Within-person variability in state anxiety across adulthood: Magnitude and associations with between-person characteristics

Denis Gerstorf,
Pennsylvania State University, USA

Karen L. Siedlecki,
University of Virginia, Charlottesville, USA

Elliot M. Tucker-Drob, and
University of Virginia, Charlottesville, USA

Timothy A. Salthouse
University of Virginia, Charlottesville, USA

Abstract

Across domains of functioning, research has shown substantial within-person variability in a number of different types of variables from one measurement occasion to another. Using data obtained from a large sample ($n = 784$, 18–97 years) at three separate occasions, we examined properties and correlates of short-term variability in a construct that by definition is prone to fluctuations, namely state anxiety. Our results revealed that participants exhibited sizeable across-occasion variation in state anxiety. The magnitude of variability was unrelated to age, but was associated with a number of individual difference characteristics such as self-reported health, aspects of personality, well-being, and cognition. However, after taking into account mean-level differences in state anxiety, evidence for unique associations of variability was minimal.

Keywords

adult lifespan; emotion; intraindividual variability; mood

A number of recent studies have demonstrated that individuals typically show considerable short-term variability across various domains of functioning, and also have shed some light on potentially underlying mechanisms and associated outcomes of such variability (Allaire & Marsiske, 2005; Deary & Der, 2005; Eizenman, Nesselroade, Featherman, & Rowe, 1997; MacDonald, Hultsch, & Dixon, 2003; Mroczek & Almeida, 2004; Nesselroade & Salthouse, 2004; Rabbitt, Osman, Moore, & Stollery, 2001; Röcke & Smith, 2005; Rowe & Kahn, 1997; Salthouse & Berish, 2005; Siegler, 1994; Sliwinski, Smyth, Hofer, & Stawski, 2006). The current study examines questions regarding short-term within-person variability in a construct that has been conceptualized as a state that varies from one occasion to the next, namely state anxiety (Cattell & Nesselroade, 1976; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Specifically, we investigate (a) the magnitude of state anxiety variability across three occasions in an adult lifespan sample, (b) how such variability is

associated with individual difference characteristics including self-reported health, personality, well-being, and cognition, and (c) whether these associations of variability are unique over and above mean-level associations.

Within-person variability over relatively short periods of time has major conceptual and methodological implications for developmental research. Among others, short-term within-person variation may constitute a stable and systematic individual difference characteristic (Fiske & Rice, 1955; Larsen, 1987; Nesselroade, 1991). Researchers across various domains have demonstrated that the magnitude of within-person variability can be large relative to between-person variability (negative affect: Röcke & Smith, 2005; perceptual-motor variables: Nesselroade & Salthouse, 2004). In addition, the magnitude of short-term variation in a given domain has been linked to central indicators of successful development and aging. For example, individual differences in the magnitude of week-to-week variation in sense of control were found to be associated with mortality a few years later (Eizenman et al., 1997), and variability in positive affect has been considered to reflect outcomes of better adaptation and less rigidity (Eid & Diener, 1999). Variability in negative affect, in contrast, was found to be more pronounced among depressed participants as compared with healthy controls (Lawton, Parmelee, Katz, & Nesselroade, 1996; Peeters, Berkhof, Delespaul, Rottenberg, & Nicolson, 2006).

The present study focuses on state anxiety, a construct considered to be particularly prone to short-term variability (Cattell & Scheier, 1961). State anxiety refers to a transitory emotional condition of feeling tense, nervous, and worried as well as reporting symptoms of increased physiological arousal at a particular moment in time (Wetherell, Reynolds, Gatz, & Pedersen, 2002). Conceptually, state anxiety can be expected to vary in intensity and fluctuate over time (Cattell & Nesselroade, 1976) primarily because it represents a systematic response to a given situation or to events in everyday life (Lawton, deVoe, & Parmelee, 1995; see also Mroczek & Almeida, 2004; Shoda, Mischel, & Wright, 1994), but maybe also because of random variation around a more or less stable level (for discussion, see Nesselroade, 1988). Given this transitory nature of states, and in line with seminal personality theories stressing the variability of behavior and feelings over time (Mischel & Shoda, 1995; Spielberger et al., 1983; Wessman & Ricks, 1966), states are usually studied in terms of both level and short-term fluctuations. Studying the nature and functional implications of variation in state anxiety may add to our understanding of (daily) variability in the arenas of affect, emotion, and mood (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Eid & Diener, 1999; Fredrickson & Losada, 2005; Röcke & Smith, 2005). Specifically, such a line of inquiry may inform us about age-related differences across the adult lifespan in the amount of variability in feeling anxious as a central indicator of psychological adjustment, as well as about its association with variables that reflect possible precursors, correlates, or consequences of affective experiences.

There is a long tradition of research suggesting that levels of trait anxiety show robust associations with a number of individual difference characteristics, with higher anxiety related to younger age (Lawton, Kleban, & Dean, 1993), being a woman (Wetherell et al., 2002), more health constraints (Aldwin, Spiro, Levenson, & Cupertino, 2001), high neuroticism (Pearman & Storandt, 2004), reports of negative affect and low well-being (Watson & Clark, 1992), and lower performance on cognitive tests (Gold & Arbuckle, 1990; Shackman et al., 2006). It is largely an open question whether such associations of mean-level trait anxiety generalize to short-term variation in state aspects of anxiety. Theoretical notions about variability indicating a general systemic instability (Schroots & Yates, 1999) as well as empirical reports of negative affect variables (Eaton & Funder, 2001; Eid & Diener, 1999; Eysenck & Eysenck, 1985; Lawton et al., 1996; Peeters et al., 2006; Strauss, MacDonald, Hunter, Moll, & Hultsch, 2002) suggest that both high mean levels, and more

variation, on aspects of unpleasant affect may be associated with poorer outcomes in terms of psychological adjustment and performance. At the same time, however, tenants of lifespan theories and initial empirical evidence suggest that variability in aspects of negative affect may be maladaptive at low levels of negative affect, but adaptive at higher levels (Carstensen et al., 2000; Cattell, 1957; Martin & Hofer, 2004). For example, Carstensen and colleagues (2000) reported that better emotion regulation in old age was associated not only with low negative states being stable, but also with highly negative states becoming increasingly labile.

Across domains of functioning, it is relatively well established that information about mean level and short-term variability constitute overlapping, but often distinct factors (Ram, Rabbitt, Stollery, & Nesselroade, 2005). For example, Eid and Diener (1999) concluded from measures of affect that only 10% of the variance in affect variability could be accounted for by mean levels of affect. Questions about the uniqueness of associations between variability and individual difference characteristics over and above associations of mean levels primarily have been addressed indirectly. In the cognitive aging literature, for example, correlates of the level are often partialed before considering variability measures (e.g., residualizing age and retest effects from variability in reaction time; see Hultsch, Strauss, Hunter, & MacDonald, 2008). In contrast, a direct empirical comparison of the predictive effects of level and variability for individual difference characteristics has only recently become a research focus. For measures of personality, Baird, Le, and Lucas (2006), for example, report from an experience-sampling study that intraindividual variability was no longer related to well-being once indices of the central tendency were taken into account (see also Salthouse, Nesselroade, & Berish, 2006). To assure the fairness of these direct empirical comparisons, a number of different factors have to be taken into account. Among the key factors is that estimates of variability may be less reliable than estimates of the central tendency, which might result in underestimating its systematic relation with other variables. One way to minimize the effects of unreliable measurement is to examine constructs of mean level and variability with latent constructs, thereby allowing a focus on variance that is common to the indicators selected for each construct free from measurement error (Loehlin, 2004).

The present article attempts to extend the study of anxiety by asking three sets of questions. First, we explore the magnitude of short-term variability in state anxiety across three occasions using a large community-dwelling adult sample ($n = 784$, 18–97 years). Because state anxiety is defined as a construct that fluctuates over time, we expect considerable across-occasion variability. Second, we explore substantive relations between the magnitude of within-person variability in state anxiety and sociodemographic characteristics such as age and gender as well as measures of health, personality, well-being, and cognitive functioning. Because these variables have previously been found to be associated with mean levels of anxiety, we expect associations between them and variability in state anxiety. We also explore whether the direction of such variability associations varies between high and low levels of state anxiety. Third, we directly compare the unique associations of level and variability of state anxiety, and we also adjust for unreliability of measurement of both level and variability by using latent constructs. We anticipate that some associations of variability might be carried by the mean, but we expect that at least some of the relations of variability to other variables are unique, and independent of the mean.

Method

Participants and procedure

The current project used data collected in four studies carried out at the Cognitive Aging Laboratory at the University of Virginia, Charlottesville, in the years 2004 and 2005.

Participants were asked to come to the laboratory for three separate sessions over an average of 11 days (SD = 10.5). Detailed descriptions of the procedures and variables are reported in Salthouse, Siedlecki, and Krueger (2006). In total, 784 adults (18–97 years; 62% women) with valid data on all variables under study were included in the present analyses. These persons did not differ from those excluded due to missing data (n = 27) on demographic (age, gender) or health variables. These variables were also not found to be associated with differences in the length of the testing period. Sample characteristics are presented in Table 1 both for the complete sample, and for three age groups separately: young (18–39 years), middle-aged (40–59 years), and older adults (60–97 years). Participants were highly educated (> 15 years, on average), they rated themselves as healthy (4.0, on average, on a 5-point scale), and their average scores on two standardized cognitive measures (Digit Symbol and Vocabulary) were above the age-adjusted norms. Participants were recruited primarily by newspaper advertisements, study flyers, and referrals from other participants.

Measures

State anxiety—Participants completed the 20-item State Anxiety subscale of the State-Trait Anxiety Inventory (STAI: Spielberger et al., 1983). This scale was developed to assess current anxiety in that participants were asked to indicate on a scale from 1 (not at all) to 4 (very much so) how strongly they felt certain emotions *right now*. Among the emotions sampled were 10 items assessing pleasant emotions such as calm or at ease (which were reverse scored to compute the total score) and 10 items assessing unpleasant emotions such as tense or upset. Participants completed the STAI prior to any of the cognitive testing in each session. Cronbach's alphas were high at each occasion (α .90).

For ease of interpretation and comparison, we standardized STAI scale scores for each session to the T metric (M = 50, SD = 10) using the between-person standard deviation at the first session. These T-standardized scale scores were used to compute the mean across the three measurement occasions to represent mean levels of state anxiety as well as the intra-individual standard deviation (ISD) across the three occasions to index the amount of within-person variability in state anxiety.

Individual difference characteristics—To examine associations between the ISD in state anxiety and individual difference characteristics, sociodemographic information and measures of health, personality, well-being, and cognition were obtained at session 1. *Sociodemographic information* included chronological age, gender, and years of education. To examine aspects of *health*, we considered subjective health and depression. Subjective health was examined by asking participants to rate their current health on a scale from 1 (excellent) to 5 (poor). In our analyses, scores for subjective health were reverse coded so that higher scores indicate better health ratings. As a screening instrument for depression, the CES-D (Radloff, 1977), which involves 20 items that ask participants how often over the last week they have felt depressive symptoms such as restless sleep or sad feelings, was used. Five factors of *personality* (neuroticism, extraversion, openness, conscientiousness, and agreeableness) were measured by Goldberg's (1999) Personality Inventory, which asks participants to rate 50 self-description items on a scale from 1 (very inaccurate) to 5 (very accurate). We also assessed trait anxiety as measured by the 20-item Trait Anxiety subscale of the STAI (Spielberger et al., 1983), which uses the same items as the state subscale, but asks participants to report how they *generally* feel. As an indicator of *well-being*, we used the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988), which asked participants to rate the extent to which they currently felt 10 positive and 10 negative emotions on a scale from 1 (very slightly or not at all) to 5 (extremely). We also considered the 18-item Need for Cognition Scale (Cacioppo & Petty, 1982), which was used to indicate the desire for cognitive stimulation on a 5-point scale. Finally, *cognitive functioning* was

assessed using the Digit Symbol Substitution Test and the Vocabulary subtest, both taken from the WAIS-III (Wechsler, 1997).

Data preparation and statistical procedures

Table 1 shows descriptive statistics for mean and ISD on state anxiety in their original scaling units as well as information about individual difference variables and their age correlations. Generally consistent with the extant literature, increased age was associated with lower levels of trait anxiety, subjective health, and depression, but also with higher levels of positive affect.

After analyzing the magnitude of the ISD in state anxiety, we also explore how between-person differences in such variability were related to other available individual difference variables (sociodemographic information, health, personality, well-being, and cognition). To do so, we carried out two sets of analyses. In a first step at the level of observed variables, we considered correlations and semi-partial correlations in which either the mean or the ISD of state anxiety was controlled for when considering relations involving the other variable. To adjust for potential biases due to differential reliabilities of mean and ISD, we proceeded to the latent variable level in a second step. Specifically, we applied structural equation modeling to focus on the common variance among indicators of mean and ISD, respectively, thereby allowing for a precise, error-free quantification of mean level and variability in state anxiety (Loehlin, 2004). All latent construct analyses were fit to the data using M*plus* (Muthén & Muthén, 1998). To guard against inflation of Type I error, the alpha level was set to $p < .01$.

Results

Magnitude of short-term variability in state anxiety

In a first descriptive step, we present between-person differences in mean levels and variability in state anxiety across three occasions. Inspection of Table 1 indicates that mean state anxiety across the three age groups considered was approximately 1.5 on a scale from 1 to 4. This pattern of relatively low state anxiety is generally consistent with other studies on emotion regulation (Watson & Clark, 1992). Despite this average low level, only $n = 41$ participants (5 %) reported no feelings of state anxiety across the three sessions. Regarding within-person variability, the average ISD was approximately 0.2, and only a minority of participants did not show variability on state anxiety across the three sessions ($n = 47$; 6%).[1]

When expressed as an effect size based on the between-person standard deviation at the first occasion (as derived from *T*-standardized scale scores), the average ISD on state anxiety amounted to more than half a standard deviation ($M = 5.19$, $SD = 4.20$), and approximately 25% of the sample ($n = 188$) exhibited across-occasion variability of three-quarters of a standard deviation or more. Figure 1 shows mean (circles) and ISD (bars) of state anxiety for a random selection of $n = 60$ participants aged 18 to 90 years. This figure is illustrative of two important findings. First, and consistent with the state concept, there is considerable across-occasion variability in state anxiety, as reflected in the size of the bars. Second, there are large between-person differences in the magnitude of the ISD across the adult age range. For example, some participants show minimal variation (e.g., participants aged 83 years), whereas others show substantial variation (e.g., participants aged 84 years).

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[1]In follow-up analyses, we routinely excluded those participants who did not report feelings of state anxiety and/or showed no variability. The substantive pattern of results reported remained virtually unchanged.

Correlates of short-term variability in state anxiety

After having shown that within-person variability in state anxiety was sizeable on average, our second objective was to examine whether differences in the magnitude of such variability were related to other individual difference characteristics with, and without, controlling for mean-level differences. Zero-order and semi-partial correlations in which either the mean or the ISD was controlled using hierarchical regression when considering relations involving the other variable are presented in Table 2.

Zero-order correlations of the ISD with the individual difference characteristics (see column 2) indicate that state anxiety fluctuations were not associated with age, but were related to several variables. Specifically, variation in state anxiety was positively associated with being a woman and with trait anxiety, depression, neuroticism, and negative affect, and negatively associated with levels of early-life education, subjective health, positive affect, need for cognition, and cognitive performance. These relations were in the same direction as those involving level of state anxiety (see columns 2 and 5; e.g., negative affect: $r_{ISD} = .14$; $r_M = .31$), and the intercorrelation between mean and ISD in state anxiety was $r = .49$, $p < .01$. The correlations with the ISD were substantially reduced after partialling the mean. With the exception of extraversion and need for cognition, none of the correlations remained significantly different from zero (see columns 3 and 4) once the mean was partialed. In contrast, controlling the ISD resulted in only a slight reduction of the relations involving the mean level, and for most variables these associations were still statistically significant (see columns 6 and 7). These results thus suggest that an index of the central tendency (mean) of state anxiety was more important in the prediction of individual difference characteristics than was an index of short-term variability (ISD) of state anxiety.

Of course, such a straightforward interpretation needs to be made with caution for a number of reasons. One key concern is that indices of mean and variability might have been differentially reliable. Indeed, using a method described by Salthouse, Nesselroade, et al. (2006),[2] the estimated reliability of the ISD (Cronbach's alpha = .69) was considerably lower than the reliability of the mean (Cronbach's alpha = .95). To address this concern, the next section reports latent construct analyses for mean level and ISD on state anxiety.

Uniqueness of associations between short-term variability in state anxiety and the correlates

In a final series of analyses, we proceed to the latent construct level and examine the unique predictive associations of error-free quantifications of level and ISD on state anxiety with individual difference characteristics. To obtain a set of observed indicators for the latent constructs, we followed classical work on item parceling (for discussion, see Kishton & Widaman, 1994; Little, Cunningham, & Shahar, 2002) and reduced the dimensionality of the raw data by combining the 20 state anxiety items to constitute three separate parcels. Specifically, means and ISDs were computed separately across the three sessions for the 20 items, and parcels were created that are equally representative for the positive and negative valence of state anxiety. The three parcels were: P1 = comfortable, pleasant, satisfied, tense, confused, and misfortune; P2 = content, secure, relaxed, nervous, indecisive, and worried; and P3 = steady, self-confident, at ease, calm, strained, frightened, jittery, and upset.

Figure 2 shows the structural model used to regress each correlate (labeled "Z") onto latent constructs representing the mean and ISD in state anxiety. It should be noted that the specific variance components of the parcels were allowed to covary because parcels of both

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[2]Salthouse, Nesselroade, et al. (2006) used the mean and ISD, respectively, across two pairs of sessions (i.e., sessions 1 and 2; sessions 1 and 3; and sessions 2 and 3) as items in the computation of Cronbach's α.

mean and ISD were derived from the same set of items. All factor loadings were above .80, suggesting that the construction of parcels resulted in highly reliable indicators of the latent factors.

The factor model showed reasonable fit to our data ($\chi^2 = 97$, $df = 5$, CFI = .98, TLI = .94). Using a hierarchically tested model comparison, we compared this model with a one-factor model that was indicated by all six parcels, which represents the possibility that a single factor contributes to both level and variability in state anxiety (see Table 3). A chi-square difference test revealed that a two-factor model fit our data significantly better than the one-factor model ($\Delta\chi^2/df = 668/1$), allowing us to conclude that mean and variability in state anxiety constitute two separable constructs. It is also noteworthy that the relations between mean and variability were higher with latent variables ($\varphi = .77$) than with observed variables ($r = .49$).[3]

Table 3 also presents results from analyses of structural invariance across the three age groups. As the reference, we use a configural invariance model in which the item-factor structure was invariant across age groups. A statistically nested model comparison revealed that the factor loadings could be set to be equal across age groups without significant loss in model fit ($\Delta\chi^2/df = 17/8$). In addition to this metric invariance, the fit was not significantly reduced after setting the factor intercorrelation to be invariant across age groups ($\Delta\chi^2/df = 6/2$), which indicates that the two latent factors showed similar relations across adulthood. In sum, a two-factor model for mean and ISD in state anxiety as shown in Figure 2 is an adequate representation of the structure in our data set for participants aged 18 to 97 years.

Using the above model, we examined the unique associations of mean and variability in state anxiety to other individual difference variables. To do so, the variables were regressed on the two latent factors of mean and ISD, either in separate or simultaneous, analyses both with, and without, controlling for age. The standardized coefficients of these analyses are presented in Table 4. Note that the strength of the associations in separate latent construct analyses was somewhat stronger than those reported for the observed variables in Table 2 (e.g., negative affect: $\varphi_{ISD} = .32$; $\varphi_M = .39$ vs. $r_{ISD} = .14$; $r_M = .31$). This suggests that the less than perfect reliability of the ISD for the observed variables tends to limit the associations of state anxiety variability with the individual difference variables.

The pattern of results in simultaneous latent construct analyses of mean and variability was very similar to that reported for the observed variables in Table 2. That is, taking into account mean levels of state anxiety substantially reduces the predictive effects of state anxiety variability; in fact, variability was only uniquely related to lower education and greater extraversion. In contrast, controlling for variability in state anxiety resulted in non-significant correlations between mean-level state anxiety and some variables (education, neuroticism, and need for cognition), the emergence of statistically significant correlations for other variables (age and extraversion), but little change in the correlations for most other variables (trait anxiety, health, depression, positive affect, and negative affect). In sum, after adjusting for differential reliabilities of mean and variability in state anxiety via latent construct analyses, there was little evidence of unique associations between within-person variability in state anxiety and various individual difference characteristics.[4]

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[3]In a model with uncorrelated specific variance components, the latent constructs for mean level and ISD showed similarly high intercorrelations. We also examined whether parcels of the ISD that were residualized for the corresponding mean-level parcel would define a reliable variability factor that is separable of the mean-level factor. The results of a model fit comparison revealed effectively the same pattern as reported in that a two-factor model ($\chi^2 = 49$, $df = 5$, CFI = .99, TLI = .96) described the structure in our data set significantly better than a one-factor model ($\chi^2 = 764$, $df = 6$, CFI = .76, TLI = .41 $\Delta\chi^2/df = 715/1$). Similarly, all factor loadings were equal to or above .70 and thus in an acceptable range.

Differential correlate-variability associations by levels of anxiety—In a final set of analyses, we explored whether the ISD in state anxiety shows differential associations to the individual difference characteristics when considering participants at either high or low levels of state anxiety. To do so, we divided our sample into two equal-sized halves ($n = 392$) based on the median on levels of state anxiety and examined differences in model fit when relations among the variables were constrained to be equal across the high and low anxiety groups. Results from this multi-group approach indicated that some ISD associations differed numerically between participants at high (e.g., age: .19, $p < .05$) and low (e.g., age: .04, $p > .10$) levels of state anxiety. However, setting these parameters invariant across groups did not result in loss of model fit as compared with models freely estimating these parameters (e.g., age: $\Delta\chi^2/df = 1/1$), which suggests that there were no statistically significant differences in the direction and magnitude of variability-correlate associations between individuals at high or low levels of state anxiety.

Discussion

The major objectives of this study were to examine the magnitude of across-occasion variability in a state measure of anxiety using a community-dwelling adult lifespan sample, and to explore its unique associations with a broad range of individual difference characteristics. Consistent with the state anxiety conceptualization and earlier empirical reports (Cattell & Nesselroade, 1976), our participants exhibited sizeable fluctuations in state anxiety from occasion to occasion, and individuals varied in the magnitude of such within-person variability. These differences in variability, when considered on their own, showed no association to age, but were found to relate to various individual difference characteristics including self-reported health, personality, well-being, and cognition. However, further analyses revealed that an index of the central tendency was a more important unique predictor of these characteristics than was an index of short-term fluctuations. In addition, we have not found evidence that the functional implications of variability vary by level of state anxiety. Our discussion attempts to integrate these findings with previous research on within-person variability in the emotion and personality literature as well as consider implications for future research.

Variability in state anxiety and its correlates

Our results regarding state anxiety add to the increasing body of research illustrating that numerous facets of the individual should be thought of as dynamic, labile, and fluctuating entities (Nesselroade, 1991). In analogy to studies on other facets of unpleasant affect (Isaacowitz & Smith, 2003; Lawton et al., 1996; Röcke & Smith, 2005; Watson & Clark, 1992), we take reports of low average state anxiety to be indicative of preserved emotion regulation in non-clinical samples. Despite the relatively low levels of state anxiety, our participants exhibited, on average, within-person variation on state anxiety across three occasions that was more than half as large as the between-person differences observed at the first occasion. We consider this effect size considerable given that participants completed the state anxiety questionnaires each time they came into our laboratory. Nevertheless, we acknowledge that such contextual limitation (i.e., laboratory setting) may have restricted the amount of between-person as well as within-person variability, as compared with, for example, contextual variability in experience sampling studies (see Charles & Pasupathi, 2003).

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[4]We acknowledge that Tables 2 and 4 merely report bivariate associations and thus do not reflect interrelations among the individual difference characteristics examined. To address this concern, we included all individual difference characteristics in one analysis and allowed intercorrelations among these variables. Again, the general pattern of asymmetrical prediction of mean and ISD in state anxiety was found.

The pattern of associations found between mean levels of state anxiety and the set of individual difference characteristics corroborates what is known from the extant literature (e.g., Wetherell et al., 2002). More interestingly, short-term variation in state anxiety showed a strikingly parallel pattern of associations. That is, both a higher level of, and more variation in, state anxiety were related to being a woman, having experienced less early-life education, reporting more trait anxiety, lower subjective health, more depression and neuroticism, lower positive affect, higher negative affect, a low desire for cognitive stimulation, and lower performance on measures of cognitive functioning. Results of our study thus suggest that there are no age differences across the adult age range in the amount of fluctuation on state anxiety as one indicator of psychological adjustment. In addition, both level and fluctuations in state anxiety were in similar ways associated primarily with variables that reflect poorer psychological adjustment or performance, be it as precursors, correlates, or consequences of affective experiences. The relative size of these associations was larger when the focus was on an error-free quantification of variability in latent space, which circumvented the limits imposed by relatively low reliability of the variability measure.

In agreement with research in other domains (personality: Eid & Diener, 1999; cognitive performance: Ram et al., 2005), our latent construct analyses showed that level and within-person variability constitute distinct factors. In addition, our study is among the first to empirically demonstrate that the same two-factor model of level and variability in an aspect of negative affect applies equally across the entire adult age range. As compared with the observed variables, the factor intercorrelation was boosted to $\varphi^2_{M,ISD} = .77$ indicating a solid overlap of characteristics underlying level and variation in state anxiety. A particular focus of the present study was the examination of the unique relations of either level or variability to a number of individual difference characteristics. The comparative approach we opted for revealed that information about an individual's short-term fluctuation in state anxiety may exhibit little unique predictive power beyond what is known from mean-level state anxiety.[5] Having corroborated this differential prediction pattern at high levels of state anxiety renders it less likely that restrictions in range and variability account for our results. In other words, individual differences in an individual's average level of state anxiety were more important than individual differences in his or her short-term variability with respect to relations with other individual difference characteristics assessed at a single point in time including self-reported health, personality, well-being, and cognition (see also Salthouse & Berish, 2005). In fact, years of education and extraversion were the only variables with unique associations to state anxiety variability. Despite sizeable occasion-to-occasion variations in state anxiety it is the relatively stable average level of state anxiety that relates to other characteristics rather than the variation around that level.

We also explored notions suggesting that variability in aspects of negative affect may have differential functional implications at high or low levels of negative states. In a seminal empirical report of such differential associations, Carstensen et al. (2000) have applied a within-person approach by classifying participants as high or low on negative affect relative to their own idiosyncratically calculated mean across some 30 sampled situations. These authors reported that under certain conditions (i.e., at high levels of negative affect) fluctuations in negative affect variables may signify positive psychological functioning, thereby indicating an individual's attempt to respond to challenges in adaptive ways. The

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[5]To address potential concerns that different levels of data aggregation were compared with one another (e.g., traits as distribution of state scores over time: Fleeson, 2001), follow-up analyses used state anxiety at the first session rather than the mean across three sessions as a level indicator; the substantive pattern of results remained virtually unchanged. In follow-up analyses examining the three age groups separately, we corroborated the general pattern of results that state anxiety variability shows only few unique associations to the correlates once mean-level differences were taken into account.

present study involved data over three measurement occasions, which lead us to opt for a between-person approach to classify participants relative to other participants' level of state anxiety. Contrary to the Carstensen et al. results, our findings indicate that the associations of state anxiety variability to the individual difference characteristics examined do not differ between high and low levels of state anxiety. We also have found the same pattern of results in separate follow-up analyses that included the variability factor but not the mean factor, which suggests that this lack of differential associations is not merely due to the strong predictive strength of the mean level. More research, however, is needed to fully understand whether this conundrum is in fact due to differences in the approach selected.

Limitations of the present study and implications for future research

We acknowledge that there are multiple strategies that may be utilized to take into account mean-level differences when examining variability (e.g., Allaire & Marsiske, 2005; Baird et al., 2006; Deary & Der, 2005; MacDonald et al., 2003; Ram et al., 2005). Such questions have primarily been addressed in the personality and cognitive aging literature, and researchers typically have minimized between-person level differences by standardizing the measures of interest within persons or by partialing out correlates of the mean such as age (or retest effects in cognitive performance) before examining a residual index of variability. In contrast, the current study opted for a direct empirical comparison of the unique predictive effects of level and variability in state anxiety. To adjust for potential biases due to differential reliabilities of indices of level and variability, we relied on statistical procedures that allowed an examination of these indices in latent space and were thus free from measurement error. Another way to address this problem is to increase the number of measurement occasions for studying variability over time, which in turn may create other problems (e.g., changing the nature of the phenomenon through extensive assessment). The asymmetrical prediction pattern of level and variability in state anxiety for individual difference characteristics found in the present study is consistent with recent reports of few unique correlate-variability associations for measures of personality (Baird et al., 2006) and cognitive functioning (Salthouse, Nesselroade, et al., 2006). Although we continue to believe that the study of within-person variability can be informative about individual differences, and particularly age-related individual differences, it is important that future researchers use analytical procedures that allow influences of variability to be distinguished from influences of the mean level of the variable.

From a developmental perspective, it is possible that within-person variability may provide unique information particularly when individuals face increased risks for declines in key domains of functioning (Baltes & Smith, 2003; Salthouse, Nesselroade, et al., 2006; see also Bisconti, Bergeman, & Boker, 2004; Gerstorf, Ram, Estabrook, Schupp, Wagner, & Lindenberger, 2008). In the present study, we attempted to address this question by age-group-specific analyses of very old participants (75+ years: $n = 102$). However, results of these analyses revealed the same pattern in that nearly all variability-correlate associations for state anxiety were carried by mean levels of state anxiety. It is an open question whether state anxiety variability assessed over more occasions, different time intervals between assessments, or a longer time frame may have revealed more unique associations. Although it is possible that the use of three measurement occasions resulted in a somewhat restricted range of variation, it is important to recognize that the within-person variability was sizeable relative to the between-person variability at the first occasion. Future research is needed to explore more fully the overlapping and distinct features of level and variability in self-report measures that are similarly transient across situations (e.g., stress appraisals) or more stable (e.g., personality). It would also be instructive to explore whether a more homogeneous measure of state anxiety than the STAI or targeting a population with clinically high levels of anxiety would reveal similar results to those reported here.

The current data did not allow us to link level and variability in state anxiety to events in the everyday lives of our participants (Eaton & Funder, 2001; Mroczek & Almeida, 2004), which may have helped to better understand the nature of the phenomenon. Specifically, having available such information would allow future researchers to examine to what extent fluctuations in state anxiety may represent random fluctuations around an individual's steady state, responses to daily hassles, or even reactivity to the measurement situation. Also, we examined only the magnitude and variability in state anxiety so that our data are not informative with respect to whether there might be systematic within- and across-domain couplings of variability, using either the ISD or other indices of variability (Leiderman & Shapiro, 1962). Studies on variability coupling within the domains of affect, mood, and personality that have explicitly considered potential mean-level effects are rare (Baird et al., 2006), and research on coupling between level-adjusted indices of variability on cognitive measures has revealed inconclusive results (Christensen et al., 2005; Hultsch, MacDonald, & Dixon, 2002; Li, Aggen, Nesselroade, & Baltes, 2001; Ram et al., 2005; Salthouse, Nesselroade, et al., 2006). Several studies examining cross-domain couplings are underway and may inform us in the future whether, for example, fluctuations in two domains (e.g., anxiety and cognitive performance) are coupled with one another.

Finally, our findings of asymmetrical relations of mean and variability in state anxiety indicate that much remains to be learned about the role of one's average level of functioning on a given characteristic compared to the fluctuations around that level. We believe that latent construct analyses of level and variability represent a thorough methodological tool in the investigation of between-person and within-person variation.

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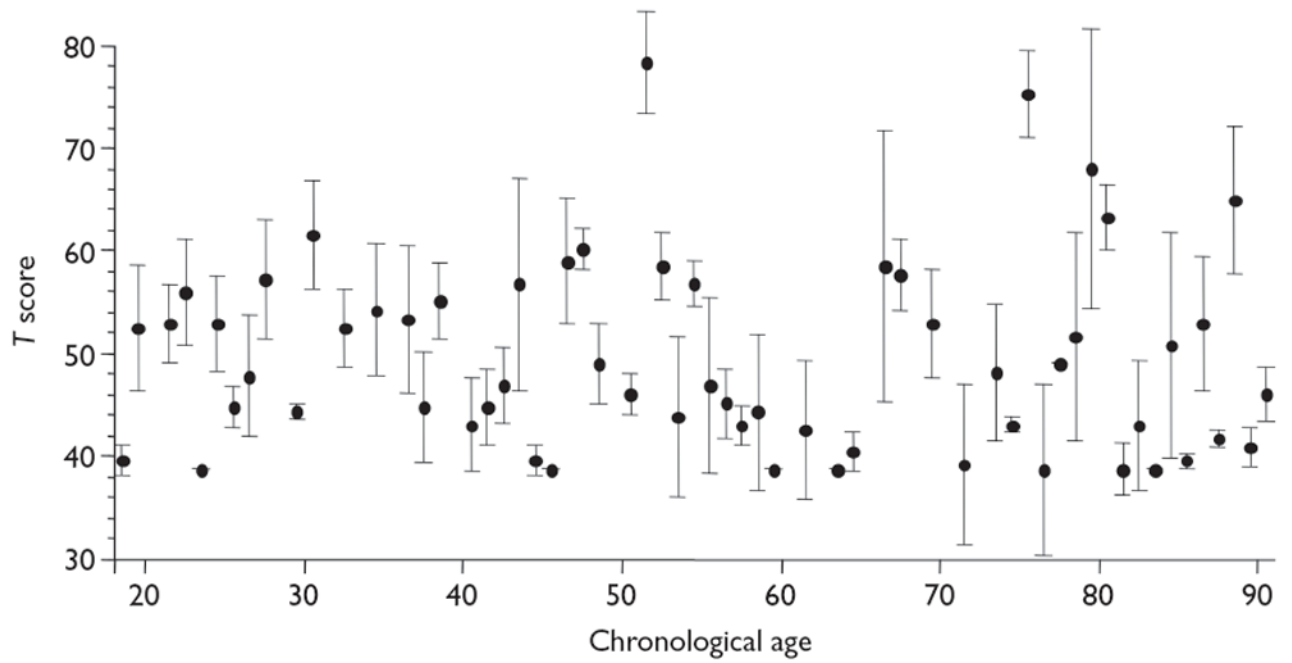
Figure 1.
Mean (circles) and intraindividual standard deviation (bars) across three assessments of state anxiety are shown for a random selection of *n* = 60 participants from age 18 to 90.

Figure 2.
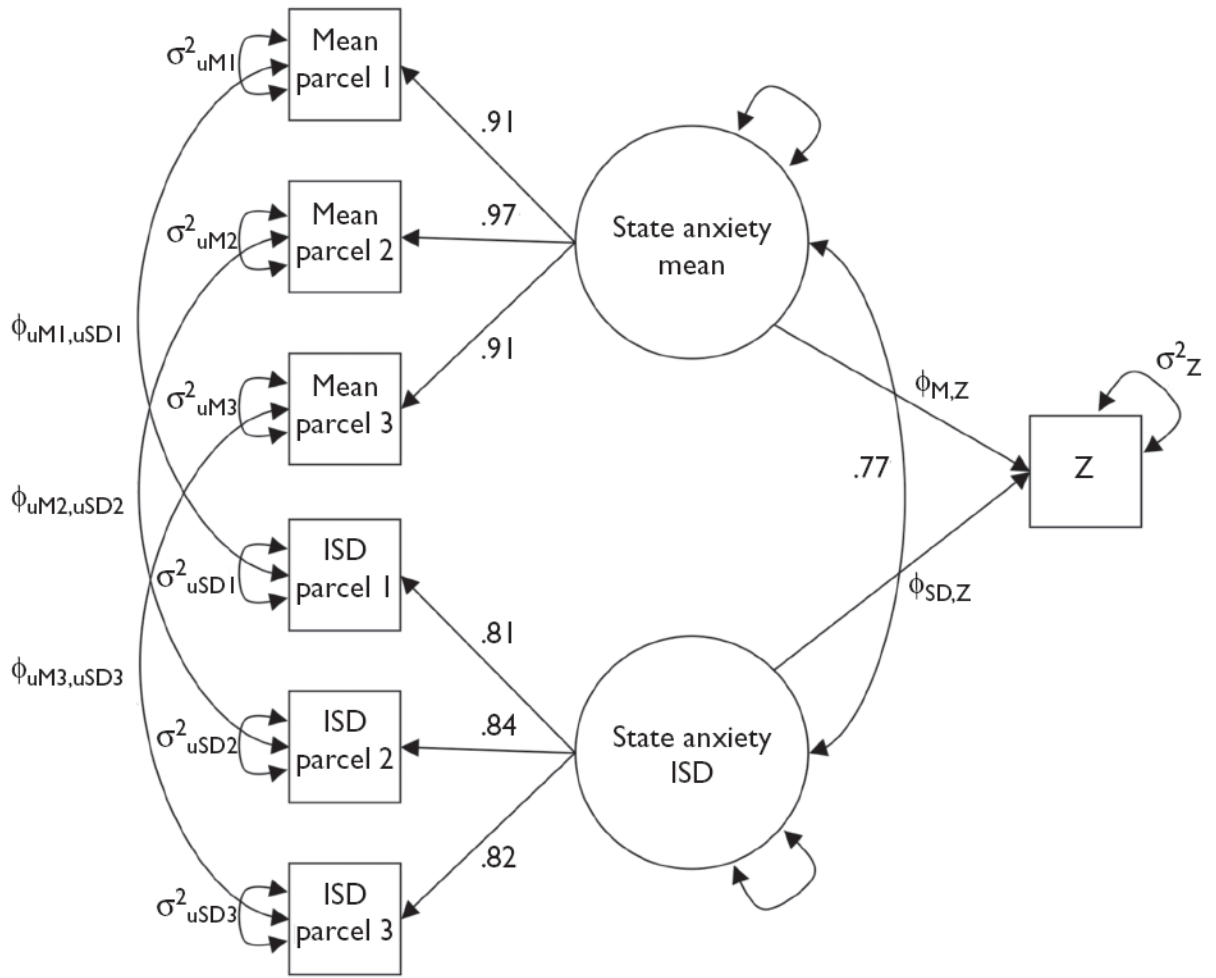Factor model of mean and intraindividual standard deviation (ISD) across three assessments of state anxiety and the prediction of individual difference characteristics (Z). Estimated factor loadings and factor intercorrelations are also shown. The 20 items of the State Trait Anxiety Inventory were combined to form three separate parcels, analogously for mean and ISD. Unlabeled paths are set to 1.

Table 1

Participant characteristics: Descriptive statistics for state anxiety and individual difference variables

Variable	Age groups			Total	r_{Age}
	18–39	40–59	60–97		
N	186	313	285	784	
State anxiety: mean (1–4)	1.5 (0.4)	1.5 (0.3)	1.4 (0.3)	1.4 (0.3)	
State anxiety: ISD	0.2 (0.2)	0.2 (0.2)	0.2 (0.2)	0.2 (0.2)	
Age	27.6 (6.2)	50.3 (5.4)	71.6 (8.1)	52.7 (18.1)	
% women	65	67	56	62	
Education	15.2 (2.1)	15.8 (2.7)	16.0 (3.0)	15.7 (2.7)	.13*
Trait anxiety (1–4)	1.9 (0.5)	1.8 (0.5)	1.6 (0.4)	1.8 (0.5)	−.23*
Subjective health (1–5)	4.2 (0.8)	4.0 (0.8)	3.8 (0.9)	4.0 (0.8)	−.22*
Depression (0–60)	12.2 (7.5)	11.2 (0.1)	8.7 (7.0)	10.5 (7.7)	−.16*
Neuroticism (1–5)	2.9 (0.6)	2.8 (0.6)	2.8 (0.8)	2.8 (0.7)	−.04
Extraversion (1–5)	3.1 (0.5)	3.1 (0.5)	3.1 (0.5)	3.1 (0.5)	.03
Openness (1–5)	3.3 (0.5)	3.3 (0.4)	3.3 (0.5)	3.3 (0.5)	−.03
Conscientiousness (1–5)	3.2 (0.5)	3.2 (0.5)	3.2 (0.5)	3.2 (0.5)	.01
Agreeableness (1–5)	3.3 (0.5)	3.3 (0.5)	3.2 (0.6)	3.3 (0.5)	−.03
Positive affect (1–5)[a]	2.9 (0.7)	3.0 (0.7)	3.3 (0.7)	3.1 (0.7)	.18*
Negative affect (1–5)[a]	1.3 (0.4)	1.3 (0.3)	1.2 (0.3)	1.3 (0.4)	−.11
Need for cognition (1–5)	2.5 (0.7)	2.4 (0.7)	2.5 (0.7)	2.5 (0.7)	−.04
Digit Symbol[b]	11.5 (2.6)	11.3 (3.0)	11.6 (3.0)	11.4 (2.9)	.05
Vocabulary[b]	13.2 (3.0)	12.4 (2.8)	13.4 (2.9)	13.0 (2.9)	.04

Note. N = 784.

[a]Positive and negative affect were available for a subsample only: N_{total} = 473, $N_{18–39}$ = 107, $N_{40–59}$ = 181, $N_{60–97}$ = 185.

[b]M = 10; SD = 3 based on age-adjusted norms published from a nationally representative normative sample.

*$p < .01$.

Table 2

Correlations of individual difference variables with the mean and intraindividual standard deviation of state anxiety before and after control of age and the other variables

| | State anxiety: (semipartial) correlation | | | | | |
| | Variability | | | Central tendency | | |
Variable	ISD	ISD.M	ISD.M.Age	M	M.ISD	M.ISD.Age
Age	–.03	.04		–.13*	–.13*	.03
Gender	.12*	.08	.08	.09*	.04	–.08
Education	–.15*	–.08	–.08	–.16*	–.10*	.49*
Trait anxiety	.25*	–.03	–.02	.55*	.50*	–.22*
Subjective health	–.12*	–.02	–.01	–.21*	–.18*	.42*
Depression	.28*	.04	.05	.50*	.43*	.09*
Neuroticism	.10*	.04	.04	.13*	.09*	–.11*
Extraversion	.04	.09*	.09*	–.08	–.11*	–.09*
Openness	.00	.04	.05	–.08	–.08	–.08
Conscientiousness	.02	.06	.06	–.06	–.08	–.03
Agreeableness	.02	.04	.04	–.01	–.03	–.10*
Positive affect[a]	–.14*	.02	.01	–.17*	–.10*	.26*
Negative affect[a]	.14*	–.06	–.05	.31*	.28*	–.35*
Need for cognition	–.17*	–.10*	–.10*	–.38*	–.36*	–.04
Digit Symbol	–.09*	–.06	–.06	–.08	–.04	–.05
Vocabulary	–.10*	–.05	–.06	–.10*	–.06	

Note. N = 784.

[a] Positive and negative affect were available for a subsample only: *N*total = 473. Gender: men = 0, women = 1.

*
p < .01.

Table 3

Comparison of one- and two-factor models for mean and within-person variability in state anxiety and invariance of the two-factor model across the three age groups

Model	χ^2	df	$\Delta\chi^2$/df	CFI	TLI
			Goodness-of-fit indices		
Two factors	96	5	—	.98	.94
One factor	764	6	668/1 *	.84	.61
Age invariance model					
Configural	106	15	—	.98	.94
Metric	123	23	17/8	.98	.96
Metric + factor covariance	129	25	6/2	.98	.96

Note. N = 784. CFI = Comparative Fit Index, TLI = Tucker-Lewis Index. Configural = Item-factor structure set to be invariant across age group, Metric = Factor loadings set to be invariant across age group, Metric + factor correlation = Factor loadings and factor covariance set to be invariant across age group.

*
p < .01.

Table 4

Standardized coefficients from latent construct analyses using mean and intraindividual standard deviation of state anxiety as separate and simultaneous predictors of individual difference variables

Variable	Separate		Simultaneous		Simultaneous + age	
	ISD	M	ISD	M	ISD	M
Age	.05	−.14	.12	−.24*	—	—
Gender	.12*	.11*	.07	.06	.10	.04
Education	−.19*	−.16*	−.15*	−.06	−.17*	−.03
Trait anxiety	.40*	.58*	−.09	.62*	−.09	.65*
Subjective health	−.14*	−.24*	.09	−.30*	.11	−.32*
Depression	.40*	.53*	−.02	.54*	−.02	.54*
Neuroticism	.15*	.14*	.09	.08	−.10	.06
Extraversion	.01	−.10	.17*	−.21*	.19*	−.23*
Openness	−.06	−.08	.00	−.08	.00	−.07
Conscientiousness	−.01	−.07	.06	−.10	.06	−.11
Agreeableness	.03	−.02	.03	−.04	.03	−.04
Positive affect[a]	−.22*	−.32*	.05	−.35*	.05	−.34*
Negative affect[a]	.32*	.39*	.05	.36*	.05	.35*
Need for cognition	−.18*	−.17*	−.12	−.08	−.14	−.05
Digit Symbol	−.10*	−.09	−.08	−.02	−.09	−.01
Vocabulary	−.13*	−.10*	−.11	.02	−.12	.00

Note. $N = 784$.

[a] Positive and negative affect were available for a subsample only: $N_{total} = 473$. Gender: men = 0, women = 1.

*
$p < .01$.