.003)***	0.065 (0.009)***	−0.005 (0.005)
Average daily physical symptoms	0.005 (0.001)***	0.011 (0.003)***	−0.004 (0.002)**
Neuroticism	0.015 (0.002)***	0.036 (0.006)***	−0.001 (0.004)
Linear time × Gender	−0.001 (0.001)†		
Linear time × Education		0.001 (0.000)*	
Linear time × Age			0.001 (0.000)***
Age	0.001 (0.001)	−0.001 (0.003)	−0.006 (0.002)*
Gender	0.011 (0.004)**	0.009 (0.008)	0.011 (0.004)*
Education	−0.001 (0.001)*	−0.006 (0.002)*	0.002 (0.001)*
Random effects			
Intercept VAR	0.000 (0.000)†	0.003 (0.001)***	0.000 (0.000)*
Residual VAR	0.003 (0.000)***	0.018 (0.001)***	0.006 (0.000)***
−2LL	−4,407.9	−1,429.5	−3,185.6
AIC, BIC	−4,403.9, −4,394.5	−1,425.5, −1,416.2	−3,181.6, −3,172.2

Notes: AIC = Akaike information criterion; BIC = Bayesian information criterion; IEF = intrinsic emotion fluctuation; NA = negative affect. Total participants were $n = 790$. Outcomes were IEF in depressive symptoms, nervousness, and NA diversity, respectively.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. $^{\dagger}p < .10$.

Discussion

The current study utilized a nested repeated measures design with two daily components spaced 10 years apart. Multilevel models with heterogeneous within-person variance, growth models, and a novel measurement approach for NA diversity are some of the methodological innovations. At the daily and micro level, Simpson's diversity index was able to provide a panoramic view of experienced daily NA. This index offered an alternative to the traditional measures of ratios for affective complexity. Treating IEF as a personality trait, multilevel models with heterogeneous within-person variance were able to test how IEF was associated with age and other between-person characteristics. At the macro level and over time, growth curves were able to model the developmental trajectories of trait-like IEF for specific aspects of daily NA to see how these daily emotional regulatory processes transpire over time in midlife and beyond. Together, the measurement and analytical approaches revealed insight into the largely unexplored concept of IEF of daily NA experiences.

Within the daily context, older people tended to have a more diverse emotional experience on average with more mixed negative emotions in the first daily component. Older people also tended to have less IEF in depressed affect and nervousness based on findings from both daily components. Because IEF in NA diversity had the opposite patterns of association with age in daily component 2 versus 1, the conclusion for age-related IEF in NA diversity still seemed paradoxical. Regarding the developmental trajectories, IEF in NA diversity increased for older people over time. However, there was no age effect for IEF in depressive symptoms or nervousness longitudinally.

Age-Related Differences and Changes in IEF in Daily NA

Although affective fluctuation is a trait comparable with average level of affect (Eid & Diener, 1999; Larsen, 1987), much of the extant research has assumed stability of affective fluctuation over time. The present study is among the first to examine both age-related differences and changes in affective fluctuations at both the between- and within-person levels (Nesselroade & Molenaar, 2010). In the daily context assessed by the first daily component, older people demonstrated higher levels of NA diversity. The positive association between age and NA diversity shows that older people tend to have more diverse NA emotions and experience complex negative feelings. This finding is consistent with the model on emotions and self-regulation proposed by Labouvie-Vief and colleagues (1989) that the more mature brain may be more capable of creating symmetrical representations of self and others, connecting self with others while still maintaining a distinct identity. Emotional regulation efforts are focused on integrating the standards of both self and others, which often entails more diverse emotional states as experienced by older adults. Substantial literature also purports affective diversity as part of emotional maturity (i.e., Larsen & Cutler, 1996).

In the daily context assessed by the second daily component, the model did not suggest any significant association

Table 5. Summary of Findings on IEF in NA Within Each Daily Component and its Longitudinal Dynamics Over Time

	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4	Other findings
Daily analysis at T1	Hypothesis 1 was supported: Older age was associated with higher levels of NA diversity.	Hypothesis 2 was supported: Older age was associated with less IEF in daily depressive symptoms and nervousness.	Hypothesis 3 was ***not*** supported: Older age was associated with less IEF in NA diversity.	N/A	1. **Fixed effects** from MLM (Table 2, top part): Greater stressor exposure and more physical symptoms were associated with lower *levels* of NA diversity. 2. **Random effects** from MLM (Table 2, bottom part): (i) After controlling for the fixed effect of stressor exposures, greater daily average stressor exposures were linearly associated with greater IEF in all aspects of daily NA. (ii) Similarly, after controlling for the fixed effect of daily physical symptoms, more daily average physical symptoms were linearly associated with greater IEF in all aspects of daily NA. (iii) Being female and being neurotic were associated with greater IEF in all aspects of daily NA; better education was associated with less IEF in daily depressive symptoms and nervousness but greater IEF in NA diversity.
Daily analysis at T2	Hypothesis 1 was ***not*** supported: There was no significant association between age and levels of NA diversity.	Hypothesis 2 was supported: Older age was linearly associated with less IEF in daily depressive symptoms and nervousness.	Hypothesis 3 was supported: Older age was associated with greater IEF in NA diversity.	N/A	1. **Fixed effects** from MLM (Table 2, top part): Greater stressor exposure and more physical symptoms were associated with lower *levels* of NA diversity. 2. **Random effects** from MLM (Table 2, bottom part): (i) After controlling for the fixed effect of stressor exposures, greater daily average stressor exposures were linearly associated with greater IEF in depressive symptoms and nervousness, but less IEF in NA diversity. (ii) Similarly, after controlling for the fixed effect of daily physical symptoms, more daily average physical symptoms were linearly associated with greater IEF in depressive symptoms and nervousness, but less IEF in NA diversity. (iii) Being female was associated with greater IEF in all NA dimensions; being more neurotic was associated with greater IEF in depressive symptoms and nervousness but less IEF in NA diversity; better education was associated with greater IEF in nervousness and NA diversity but less IEF in depressive symptoms.
Longitudinal analysis over 10 years	N/A	N/A	N/A	Hypothesis 4 was ***partially*** supported: Older people tended to have increasing IEF in NA diversity over time.	1. ***Unconditional* models** (Table 3): IEF in depressive symptoms decreased over time. IEF in NA diversity and IEF in nervousness remained stable. 2. ***Full* models with covariates** (Table 4): (i) IEF in depressive symptoms decreased over time, IEF in NA diversity and IEF in nervousness remained stable. (ii) For the trajectory of IEF in depressive symptoms, there was a borderline gender difference over time: Women had a steeper decrease than men. (iii) For the trajectory of IEF in nervousness, although the general trend was n.s., there was an education effect: The better educated had increasing IEF in nervousness over time.

Note: IEF = intrinsic emotion fluctuation; MLM = multilevel model; NA = negative affect.

between age and the level of NA diversity. However, older people did tend to have greater IEF in NA diversity. Findings from both daily components suggested that older people had less IEF in depressive symptoms and nervousness. These findings are consistent with SST, which denotes better emotional regulation among older people as having more emotional stability (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). The fact that diversity in negative emotions can still be unstable among the older people suggested by current findings supplements one subtlety of better emotional regulation with aging. Older people are not simply more emotionally stable with less fluctuation in single emotions (Carstensen et al., 2011); they are able to juxtapose diverse emotions that can potentially maximize their daily well-being.

As shown by the developmental trajectories of IEF over time, IEF in depressive symptoms decreased. Thus, more stability is observed in this single and specific aspect of daily NA. This could suggest better emotional regulation associated with aging and is consistent with SST. For IEF in NA diversity, however, the findings were more complex. Although older people had less fluctuations on average in this aspect of daily NA, its trajectory was increasing over time. Sliwinski, Almeida, Smyth, & Stawski (2009) have also shown that fluctuations in stress-related NA increased from midlife into old age. These findings could suggest declining biological systems and cognitive functioning associated with aging. Therefore, older people may have fewer resources to cope with daily circumstances when they are engaged in social tensions, resulting in increased levels and variability of daily NA (Charles et al., 2009; Sliwinski et al., 2009).

The concept of emotional diversity may be analogous to biodiversity in an ecosystem (Quoidbach et al., 2014). As a relative abundance of various species within an ecosystem can foster ecosystem flexibility and resilience, greater emotional diversity may in fact represent healthier emotional functioning. Another way of thinking about diversity of emotions is that one's reactions to stressors are more nuanced and therefore potentially more adaptive. One can see different perspectives on a problem, rather than being bound by a single negative emotion. Thus, it follows that the diversity of emotions, over and above the levels of affect, can have direct benefits for physical health and emotional well-being (Quoidbach et al., 2014). If lack of emotional diversity is associated with health risks and mortality, individuals with less emotional diversity and probably less variability in emotional diversity would be underrepresented in old age. Therefore, the increased lability in NA diversity may also reflect an age-related reduction in between-person variability due to selective mortality.

IEF in NA and Associations With Other Between-Person Characteristics

The positive associations between IEF in specific aspects of NA and daily stressor exposures and physical symptoms are largely consistent with findings from cross-sectional studies. Liu and colleagues (2015) found that greater daily stressor exposures were associated with greater within-person fluctuations in depressive symptoms and anger among family caregivers of individuals with dementia. The negative associations between IEF in NA diversity and stressor exposures and physical symptom severity in the second daily component seemed a bit puzzling. A possible explanation is that the sample is older in the second daily component, and the negative associations at the between-person levels may reflect diminishing resources and declining physical functioning for older individuals to deal with daily challenges, resulting in greater fluctuations in NA diversity (Sliwinski et al., 2009).

The finding that women had greater IEF in nearly all aspects of daily NA is also consistent with the literature. Almeida and Kessler (1998) showed that women tended to report a higher prevalence of days that are high distress than men did. They suggested that women may be more ruminative, which may amplify and prolong the distress making them more reactive to a multitude of daily experiences than men. It is thus possible for women to have more fluctuations in NA as the days unfold. The finding that better education was associated with less IEF in depressed affect is consistent with findings by Liu and colleagues (2015). The opposite patterns of between-person association between education and IEF in nervousness in the two daily components, again, seemed puzzling. Possible explanations are that the sample was older in the second daily component, and many participants experienced life-course transitions such as retirement, changes in family structure, and losses of friends and relatives. The fact that data in the second daily component were collected in a difficult economic time (i.e., 2004–2009 versus 1994–1995) may also be at play for greater IEF in nervousness, reflecting participants' uncertainty about their financial future. The significant positive association between education and NA diversity suggests the protective benefits of having richer emotional experiences among people who are better educated and, probably, had higher socioeconomic status.

The positive associations between IEF in specific aspects of daily NA and neuroticism are consistent with past findings. Neuroticism is associated with mood swings and inefficient emotional regulation skills in certain problem-solving situations (Kokkonen & Pulkkinen, 2001). Additionally, Mroczek and Almeida (2004) reported that older individuals who are highly neurotic tended to have the highest NA levels in response to stressors. If being neurotic has negative connotations in terms of efficient emotional regulation, then the negative associations between neuroticism and IEF in NA diversity in Daily Component 2 were consistent with the literature. Larsen and Cutler (1996) reported that greater emotional diversity was associated with lowered emotional reactivity and less neuroticism. Thus, neuroticism may be associated with less emotional diversity, and probably less fluctuations in NA diversity.

Limitations and Conclusions

There are limitations in the current study. Although between-person differences and within-person changes in affective fluctuations over time are important in understanding emotional regulation and affective experience, there are few studies conducted on this topic. Even fewer studies have explored the concept of IEF and its associations with age and other individual characteristics such as gender, education, and neuroticism (Eid & Diener, 1999). Among the extant studies, within-person affective variability has been operationally defined in various ways, which may relate to different personality theories. Additionally, different operationalization methods make it difficult to critically compare findings on the same topic (Eid & Diener, 1999, Riediger & Rauers, 2014). Further, the current study only examined IEF in NA. Situational-specific determinants such as daily stressors and personality variables may be particularly important for IEF in positive affect (Eid & Diener, 1999). For example, it is possible that IEF may vary with affective disorders or cognitive impairment, however, more research is needed to understand the specificity of these associations. Our study looked at IEF in midlife, however, it would be useful to examine IEF in late life in order to gain a more comprehensive understanding. Additionally, the data from these two daily components were collected in distinctive historic times. The findings within each daily component may be idiosyncratic given the specific social environment; and some opposite patterns of associations were observed within these two daily components. Additional covariates for year of collection could be examined to substantiate potential cohort and economic effects. Also, some constructs measured within each daily component used slightly different instruments (i.e., daily physical symptoms and NA diversity), and some of them had low reliability as measured by Cronbach's alpha. All these factors call for cautious interpretation.

Although there is growing consensus that emotional well-being improves from early adulthood to old age (Carstensen et al., 2011), the current findings reveal exciting but mixed insight into emotional regulation of daily affective experience among middle-aged adults. Within the daily context, older people tended to have less IEF in depressive symptoms and nervousness and are more emotionally diverse. Longitudinally, although older people had lower levels of IEF in NA diversity, they tended to have increasing IEF in NA diversity over time. Future studies are necessary to further reveal the concept of IEF, emotional diversity, and their complicated and interactive associations with age and other individual characteristics in the process of aging.

Funding

The MIDUS I study (Midlife in the United States) was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development. The MIDUS II research was supported by a grant from the National Institute on Aging (P01-AG020166) to conduct a longitudinal follow-up of the MIDUS I investigation.

References

Almeida, D. M., & Horn, M. C. (2004). Is daily life more stressful during middle adulthood? In O. G. Brim, C. D. Ryff, & R. C. Kessler (Eds.), *How healthy are we?: A national study of well-being at midlife* (pp. 425–451). Chicago, IL: University of Chicago Press.

Almeida, D. M., & Kessler, R. C. (1998). Everyday stressors and gender differences in daily distress. *Journal of Personality and Social Psychology*, **75**, 670–680. doi:10.1037/0022-3514.75.3.670

Almeida, D. M., Wethington, E., & Kessler, R. C. (2002). The daily inventory of stressful events: An interview-based approach for measuring daily stressors. *Assessment*, **9**, 41–55. doi:10.1177/1073191102091006

Baumeister, R. F. (1991). On the stability of variability: Retest reliability of metatraits. *Personality and Social Psychology Bulletin*, **17**, 633–639. doi:10.1177/0146167291176005

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, **88**, 588–606. doi:10.1037/0033-2909.88.3.588

Carstensen, L. L., Fung, H. H., & Charles, S. T. (2003). Socioemotional selectivity theory and the regulation of emotion in the second half of life. *Motivation and Emotion*, **27**, 103–123. doi:10.1023/a:1024569803230

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology*, **79**, 644–655. doi:10.1037/0278-6133.17.6.494

Carstensen, L. L., Turan, B., Scheibe, S., Ram, N., Ersner-Hershfield, H., Samanez-Larkin, G. R.,…Nesselroade, J. R. (2011). Emotional experience improves with age: Evidence based on over 10 years of experience sampling. *Psychology and Aging*, **26**, 21–33. doi:10.1037/a0021285

Charles, S. T., & Almeida, D. M. (2006). Daily reports of symptoms and negative affect: Not all symptoms are the same. *Psychology & Health*, **21**, 1–17. doi:10.1080/14768320500129239

Charles, S. T., Piazza, J. R., Luong, G., & Almeida, D. M. (2009). Now you see it, now you don't: Age differences in affective reactivity to social tensions. *Psychology and Aging*, **24**, 645–653. doi:10.1037/a0016673

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

Grühn, D., Lumley, M. A., Diehl, M., & Labouvie-Vief, G. (2013). Time-based indicators of emotional complexity: Interrelations and correlates. *Emotion*, **13**, 226–237. doi:10.1037/a0030363

Hedeker, D., & Mermelstein, R. J. (2007). Mixed-effects regression models with heterogenous variance: Analyzing ecological momentary assessment (EMA) data of smoking. In T. D. Little, J. A. Bovaird, & N. A. Card (Eds.), *Modeling contextual effects in longitudinal studies*. Mahwah, NJ: Erlbaum.

Hedeker, D., Mermelstein, R. J., Berbaum, M. L., & Campbell, R. T. (2009). Modeling mood variation associated with smoking: An application of a heterogeneous mixed-effects model for analysis of ecological momentary assessment (EMA) data. *Addiction*, **104**, 297–307. doi:10.1111/j.1360-0443.2008.02435.x

Hedeker, D., Mermelstein, R. J., & Demirtas, H. (2008). An application of a mixed-effects location scale model for analysis of Ecological Momentary Assessment (EMA) data. *Biometrics*, **64**, 627–634. doi:10.1111/j.1541-0420.2007.00924.x

Hill, M. O. (1973). Diversity and evenness: A unifying notation and its consequences. *Ecology*, **54**, 427–432. doi:10.2307/1934352

Hoffman, L. (2007). Multilevel models for examining individual differences in within-person variation and covariation over time. *Multivariate Behavioral Research*, **42**, 609–629. doi:10.1080/00273170701710072

Kokkonen, M., & Pulkkinen, L. (2001). Examination of the paths between personality, current mood, its evaluation, and emotion regulation. *European Journal of Personality*, **15**, 83–104. doi:10.1002/per.397

Kuppens, P., Allen, N. B., & Sheeber, L. B. (2010). Emotional inertia and psychological maladjustment. *Psychological Science*, **21**, 984–991. doi:10.1177/0956797610372634

Labouvie-Vief, G., Hakim-Larson, J., DeVoe, M., & Schoeberlein, S. (1989). Emotions and self-regulation: A life span view. *Human Development*, **32**, 279–299. doi:10.1159/000276480

Lachman, M. E., & Weaver, S. L. (1997). *The Midlife Development Inventory (MIDI) Personality Scales: Scale construction and scoring (Technical Report)*. Waltham, MA: Brandeis University.

Larsen, R. J. (1987). The stability of mood variability: A spectral analytic approach to daily mood assessments. *Journal of Personality and Social Psychology*, **52**, 1195–1204. doi:10.1037/0022-3514.52.6.1195

Larsen, R. J., & Cutler, S. E. (1996). The complexity of individual emotional lives: A within-subject analysis of affect structure. *Journal of Social and Clinical Psychology*, **15**, 206–230. doi:10.1521/jscp.1996.15.2.206

Liu, Y., Kim, K., Almeida, D. M., & Zarit, S. H. (2015). Daily fluctuation in negative affect for family caregivers of individuals with dementia. *Health Psychology*, **34**, 729–740. doi:10.1037/hea0000175

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, **33**, 335–343. doi:10.1016/0005-7967(94)00075-U

Mroczek, D. K., & Almeida, D. M. (2004). The effect of daily stress, personality, and age on daily negative affect. *Journal of Personality*, **72**, 355–378. doi:10.1111/j.0022-3506.2004.00265.x

Nesselroade, J. R., & Molenaar, P. C. M. (2010). Emphasizing intraindividual variability in the study of development over the lifespan. In W. F. Overton (Ed.), *The handbook of life-span development* (pp. 30–54). New York, NY: John Wiley & Sons, Inc.

Piazza, J. R., Charles, S. T., Sliwinski, M. J., Mogle, J., & Almeida, D. M. (2013). Affective reactivity to daily stressors and long-term risk of reporting a chronic physical health condition. *Annals of Behavioral Medicine*, **45**, 110–120. doi:10.1007/s12160-012-9423-0

Quoidbach, J., Gruber, J., Mikolajczak, M., Kogan, A., Kotsou, I., & Norton, M. I. (2014). Emodiversity and the emotional ecosystem. *Journal of Experimental Psychology: General*, **143**, 2057–2066. doi:10.1037/a0038025

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Riediger, M., & Rauers, A. (2014). Do everyday affective experiences differ throughout adulthood? A review of ambulatory-assessment evidence In P. Verhaeghen & C. Hertzog (Eds.), *The Oxford handbook of emotion, social cognition, and everyday problem solving during adulthood* (pp. 61–79). New York, NY: Oxford University Press.

Röcke, C., & Brose, A. (2013). Intraindividual variability and stability of affect and well-being: Short-term and long-term change and stabilization processes. *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry*, **26**, 185–199. doi:10.1024/1662–9647/a000094

Röcke, C., Li, S.-C., & Smith, J. (2009). Intraindividual variability in positive and negative affect over 45 days: Do older adults fluctuate less than young adults? *Psychology and Aging*, **24**, 863–878. doi:10.1037/a0016276

Simpson, E. H. (1949). Measurement of diversity. *Nature*, **163**, 688. doi:10.1038/163688a0

Sliwinski, M. J., Almeida, D. M., Smyth, J., & Stawski, R. S. (2009). Intraindividual change and variability in daily stress processes: Findings from two measurement-burst diary studies. *Psychology and Aging*, **24**, 828–840. doi:10.1037/a0017925

Spielberger, C. D. (2010). State-trait anxiety inventory. In I. B. Weiner & W. E. Craighead (Eds.), *The Corsini encyclopedia of psychology* (4th ed., Vol. **1**). Hoboken, NJ: John Wiley & Sons.

Watson, D. (1988). Intraindividual and interindividual analyses of positive and negative affect: Their relation to health complaints, perceived stress, and daily activities. *Journal of Personality and Social Psychology*, **54**, 1020. doi:10.1037/0022-3514.54.6.1020

Watson, D., & Pennebaker, J. W. (1989). Health complaints, stress, and distress: Exploring the central role of negative affectivity. *Psychological Review*, **96**, 234–254. doi:10.1037/0033-295X.96.2.234

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