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Intraindividual Variability in Affect: Reliability, Validity, and Personality Correlates

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This article gives an overview of previous work on affect variability, discusses the methodological shortcomings of research on affect variability, and presents the results of an empirical study of intraindividual variability in primary emotions across time. The results of a daily assessment study using structural equation modeling and nonlinear regression analyses showed that intraindividual variability in affect is a multidimensional construct that is sufficiently stable to be considered a psychological trait and can be reliably measured by the intraindividual standard deviation. Intraindividual variability showed convergent validity with mean level scores and neuroticism but was sufficiently distinct to be considered a unique trait. This was particularly true of intraindividual variability in positive emotions; only about 10% of the variance could be accounted for by mean affect levels and the variables of the 5-factor model of personality.

Analysis of intraindividual variability in behavior, attitudes, and feelings is as established as empirical research in personality psychology. In his seminal book *Psychology of Individual Differences,* William Stern (1900) distinguished stable person-specific dispositions from momentary factors (e.g., fatigue) in analyzing the daily variation of "mental energy." He concluded that the momentary behavior of an individual is influenced by both kinds of variables. Hence, he recommended calculating the mean value of repeatedly measured behavioral acts to eliminate the influences of momentary dispositions and to allow consideration of fluctuations across time if the primary interest lies in the variability itself. Both the distinction between stable and changeable dispositions and the method of aggregation have become popular in personality psychology. Indeed, a major debate in personality psychology has involved the question of the extent to which individuals are stable and consistent. In the debate about the consistency of behavior, intraindividual variability is defined as either (a) intraindividual variability in item scores of a questionnaire or (b) intraindividual fluctuations across situations and time. These concepts are linked to different research traditions in personality psychology.

The majority of studies related to variability in item scores were conducted in the framework of the moderator variable approach. The primary purpose of this area of research was to examine whether intraindividual variability is an important moderator for predicting behavior by trait measures (for an overview, see Schmitt, 1990; Zuckerman et al., 1988; Zuckerman, Bernieri, Koestner, & Rosenthal, 1989). Several concepts developed within that field of research have one of their roots in intraindividual variability; examples are *intraindividual predictability* (Berdie, 1961) or *differential predictability* (Paunonen, 1988), *intraindividual consistency* (Bem & Allen, 1974), *person reliability* (Lumsden, 1977), *metatraits* (Baumeister, 1991; Baumeister & Tice, 1988; Britt, 1993; Hershberger, Plomin, & Pedersen, 1995; Tice, 1989), and *traitedness* (Tellegen, 1988).

Research on intraindividual variability across situations and time, on the other hand, goes back to state–trait theories of behavior (such as Stern's early approach). In these theories, variability characterizes the fluctuation of states around more or less stable traits (Cattell, 1973; Nesselroade, 1991). Wessman and Ricks's (1966) distinction of *average hedonic level* and *hedonic variability;* Spielberger's (1979) state–trait models of anxiety, anger, and curiosity; and Mischel and Shoda's (1995) social–cognitive theory of personality are prominent examples of personality theories stressing the variability of behavior and feelings across situations. Because intraindividual variability across situations can be analyzed only in a longitudinal study, variability across situations is likely to be confounded with variability across time.

Since Wessman and Ricks's (1966) seminal study on mood and personality, intraindividual variability in affect has attracted increasing interest from personality psychologists because Wessman and Ricks showed that intraindividual variability in affect is different from the average level of affect and therefore reflects different aspects of one's emotional life. In contrast to baseline measures of mood, intraindividual variability marks affective reactivity to situations. In particular, intraindividual variability in affect characterizes the dynamic dimension of affect over time and is important for a full understanding of affective responses (Morris, 1989). Furthermore, intraindividual variability in affect is a key outcome variable in studies on personality integration and complexity (Tobacyk, 1981), self-complexity (Campbell, Chew, &

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Scratchley, 1991; Linville, 1982), affect intensity (Larsen & Diener, 1987), and affect complexity (Larsen & Cutler, 1996), as well as research on traits such as neuroticism, extraversion, and sensation seeking (e.g., Hepburn & Eysenck, 1989; Larsen & Kasimatis, 1990). According to Larson, Csikszentmihalyi, and Graef (1980), affect variability is part of a syndrome of psychological disequilibrium. For instance, Depue et al. (1981) used affect variability in validating a questionnaire for identifying individuals at risk for bipolar disorders. Furthermore, mood variability is considered a possible etiologic factor in the development of nonclinical depression (Costello, Benjamin, Angold, & Silver, 1991; McConville & Cooper, 1996). Thus, intraindividual variability plays an important role in the study of differences between clinical and nonclinical emotional states and traits (Morris, 1989). Finally, affect variability might be an important variable in experimental research, one that moderates the reaction of individuals to emotional stimuli (Bohner, Hormuth, & Schwarz, 1991).

Although interindividual differences in affect variability are important in understanding affective experiences, there are comparatively few studies on this topic (Watson & Clark, 1994). The aim of the present article is to review and to extend current knowledge of intraindividual variability in affect across time. Particularly, we want to contribute to answering four questions that Fiske and Rice (1955) considered as foundation stones for a research program on intraindividual variability: (a) "Can one partial out from the conventional error variance of psychometrics a component of variance over time that is associated with the individual?" (b) "Are there variability factors analogous to the well-known factors of level scores in mental abilities, interests, and personality?" (c) "How can the concept of intraindividual variability contribute to solving problems in the prediction of behavior?" and (d) "What is the significance of this concept for the study of personality and personality theory?" (p. 217).

In the next three sections, we review the research on affect variability with regard to these questions. We show that previous studies were affected by several methodological shortcomings and suggest a research strategy to circumvent these problems. Finally, we apply this research strategy to a longitudinal study on affect variability and discuss the implications of this study for further research on affect variability.

Reliability, Stability, and Dimensionality

In terms of test theory, Fiske and Rice's (1955) first question is concerned with the reliability of intraindividual variability. Analysis of intraindividual variability as a "true" phenomenon makes sense only if the fluctuations in test or item scores do not simply reflect unsystematic measurement error. Furthermore, their first question is related to the stability of intraindividual variability across time; they considered variability a person-specific characteristic determined by "more or less enduring factors" (Fiske & Rice, 1955, p. 218). This conception is justified only if variability has a degree of stability. In terms of test theory, this question deals with the construct validity of intraindividual variability: Is intraindividual variability in affect a personality trait, or does it change between different time periods? To answer this question, it is necessary to separate measurement error from true intraindividual differences across time. A retest correlation of two variability scores measured in two different periods of time cannot be used appropriately to test the assumption that intraindividual variability is a personality trait. A low retest correlation, for instance, can occur if (a) variability scores are perfectly reliable but intraindividual variability is unstable across time, (b) intraindividual variability is a stable personality trait but cannot be reliably measured, and (c) intraindividual variability is unreliable and unstable. Therefore, it is necessary to distinguish between reliability and stability and to analyze the stability of variability on the true score level.

Fiske and Rice's (1955) second question refers to another component of construct validity, the dimensionality or factorial validity of variability. To address this issue, it is necessary to determine to what extent the systematic fluctuations of different attributes are related to each other, how many dimensions are needed to explain the association between different variability variables, and whether the structure of variability resembles the structure of level scores. What is known about the reliability, stability, and dimensionality of intraindividual variability in affect? Although studies have been conducted on intraindividual variability in affect (e.g., Clum & Clum, 1973; Depue et al., 1981; Hedges, Jandorf, & Stone, 1985; Hepburn & Eysenck, 1989; Larsen, 1987; Larsen & Cutler, 1996; Larsen & Diener, 1987; Larsen & Kasimatis, 1990; Larson, 1983; Larson et al., 1980; Linville, 1982; Penner, Shiffman, Paty, & Fritzsche, 1994; Tobacyk, 1981; Vestre, 1984), knowledge about reliability, stability, and dimensionality is limited. This is primarily due to two reasons: (a) In the majority of the studies, data on reliability, stability, and dimensionality have not been reported, and (b) most of the reported results do not clearly distinguish among these three concepts. In the remainder of this section, we discuss the last topic in more detail.

As Kraemer, Gullion, Rush, Frank, and Kupfer (1994) pointed out, the question of whether a psychological construct is more a trait or more a state can be appropriately answered only when error variance is separated from true variance. Then the trait or state character of a variable can be analyzed by estimating the proportion of true variance that is due to (stable) trait variance. If the error variance is not separated from true variance, it is impossible to judge whether a small retest correlation coefficient is due to measurement error or to true instability. Analogously, it is necessary to separate measurement error from true interindividual differences to analyze the dimensionality of variability. If measurement error is not separated from true score differences, it cannot be judged whether a low communality in a factor analysis is due to the unreliability of a measure or due to the item specificity indicating a multidimensional structure on the true score level.

Distinctions among reliability, stability, and dimensionality have not been sufficiently considered in previous studies on affect variability. To estimate the homogeneity of variability in different affect variables, Wessman and Ricks (1966) and Tobacyk (1981) reported the results of factor analyses of the Personal Feeling Scales. In both studies, one factor explained the majority of variance (between 82% and 91% in Wessman and Rick's study and 61.5% in Tobacyk's study). These results suggest that there are strong associations between different variability variables. Nevertheless, there were differences between the variables as well: The communalities in Wessman and Rick's study, for example, varied between .12 and .95. Similarly, Penner et al. (1994) found an internal consistency (alpha) of .84 by in an analysis of 11 mood items. This result indicates high homogeneity of variability. However, the correlations (*r*s) between the variability variables ranged

from −.03 to .73. Hence, it is likely that there are strong differences between different moods as well. In all three studies, the unidimensionality assumption (implying that all variables are measuring the same true score variable) was not tested in a strong way. Thus, it is not clear whether the differences in the item communalities and item correlations were due to differences in item reliabilities or due to the multidimensionality of the true scores. Because the different types of affect are represented by only one item in the scale used in most previous studies (e.g., the emotions *harmony vs. anger* and *tranquility vs. anxiety* in the Personal Feeling Scales), it is not possible to separate measurement error from true scores and to analyze dimensionality on the level of error-free true score variables.

On the basis of all three studies reported, it can be expected that the reliability of variability measures is reasonably high; however, these studies do not permit an appropriate estimate of reliability. Furthermore, all three studies show that large differences in the associations between the variability scores of different affects exist, although the associations seem to be high on average. To analyze reliability and dimensionality on the level of the true score variables, it is necessary to assess each affect with at least two different items and to test different assumptions about the homogeneity of the true scores of different variability measures. We have not uncovered any study addressing these issues, and the first aim of the present investigation was to analyze the reliability and dimensionality of variability in affect in a stronger way. Furthermore, studies of affect variability have focused on variability in mood or emotions included in the Personal Feeling Scales (Wessman & Ricks, 1966). The dimensionality of variability across a broader affect range, including primary emotions such as joy and shame, has not been systematically analyzed. Hence, our second aim was to analyze variability in affect based on a systematic selection of emotions.

There are also only a few studies that have analyzed the stability of affect variability. Larson (1983) reported a correlation of .51 between two variability measures (intraindividual standard deviation) computed for the first half and the second half of the study week. Penner et al. (1994) reported correlations of two variability measures (intraindividual standard deviation of odd and even days) between .61 and .88 for a period of 12–14 days. The correlations of the variability variables defined for the first and the last 5 days of their study were smaller (between .23 and .64). According to both studies, there is a fair amount of stability in terms of affect variability. This is in line with results produced for intraindividual variability in constructs other than affect (e.g., Eizenman, Nesselroade, Featherman, & Rowe, 1997). The reported correlations, however, are only rough estimators of the stability of variability, because they do not take measurement error into account. Because these are correlations of manifest variables, instability and unreliability are confounded, and true stability is underestimated (Heise, 1969). Therefore, it is unclear whether a nonperfect retest correlation is due simply to the unreliability of the measures or whether there is true instability in variability. Furthermore, the estimates of stability were based only on very short time intervals in these studies. Stability over longer time periods is still an open question. Thus, our third aim was to study the stability of variability on the basis of latent variable models and longer time periods.

Predictive Validity

Fiske and Rice's (1955) third question concerns the usefulness of intraindividual variability for prediction. The prediction and explanation of interindividual differences in behavior, attitudes, and feelings by personality traits is one of the major aims of personality psychology. The utility of personality traits for predicting behavior was questioned by Mischel (1968). In the debate on the consistency and stability of behavior that was ignited by Mischel's book, different approaches were discussed to enhance the predictability of behavior by trait variables (Bem & Allen, 1974; Schmitt, 1990; Zuckerman et al., 1988, 1989). For analyzing the predictive validity of intraindividual variability, Ghiselli's (1960) concept of *differential predictability* is appropriate. According to this concept, there are interindividual differences in the precision with which states can be predicted by traits, and it is reasonable to assume that intraindividual variability is related to this kind of differential predictability. In particular, the absolute value of the residual (state value minus value predicted by the trait) recommended as a measure of predictability by Ghiselli (1960; see also Wiggins, 1973) should depend on intraindividual variability, indicating that people with high variability scores will show less precision in their predicted state scores. That is, the deviation from the predicted value is generally higher for people with high variability. This kind of differential predictability has not been analyzed in studies of affect variability. Analyzing the correlation between state predictability and affect variability, however, is important in validating the concept of intraindividual variability. Just as the predictive validity of traits is explored by analyzing the correlation between traits and states, the predictive validity of intraindividual variability can appropriately by scrutinized by analyzing the correlations between intraindividual variability and differential predictability of future states.

We are not aware of any study in which the predictive validity of intraindividual variability in affect has been analyzed. Thus, our fourth aim was to analyze the predictive validity of variability by referring to Ghiselli's (1960) concept of differential predictability.

Variability and Personality: Convergent and Discriminant Validity

In personality psychology, there is an increasing interest in the relation between personality and affective responses (e.g., Costa & McCrae, 1980; Diener, Smith, & Fuijta, 1995; McCrae & Costa, 1991; Meyer & Shack, 1989; Watson & Clark, 1992). Most studies, however, have focused on the personality correlates of affective states and traits (mean levels). Studies dealing with intraindividual variability in affect and its relations to personality variables are rare. Intraindividual variability in affect would be particularly important for personality psychology if it is not completely redundant with mean levels of affect and other emotional traits. However, it should be correlated with personality variables that are related to emotional lability. Thus, there should be convergent as well as discriminant validity.

The associations between intraindividual variability in affect and personality variables have been mainly analyzed within Eysenck's personality theory. On the basis of the empirical findings that extraverts tend to show variations between positive affect and neutrality and that neurotics show changes from negative affect to

neutrality, Eysenck and Eysenck (1985) concluded that extraversion should be related to variability in positive affect and neuroticism to variability in negative affect.

Hepburn and Eysenck (1989), McConville and Cooper (1992), and Williams (1990) analyzed the relations between mood variability and both neuroticism and extraversion. Hepburn and Eysenck found a significant correlation between variability of positive affect and extraversion, as well as between variability of negative affect and extraversion and neuroticism, respectively. In Williams's (1990) review of six studies, significant mean partial correlations (after correction for the correlation between variability and mean level) were reported for neuroticism and variability in negative affect. Extraversion was significantly correlated with elation and euphoria. In contrast to these results, neither Howarth and Zumbo (1989) nor McConville and Cooper (1992) found a clear relation between the two personality factors (neuroticism and extraversion) and mood variability.

Although these studies provide valuable insights into the relations between variability in affect and personality, they were limited in three ways. First, they focused on Eysenck's personality system and the two broad personality variables of neuroticism and extraversion. The results of McCrae and Costa (1991) as well as Watson and Clark (1992) showed that agreeableness and conscientiousness were also significantly correlated with affect. Velting and Liebert (1997) showed that openness to experience is an important personality correlate of mood variability as well. Individuals who are more open to experience, particularly to emotions, show greater variability in moods. Second, the reported results concentrate on moodlike affect (e.g., elation, depression, activation, and deactivation). The relations between variability in more specific emotions (e.g., joy, love, and shame) and personality have not been sufficiently explored in previous studies. Because the affective space might best be described by a multidimensional model (e.g., Diener et al., 1995), analysis of intraindividual variability in specific types of affect might offer further insights into the personality correlates of affective responses. Third, the relation between variability and personality was corrected for the high dependencies of variability scores on the mean level variables only in the studies reported by Williams (1990), and even in this study correction was made for linear dependencies but not for curvilinear relations. Thus, in some studies, the associations between personality and variability variables could reflect correlations between the personality and mean level variables only, and it remains unclear whether the personality variables contain a variability-specific component that is not shared with the mean values in affect. Hence, it is important to analyze the convergent and discriminant validity of intraindividual variability in affect with respect to mean affect levels and personality factors in a stronger way. This was the last aim of our study. Before the methods and the results of the study are reported, some measures for the assessment of variability are discussed.

On the Measurement of Variability

Three methods have been used in previous studies to assess intraindividual variability in affect across time: (a) self-reported or other-reported intraindividual variability (e.g., Eid, Notz, Steyer, & Schwenkmezger, 1994; Underwood & Froming, 1980), (b) the intraindividual standard deviation of repeatedly measured affective states (e.g., Larsen & Diener, 1987), and (c) spectral analysis (e.g., Larsen, 1987). The three methods cover different aspects of variability and have different advantages and disadvantages. Self- or other-reported variability is important because it reflects one's own or others' view of oneself, but it could be influenced by judgment bias and might therefore not reflect "true" variability. The intraindividual standard deviation is easy to calculate, does not depend on restrictive assumptions, and is face valid, but it does not reproduce the process of change, and it might confound the frequency and extremity of change (Larsen, 1987). In spectral analysis, the frequency of affective changes can be adequately reproduced; however, such an analysis does not cover the extremity of change. Furthermore, spectral analysis depends on strong assumptions that limit its applicability in daily assessment studies (a large number of occasions, equally spaced time points, and the stability of the variability process itself).

In the present study, we measured variability with the intraindividual standard deviation for two reasons. First, the standard deviation has been used in the majority of studies on intraindividual affect variability across time (as well as on intraindividual variability across items). Earlier we argued that previous studies using this coefficient have been affected by certain methodological shortcomings. Hence, we want to shed more light on this coefficient, and we hope that this contributes to a better evaluation of most of the studies conducted on intraindividual variability. Second, it is easier to analyze the research questions derived so far when intraindividual variability is measured by one coefficient rather than a set of periodic components such as in spectral analysis. Thus, we define intraindividual variability as the intraindividual standard deviation across time. At the same time, it should be noted that the standard deviation does not exhaust the forms of variability that may exist in a data set.

Summary

We analyzed a number of aspects of mood variability in ways that go substantially beyond earlier studies. We used measurement and statistical methods that allow for the control of measurement errors, we clearly separated variability from mean level affect, and we refer to a broad range of positive and negative affect. The purpose of the study was to attain a clearer grasp of the characteristics of mood variability. For example, we sought to determine whether affect variability can be measured reliably, whether it shows stability over time, and whether it is a single dimension or multidimensional. We also sought to determine whether affect variability is a valid predictor of the predictability of future states and how it is related to other personality traits. Although mean levels of affect have now been studied in depth in relation to personality, affect variability has been relatively neglected. Our goal was to provide a comprehensive understanding of individual differences in affect variability. A thorough description of affect variability should serve to initiate creation of a theory explaining this phenomenon.

Method

Participants

The participants were 180 college students (99 women and 81 men) enrolled in a semester-long course on subjective well-being at the Univer-

sity of Illinois. Participants completed a set of self-report personality and affect scales and provided daily reports of their emotions and experiences over 52 days. This data set was the base for other studies as well (e.g., Diener et al., 1995).

Measures

The reported results refer to 24 emotion terms belonging to six scales: *love* (affection, love, caring, and fondness), *joy* (joy, happiness, contentment, and pride), *fear* (fear, worry, anxiety, and nervous), *anger* (anger, irritation, disgust, and rage), *shame* (shame, guilt, regret, and embarrassment), and *sadness* (sadness, loneliness, unhappiness, and depression). These terms represent a sample of the primary emotions of Western emotion theories. Selection of the items has been described by Diener et al. (1995). The participants rated each item on a 7-point scale ranging from *none* (1) to *always* (7). Intermediate response options were labeled with intermediate time values: *slight amount (rare), some of the time, about half of the time, much of the time,* and *almost always.* Participants were instructed as follows: "Using the scale below, indicate how often you felt each of the emotions. Put a number from 1 to 7 to accurately reflect how much of the time today when awake you felt that emotion." The respondents completed the affect questionnaire each evening before retiring. The daily reports were returned the following day, and weekend reports were returned on Monday. As a means of assessing the personality variables of the five-factor model of personality (neuroticism, extraversion, openness to experiences, agreeableness, and conscientiousness), participants had completed the NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1989) before the daily assessment of emotions began.

Intraindividual variability in each affect adjective was measured by the intraindividual standard deviation across time. Because the first occasion of measurement was considered to be a training session, the intraindividual standard deviation was calculated on the basis of the 51 remaining daily assessments. Up to three missing daily values were accepted per person, and the intraindividual standard deviation was calculated on the basis of the valid measures (i.e., at least 48 occasions of measurement). Ten participants had more than three missing daily values and were excluded from the study.

Models and Methods of Data Analysis

The reliability, dimensionality, and stability of affect variability were analyzed in the framework of confirmatory factor analysis. Because the intraindividual standard deviations were not normally distributed, the fit of the models was evaluated via the Satorra–Bentler corrected chi-square test statistic for nonnormal data (Satorra & Bentler, 1994) and the comparative fit index (CFI; Bentler, 1989). Uncorrected maximum-likelihood chi-square statistics are reported as well.

To analyze reliability, we evaluated the fit of a one-factor model for the intraindividual standard deviations of the four affect adjectives belonging to one emotion category. If a one-factor model had to be rejected, the fit of a two-factor model was analyzed. The theoretical rationale for the two-factor model is explained in the Results section. The reliabilities of the scale (mean score of the intraindividual item standard deviations belonging to one affect category) were estimated via coefficient ω (McDonald, in press). This coefficient, which is the ratio of the true score variance of a scale to the total variance of the scale, can be computed on the basis of the results of a confirmatory factor analysis on the item level. Whereas the alpha coefficient represents reliability in the case of a one-factor model with equal loadings only, coefficient ω is the estimate of reliability in the case of an one-factor model with unequal loadings.

Dimensionality was analyzed with a common factor model as well. Because the number of items (24 intraindividual standard deviations) was relatively large for a sample size of 170 (see the recommendations of Bentler & Chou, 1987), the number of manifest variables was reduced by defining two test halves for each affect domain. The items indicating one latent variability factor were randomly assigned to two test halves (mean score of the items belonging to that test half) and analyzed in a common-factor model. The loadings of indicators belonging to the same factor were set equal to each other.

In analyzing the stability of variability, we calculated the intraindividual item standard deviation for 7 weeks (Day 2 to Day 51) separately; that is, each standard deviation reflected the variability across 7 days. The choice of the number of days included in one time period was somewhat arbitrary. We selected 7 days because a week is a natural unit for structuring one's life. No missing values were accepted in the stability analyses. To reduce the number of manifest variables, we calculated two test halves for each affect category and time period. Figure 1 shows the model used to analyze the stability of variability for 3 weeks, but its extension to 7 weeks is straightforward. This *multistate–multitrait model* was described by Marsh and Grayson (1994) for continuous response variables and by Eid (1996, 1997), as well as Eid and Hoffmann (1998), for ordered response variables. It belongs to the class of latent state–trait models that have been applied in different areas of psychology (e.g., Deinzer et al., 1995; Dumenci & Wardle, 1996; Eid & Langeheine, in press; Eid et al., 1994; Kenny & Zautra, 1995; Schmitt & Steyer, 1993; Steyer, Ferring, & Schmitt, 1992; Steyer, Schwenkmezger, & Auer, 1990). This model allows separation of variance due to measurement error from true variance and estimation of the proportion of true variance due to the trait. Therefore, the model fulfills the criteria for validating trait variables proposed by Kraemer et al. (1994).

To separate measurement error from true interindividual differences, each variability scale had to be split up into test halves. A test half is indicated by the index i. Furthermore, variability scores had to be calculated for each of the 7 weeks separately. The index k indicates the week. In this model, it is assumed that there is a stable latent trait variable T_i for each test half for the entire period. These latent trait variables measured week-unspecific interindividual differences in intraindividual variability that were stable across all 7 weeks (i.e., there were participants who were generally more or less variable over the entire study period). The test halves i measured different (but associated) latent trait variables, an assumption that often has to be made to consider the test- or item-specificity problem in longitudinal research (Eid, 1996; Marsh & Grayson, 1994).

Furthermore, it was assumed that interindividual differences in variability were not perfectly stable across the 7 weeks; rather, there were week-

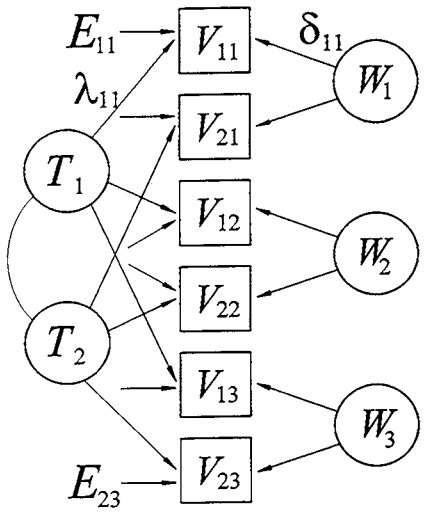

Figure 1. Multistate–multitrait model for 3 weeks and two test halves. V_{ik} = observed variability scores for test half i and week k; T_i = latent trait variable for test half i; W_k = latent week-specific deviation variable; E_{ik} = error variable; λ_{ik} and δ_{ik} = loading parameters.

specific influences. That is, an individual could be more variable in one week and less variable in another week. This assumption was reasonable for the daily assessment of affect, in which we did not have any control over the situational or interactional factors influencing affect variability. Because weeks can be different with regard to their situational demands, it is necessary to represent their specific influences in a model measuring variability. Week-specific influences that were unique for each week of measurement are represented by the variables W_k. Finally, interindividual differences in variability within a certain week depend on measurement error as well. Measurement error is represented by the error variables E_{ik}. Formally, the model is defined by the equation $V_{ik} = \lambda_{ik} T_i + \delta_{ik} W_k + E_{ik}$, where λ_{ik} and δ_{ik} are loading parameters.

Thus, this model considers stable interindividual differences as well as week-specific fluctuations. But, in contrast to autoregressive models, we do not assume that there is a developmental process in affect variability. According to this model, fluctuations in variability are characterized by state variability and not by trait change (for the distinction between variability and change, see Eid & Hoffmann, 1998; Nesselroade, 1991), which means that variability itself is variable. The question of whether interindividual differences in affect variability in one period of time reflect more stable interindividual differences than week-specific differences can be analyzed in this model by comparing two variance components that are well defined in latent state–trait theory: consistency and specificity.[1] The *consistency coefficient* $\mathrm{Con}(V_{ik}) = \lambda_{ik}^2 \mathrm{Var}(T_i)/\mathrm{Var}(V_{ik})$ is the proportion of variance of a manifest variability variable that is due to stable interindividual differences. The *specificity coefficient* $Spe(V_{ik}) = \delta_{ik}^2 \mathrm{Var}(W_k)/\mathrm{Var}(V_{ik})$ is the proportion of variance of a manifest variability variable that is due to week-specific effects (i.e., effects that are unique for a single week k). Both coefficients sum to the reliability coefficient $\mathrm{Rel}(V_{ik}) = 1 - [\mathrm{Var}(E_{ik})/\mathrm{Var}(V_{ik})]$, that is, the reliability of a variability variable within one period of time. If intraindividual variability in affect is more a traitlike than a statelike construct, the consistency coefficients should be high, and the specificity coefficients should be low. If intraindividual variability is a pure trait variable, the consistency coefficient should equal the reliability coefficients, and the specificity coefficients should be zero. Hence, the consistency and specificity coefficients can be used to evaluate the trait character of intraindividual variability. The consistency, specificity, and reliability coefficients are defined for each test half. To estimate these coefficients for the total scale (mean value of both test halves), we developed aggregation equations (see the Appendix).

The predictive validity of affect variability was analyzed with regression analyses. For each affect scale, the mean value of the daily affect states and the mean of the intraindividual standard deviations for the affect items belonging to one affect dimension were calculated for the first 2 weeks. Then we conducted regression analyses with the mean affect level scores as predictors. Criterion variables were the corresponding affect state variables on a single day. Five different days were included: the 22nd, 29th, 36th, 43rd, and 50th days of the study. We selected these days because we were interested in whether there was a decrease in predictive validity across time. Therefore, we selected 5 days with the same distance between 2 successive days. On the basis of the results of the regression analyses, we calculated the square root of the absolute value of the residual as an indicator of predictive precision (deviation of the state value from the state value predicted by the mean level variable). We chose this indicator among other possible coefficients (e.g., absolute value of the residuals or square root of the squared residuals) because it was normally distributed in all cases and, therefore, had the best distributional properties. These indicators of predictive precision were correlated with the variability scores calculated across the first 2 weeks. Significant correlations would indicate predictive validity of the variability scores. The convergent validity and discriminant validity between the variability scores, on the one hand, and the mean level scores as well as the personality scales, on the other hand, were assessed in nonlinear multiple regression analyses to allow consideration of possible nonlinear relationships between variability and mean level scores.

Results

Reliability

The goodness-of-fit coefficients of the accepted confirmatory factor models, estimated reliability coefficients, means, and standard deviations, as well as the minimal and maximal values of the total scales, are shown in Table 1. A one-factor model of variability fit well for all emotion categories with the exception of joy. For this category, a one-factor model had to be rejected, maximum-likelihood $\chi^2(2, N = 168) = 15.66$, $p < .001$, Satorra–Bentler $\chi^2(2, N = 168) = 11.99$, $p < .001$, and a two-factor model with correlated factors showed an appropriate fit. In this two-factor model for joy, it was assumed that the two moodlike items *happiness* and *contentment* were indicators of the first factor and the emotionlike items *joy* and *pride* were indicators of the second factor. The reliability estimates were very high for the four-item scales (between $r_{ii} = .86$ and $r_{ii} = .91$) and were appropriate even for the two-item scales ($r_{ii} = .87$ and $r_{ii} = .69$, respectively). The mean values and standard deviations show that there is more intraindividual variability in positive affect than in negative affect. The *fear* variability scales had the highest mean values and standard deviations of all negative affect scales, being close to those of the positive affect scales.

Construct Validity

Factorial validity. To analyze the dimensionality of variability, we examined a confirmatory factor analysis model with 14 manifest variables and seven correlated factors. In this model, two test halves were defined for all unidimensional affect categories by computing the mean values across 2 variability variables. For the two-dimensional affect category joy–happiness, all 4 variability variables were included in the analysis. A model without double loadings and with equal loadings of both indicators on the corresponding latent variable showed a good fit, maximum-likelihood $\chi^2(63, N = 168) = 105.46$, $p < .01$, Satorra–Bentler $\chi^2(63, N = 168) = 80.18$, $p = .07$, CFI = .98. All correlations were positive and significantly different from zero ($p < .01$), indicating that people characterized by higher variability in one affect show higher variability in another affect as well (see Table 2). The correlations within positive affect variables (between .75 and .84) and within negative affect variables (between .69 and .82) were much higher than the correlations between variables of opposite valence (between .30 and .57). However, a two-factor model had to be rejected because it did not fit the data as well as the seven-factor model presented in Table 2. The fit of a two-factor

[1] In this model, the latent trait variables are uncorrelated with the week-specific variables and the error variables. Furthermore, a week-specific latent variable is uncorrelated with all other week-specific latent variables and all error variables. Finally, an error variable is uncorrelated with all other error variables. Therefore, the variance of the observed variability variable can be additively decomposed into the variances of the trait variables, the occasion-specific latent variables, and the error variables. Then the consistency, specificity, and reliability coefficients can be defined on the basis of this variance decomposition.

Table 1
Confirmatory Factor Analysis of Variability Variables Within the Emotion Categories and Descriptive Statistics of the Total Scale (Mean of the Variability Variables)

Basic category and emotion terms	Maximum likelihood χ^2	Maximum likelihood p	Satorra–Bentler χ^2	Satorra–Bentler p	CFI	Factor loading	Reliability	M	SD	Minimum	Maximum
One-factor model (df = 2)											
Love	0.73	.69	0.48	.79	1.00		.90	0.91	0.29	0.07	1.86
Affection						.89					
Love						.93					
Caring						.76					
Fondness						.77					
Anger	1.44	.49	1.47	.48	1.00		.91	0.66	0.22	0.16	1.40
Anger						.86					
Irritation						.71					
Disgust						.90					
Rage						.88					
Fear	7.00	.03	4.40	.11	.98		.87	0.81	0.27	0.15	1.90
Fear						.83					
Worry						.81					
Anxiety						.73					
Nervous						.78					
Shame	5.04	.08	5.12	.08	.99		.86	0.60	0.23	0.09	1.20
Shame						.80					
Guilt						.77					
Regret						.80					
Embarrassment						.77					
Sadness	2.77	.25	2.51	.29	1.00		.88	0.72	0.26	0.18	1.66
Sadness						.79					
Loneliness						.66					
Unhappiness						.86					
Depression						.90					
Two-factor model (df = 1)											
Happiness	0.95	.33	0.66	.42	1.00		.87	1.01	0.29	0.19	1.83
Happiness						.83[a]					
Contentment						.91[a]					
Joy[b]							.69	0.88	0.29	0.17	1.83
Joy						.95[c]					
Pride						.46[c]					

Note. N = 168. CFI = comparative fit index.
[a] Factor 1. [b] r(Factor 1, Factor 2) = .71. [c] Factor 2.

model with free loadings within positive and negative affects was as follows: maximum-likelihood $\chi^2(76, N = 168) = 394.50$, $p < .01$, Satorra–Bentler $\chi^2(76, N = 168) = 289.92$, $p < .01$, CFI = .81. Hence, the variability of affect is best described by a multidimensional common factor model with correlated latent variables. Therefore, it is important to differentiate among the variability in love, happiness, joy, anger, fear, shame, and sadness.

Table 2
Correlations Among the Seven Latent Variability Variables

Variable	1	2	3	4	5	6	7
1. Love	—						
2. Happy	.84	—					
3. Joy	.75	.80	—				
4. Anger	.38	.40	.51	—			
5. Fear	.57	.52	.44	.69	—		
6. Shame	.41	.42	.48	.82	.71	—	
7. Sad	.51	.52	.30	.71	.72	.71	—

Note. N = 168.

Trait and state aspects. The fit statistics of the multistate–multitrait models, as well as the estimated reliability, consistency, and specificity coefficients, are reported in Table 3. In models with 81 degrees of freedom, it was assumed that all loadings were equal to 1 and did not depend on the week considered. For the affect category joy, the variance of one occasion-specific residual had to be fixed to zero because of a small negative value, resulting in 82 degrees of freedom. In models with 69 degrees of freedom, the assumption of occasion-independent loadings on the latent trait variables was too restrictive, and occasion-specific loadings were allowed. The sample sizes differed between the affect categories because of differences in the number of participants with missing values.

According to the Satorra–Bentler corrected chi-square statistic, only two models had to be rejected (fear and shame). Even for these

Table 3
Latent State–Trait Analysis of the Variability Variables Across Time: Model Fit, Reliability, Consistency, and Specificity Estimates

Basic category	Maximum likelihood χ^2	Maximum likelihood p	Satorra–Bentler χ^2	Satorra–Bentler p	CFI	Trait correlation	Week 1	2	3	4	5	6	7
Love (df = 81, N = 148)	114.42	<.01	85.63	.34	.97	.89							
REL							.69	.78	.76	.81	.77	.79	.79
CON							.58	.67	.68	.68	.62	.69	.70
SPE							.11	.11	.08	.13	.15	.10	.09
Happiness (df = 81, N = 147)	111.42	<.01	95.35	.13	.95	.91							
REL							.58	.62	.68	.61	.62	.71	.72
CON							.44	.56	.53	.55	.54	.53	.61
SPE							.14	.08	.15	.06	.08	.18	.11
Joy (df = 82, N = 153)	100.50	.81	85.66	.37	.97	.55							
REL							.51	.59	.50	.50	.51	.49	.49
CON							.43	.54	.46	.48	.47	.49	.46
SPE							.08	.05	.04	.02	.04	.00	.03
Anger (df = 69, N = 147)	96.47	.02	78.72	.20	.97	.76							
REL							.72	.81	.81	.80	.82	.78	.80
CON							.18	.39	.45	.60	.57	.46	.47
SPE							.54	.42	.36	.20	.25	.32	.33
Fear (df = 69, N = 143)	110.02	<.01	96.38	.02	.97	.89							
REL							.86	.72	.85	.90	.90	.88	.88
CON							.29	.26	.38	.45	.61	.75	.57
SPE							.57	.46	.47	.45	.29	.13	.31
Shame (df = 69, N = 138)	116.78	<.01	100.98	.01	.95	.88							
REL							.86	.86	.70	.71	.69	.76	.81
CON							.42	.56	.60	.52	.53	.46	.61
SPE							.44	.30	.10	.19	.16	.30	.20
Sadness (df = 81, N = 139)	108.76	.02	93.87	.16	.97	.84							
REL							.74	.74	.80	.67	.77	.71	.78
CON							.55	.63	.71	.60	.67	.62	.66
SPE							.19	.11	.09	.07	.10	.09	.12

Note. CFI = comparative fit index; REL = reliability estimate; CON = consistency estimate; SPE = specificity estimate.

two models, however, the ratio of chi-square values and degrees of freedom was relatively small and the CFI coefficients were larger than .95, indicating a good approximate fit. The reliabilities were smaller than in the confirmatory factor models based on all occasions of measurement because the variability coefficients were calculated on seven occasions only. Nevertheless, the reliabilities of the scales with four affect adjectives were relatively large, ranging between .67 and .90. The reliabilities of the joy and happiness variables were smaller (between .49 and .72). The specificity coefficients were very small for all positive affect variables and for sadness (between .00 and .19). Consequently, the consistency coefficients were relatively large. Thus, for these affect variables, interindividual differences in intraindividual variability were very stable and only slightly influenced by week-specific interindividual differences. The specificity coefficients were larger for the negative affect variables anger, fear, and shame (between .10 and .57). They were particularly large for the first weeks and smaller for the following ones. For these variables, interindividual differences in intraindividual variability depended on stable as well as variable differences, although they were determined to a much larger degree by stable interindividual differences at the end of the study. Even for these affect variables, the consistency coefficients were relatively large and much larger than the specificity coefficients for the final 4 weeks.

Predictive Validity

Correlations between the variability scores calculated across the first 2 weeks and the square roots of absolute residuals on 5 days are given in Table 4. The first correlation of the emotion category love (r = .37), for instance, shows that there was a significant association between (a) variability in love (measured across the first 2 weeks) and (b) the (absolute) deviation of the love state measured on Day 22 from its expected value given the mean level of love. This shows that the precision with which state values of

Table 4
Predicting the Square Root of Absolute Residuals by Intraindividual Variability (Standard Deviation): Correlations

Basic category	Day 22	Day 29	Day 36	Day 43	Day 50
Love	.37**	.24**	.29**	.28**	.23**
Happiness	.13	.32**	.13	.24**	.30**
Joy	.35**	.33**	.25**	.29**	.29**
Anger	.27**	.41**	.42**	.17*	.21**
Fear	.46**	.26**	.21**	.31**	.32**
Shame	.40**	.21**	.18*	.19*	.32**
Sadness	.34**	.37**	.35**	.29**	.22**

* $p < .05$. ** $p < .01$.

love can be predicted by mean levels of love is smaller for people with high variability. Therefore, people with high variability are less predictable than people with low variability. The interpretation of the other correlations is straightforward. The results show that intraindividual variability was a significant predictor of the precision of prediction in 33 of 35 analyses, the correlations ranging from .13 to .46. Most of the correlations were in the .30 range. Furthermore, there was no strong decline in the size of the correlations across time, indicating that the predictive validity of variability does not depend on the time lag considered. In sum, these results clearly demonstrate the predictive validity of intraindividual variability.

Variability and Personality: Convergent and Discriminant Validity

To analyze the relations between variability and personality, we calculated the correlations between the variability scores (across all days) and the five subscales of the NEO-FFI (Costa & McCrae, 1989). To compare these associations with the relations between mean level and personality variables, we calculated the correlations of the mean values and the personality variables as well. Finally, to determine which personality factor had the most important influence on intraindividual variability, we computed multiple regression analyses correcting for the dependency of the variability variables on the mean level variables. This was done in a hierarchical nonlinear regression analyses in which the mean level scores were entered in the first step, the squared mean level scores were entered in the second step, and the personality variables were entered in the third step. To consider the interactions between neuroticism and extraversion proposed in Eysenck and Eysenck's (1985) model of affect variability, we also entered the product term of neuroticism and extraversion.

The correlations between the personality variables and the variability scores, as well as the mean levels, are reported in Table 5. Neuroticism was positively correlated with all mean level variables of the negative affect categories and negatively correlated with the mean positive affect categories. Furthermore, neuroticism was significantly positively correlated with all variability variables with the exception of joy and happiness. Extraversion was negatively correlated with the mean level variables of all negative affect categories and was significantly positively correlated with happiness and joy but not love. The correlations with variability, however, were significant only for joy and sadness. Openness to experiences was not significantly correlated with any of the mean level variables or variability variables. Agreeableness showed positive correlations with the mean level variables of love and happiness and negative correlations with the mean level variables of anger and sadness. Only variability in anger was significantly correlated with agreeableness. Conscientiousness was significantly related only to the mean level variable of happiness.

Thus, for intraindividual variability, the most important personality variable was neuroticism, because it was related to the variability in all negative affect categories and to the positive affect of love. Comparisons of variability with mean levels showed that there were many more significant correlations for the mean levels, and each mean level variable was significantly related to at least two personality variables.

The importance of neuroticism as the most powerful personality variable for predicting interindividual differences in variability was supported by the multiple regression analyses (see Table 6). Even after correction for the influences of the mean levels, which were highly correlated with neuroticism, neuroticism had a significant influence on variability for six of the seven affect categories considered. Extraversion, however, had a significant influence on

Table 5
Intraindividual Variability (Standard Deviation), Mean Level, and Personality: Correlations

Basic category	Neuroticism	Extraversion	Openness to Experiences	Agreeableness	Conscientiousness
Love (N = 169)					
M	−.17*	.12	.04	.27**	.09
SD	.20*	.00	.01	−.04	−.10
Happiness (N = 170)					
M	−.42**	.26**	−.02	.29**	.17*
SD	.14	.02	.00	.02	.00
Joy (N = 170)					
M	−.25**	.35**	−.04	−.02	.12
SD	−.08	.25**	−.05	.04	.03
Anger (N = 170)					
M	.35**	−.19*	−.05	−.19*	−.09
SD	.32**	−.05	−.05	−.18*	−.05
Fear (N = 169)					
M	.47**	−.20*	.00	−.08	.01
SD	.45**	−.009	.06	−.03	−.03
Shame (N = 170)					
M	.31**	−.17*	.00	−.11	−.15
SD	.38**	−.05	.01	−.08	−.14
Sadness (N = 170)					
M	.46**	−.22**	.00	−.17*	−.12
SD	.49**	−.21**	.02	−.08	−.13

* $p < .05$. ** $p < .01$.

Table 6
Summary of the Nonlinear Multiple Regression Analyses for the Variability Scales (Dependent Variables), Mean Value Scales, and NEO-FFI Personality Scales (Independent Variables)

Variable	*B*	*SE B*	β
Love (N = 169; R^2 = .116)			
M	.243**	0.083	0.940
*M*M*	−.035*	0.015	−0.743
N	.003**	0.001	0.240
Happiness (N = 170; R^2 = .117)			
M	.393**	0.094	1.423
*M*M*	−.062**	0.015	−1.431
N	.002*	0.001	0.175
Joy (N = 170; R^2 = .249)			
M	.361**	.057	1.478
*M*M*	−.059**	.012	−1.154
Anger (N = 170; R^2 = .470)			
M	.525**	.067	1.217
*M*M*	−.110**	.025	−0.663
N	.001*	.001	0.132
E	.002*	.001	0.129
Fear (N = 169; R^2 = .426)			
M	.353**	.065	0.940
*M*M*	−.052**	.018	−0.492
N	.004**	.001	0.274
E	.003**	.001	0.202
Shame (N = 170; R^2 = .512)			
M	.599**	.057	1.361
*M*M*	−.166**	.022	−0.971
N	.002**	.001	0.208
Sadness (N = 170; R^2 = .520)			
M	.561**	.065	1.259
*M*M*	−.145*	.025	−0.839
N	.003**	.001	0.248

Note. The semi-partial regression coefficients were not significant for the openness, agreeableness, and conscientiousness scales or for any of the interaction terms (product of mean value scales and personality scales) and are therefore not reported. *M* = mean level scale; *M*M* = quadratic mean level scale; N = neuroticism; E = extraversion. NEO-FFI = NEO Five-Factor Inventory.
* $p < .05$. ** $p < .01$.

variability only for fear and anger. The product terms indicating interactions between neuroticism and extraversion had no significant influence. The other personality variables did not show any significant contribution to predicting interindividual differences in intraindividual variability in the multiple regression analyses. Furthermore, the regression analyses revealed that the mean level variables were significant predictors of variability scores. Moreover, the quadratic component was significant in all cases; that is, the relations between variability and the mean level variables are best described by an inverse U-shaped function. This was to be expected, because less variability is possible when a mean is very high or very low. The mean variables accounted for the majority of the explained variance in the multiple regression analyses. Before the other personality variables were entered, the coefficients of determination for the mean level scores were .06 (love), .09 (happiness), .25 (joy), .45 (anger), .36 (fear), and .48 (shame).

The most important result of these analyses is that mean levels and personality factors can only explain a maximum of 52% of the variance of variability. Thus, intraindividual variability is sufficiently distinct from other personality variables to be considered a different personality trait. The discriminant validity was particularly large for intraindividual variability in positive affects, for which almost 90% of the variance remained unexplained by personality and mean levels of affect. Thus, research on intraindividual variability in positive affect can perhaps offer the most new insights into personality processes.

Discussion

The results of our analyses show that intraindividual variability in affect is a multidimensional construct that is sufficiently stable to be considered a psychological trait and can be reliably measured by the intraindividual standard deviation. Intraindividual variability shows convergent validity with mean level scores and neuroticism, but it is sufficiently distinct to be considered a unique trait.

The analyses reported in this article differ from those of previous studies on variability in affect in four important aspects. The first is method of data analysis. The use of structural equation modeling allowed for analysis of reliability and construct validity in a more appropriate way than in former studies. The second aspect is data sampling across time. The long period of time considered in this study made it possible to analyze the stability of variability across seven subperiods, whereas former studies concentrated on much shorter time periods. Furthermore, the design of the study enabled us to explore the predictive validity of intraindividual variability in affect by considering several time lags, a research question that, to our knowledge, has not been addressed before. The third aspect is sampling of affect. The sample consisted of the primary emotions of Western emotion theories, and each emotion class was represented by several terms. This permitted us to analyze the dimensionality of variability in a stronger way. Previous studies, on the other hand, focused mainly on moods or single emotions of one emotion category. The final aspect involves personality variables. Whereas former studies of the relation between affect variability and personality focused on Eysenck's personality system, we based our analyses on a wider range of personality variables (i.e., the five-factor model of personality). All four aspects revealed important findings about affect variability that are discussed subsequently.

Reliability and Construct Validity

Because measurement errors were not controlled in previous studies of variability in affect, it remained an open question to what degree the instability and sometimes low communalities in these studies were due to measurement error influences. Our analyses revealed three important findings via structural equation modeling.

First, interindividual differences in intraindividual variability can be measured reliably with intraindividual standard deviations. The large reliabilities meet the requirements for proper measurements in psychology. These reliabilities, however, depend on the number of occasions of measurement included in the calculation of variability coefficients. They were very high for 51 occasions of measurement but lower for 7 occasions (1-week intervals). This problem of lower reliabilities for shorter time periods can be diminished by aggregating different variability scores within one time period. The reliabilities of the four-item scales were satisfac-

tory even for 7 occasions of measurement, whereas the reliabilities of the two-item scales were lower. Thus, there are two ways to enhance the reliability of variability: including more occasions of measurement or including more indicators of the same variability construct. The improvement of reliabilities by aggregating variability scores across time periods as well as across items within time periods can be explained by the well-known aggregation effect (Epstein, 1979; Steyer & Schmitt, 1990), and therefore aggregation formulas can be used for estimating the number of occasions and items needed. Thus, our analyses indicate that future studies on affect variability should include several indicators of one emotion category, particularly if the number of occasions cannot be very large.

Second, taking measurement error into account, the analyses showed that the instability of variability was very small for positive affect variables and moderately high for negative affect variables. It was revealed that the specificity coefficients were generally higher for the first week. The reason for this result could be that the participants were required to familiarize themselves with the daily assessment method, that is, to become aware of their emotions and to report them. One consequence of this result for future studies on affect variability might be to consider the first week as a training period and to use the later occasions of measurement for analyzing the research questions of interest. For each affect category, however, the consistency coefficients were larger than the specificity coefficients in nearly all analyses. Therefore, intraindividual variability is more a trait variable than a week-specific state variable.

Third, concerning factorial validity, our analyses clearly demonstrate that intraindividual variability is a multidimensional construct, although the factor correlations were relatively high within the groups of positive and negative affect. As discussed subsequently, the multidimensional character of intraindividual variability was supported not only by the structural analyses but by the differential personality correlates of variability scores.

Predictive Validity of Variability Across Time

Dividing the entire time period into seven sub-periods enabled us to analyze the predictive validity of the variability scores across several time lags. This made it possible to study the generalizability of the findings for one occasion of measurement to other occasions of measurement. According to our results, intraindividual variability in affect is a valid predictor of interindividual differences in predictability (precision of prediction). It is important to note that this result was stable over time and that intraindividual variability could even predict differential predictability 5 weeks later. Hence, intraindividual variability can be used to select more and less predictable individuals. For example, if one wants to analyze situational effects in detail, it would be worthwhile to select highly variable individuals because they can be expected to react more strongly to situational stimuli.

Variability in Primary Emotions: Factorial, Convergent, and Discriminant Validity

The third major advantage of this study was that the emotions were theoretically sampled on the basis of different emotion theories (Diener et al., 1995). Thus, the dimensionality of variability could appropriately be analyzed. Furthermore, each affect category was assessed by several items. Only the measurement of one affect category with multiple items made it possible to separate measurement error from true differences and to show that the structure of variability on the latent level is best described by a multidimensional model and not be a one-dimensional model (as assumed by Tobacyk, 1981, and Wessman & Ricks, 1966).

There were two major differences between the structure of the variability scores and the trait variables (see Diener et al., 1995, for the structure of the trait variables): (a) The affect category joy–happiness was two-dimensional for the variability scores but unidimensional for the trait variables, and (b) the correlations between positive and negative affect categories were positive for the variability scores but negative for the trait variables. What are the reasons for these differences? The two-factor structure for the affect domain joy–happiness discriminates between a more moodlike factor (contentment and happiness) and a more emotionlike factor (joy and pride). Moods and emotions, however, are linked to different kinds of events: Emotions are more likely to be precipitated by quickly occurring events, whereas moods are more linked to slowly occurring events (Davidson, 1994). Thus, it is plausible that the two kinds of affect differ in their variability structure. In contrast to the variability scores, the mean levels mark more the degree of positive affect people experience in their lives that might be due to a general disposition to react to positive stimuli. Thus, there could be unidimensionality of happiness and joy according to their mean levels (Diener et al., 1995), indicating that people experiencing more happiness have more joy in their lives as well. Differences between the two types of affect in their variability, however, might be due to differences in situational features eliciting happiness and joy, respectively. These hypotheses, however, are speculative and must be analyzed in future studies.

The positive correlations of the variability scores between positive and negative affect categories (in contrast to the negative correlations of the trait variables) are in line with previous studies (e.g., Penner et al., 1994; Tobacyk, 1981; Wessman & Ricks, 1966). These high positive associations might be explained by interindividual differences in emotional reactivity. Emotional reactivity has been considered a personality trait by several researchers (Diener, Larsen, Levine, & Emmons, 1985; Larsen & Diener, 1987; Underwood & Froming, 1980). Affect reactivity characterizes interindividual differences in an individual's response to different affective stimuli. This assumption of cross-emotional consistency in reactivity to an emotional event has been supported by several studies (see Larsen & Diener, 1987, for a review). If participants differ in their reactivity and intensity across different types of affect, they should differ in their affect variability as well, and consequently the variability variables should be positively correlated. Although the factor correlations were relatively high, there are several pieces of evidence supporting a multidimensional structure of affect variability, even within positive and within negative affect variables. The specificity coefficients of the negative emotions anger, fear, and shame, for example, were higher than those of the sadness scale, indicating differences in the variability of negative affect. One explanation for this result could be that the situational stimuli causing anger, fear, and shame might be more changeable between the different weeks than for sadness. Because the sample analyzed was composed of students, the weeks could have differed, for instance, in the number of oral presenta-

tions, exams, and so forth. Thus, one reason for a multidimensional structure might be that the different emotions are elicited by different situations, and the frequency of the relevant situations can differ between emotions and weeks. Another explanation could be that the variability in sadness depends more on personality aspects such as hormone cycles. Hence, analyzing situational features, their interaction with personality variables (e.g., hormone cycles), and their influences on affect variability seems to be a worthwhile task for future studies on affect variability and might be particularly important for separating variability in sadness from other types of negative affect. In addition, measuring the variability in emotion-producing events in people's lives would also help shed light on the genesis of affect variability.

In addition to the differences in the stability coefficients, the variability scores differed in their personality correlates. Whereas the variability scores of all negative affect categories were correlated with neuroticism, only sadness was related to extraversion, and only anger was associated with agreeableness. Furthermore, the variability in only one positive affect (love) was correlated with neuroticism, and only one positive affect (joy) was related to extraversion. These divergent relations between variability scores and personality factors clearly support a multidimensional structure of affect variability. Furthermore, these correlations show that neuroticism is the most important personality variable of the five-factor model in terms of predicting interindividual differences in affect variability. Even after correction for the dependencies of the variability scores on the mean levels in multiple regression analyses (see Table 5), neuroticism was a significant predictor in six of seven cases. Only in the case of joy did neuroticism not significantly contribute to predicting interindividual differences in affect. On the other hand, with the exception of fear and anger, extraversion did not play an important role in regard to variability.

These results can be explained by a two-component personality model of affect variability. A first prerequisite for experiencing affect variability is the disposition of an individual to respond with a specific affect system. This dispositional responsivity is characterized by its mean level. Thus, to be able to love or feel happiness is a precondition for the variability in this affect. But, second, variability seems to depend on the broader disposition of neuroticism as well. That is, individuals with the same affect mean level are more variable if they are more neurotic. This makes sense because variability in affect is one defining characteristic of neuroticism, and items assessing emotional variability are included in neuroticism questionnaires. Thus, the correlations between global judgments of neuroticism and variability in daily affect provide support for the validity of neuroticism questionnaires as well. It is important to note that this relation with neuroticism was significant even for the positive emotions of love and happiness.

One possible explanation for the role of neuroticism might be that neurotic people tend to react with their negative affect system more easily and that they therefore might be less able to maintain their positive affect. Thus, their responsivity to stimuli eliciting negative affect in general might increase their variability in specific negative emotions. On the other hand, their negative reactivity results in a frequent loss of positive affective states. But, because individuals with high variability are also disposed to react with positive affect, they can achieve a positive affective state again. Hence, high variability in love and happiness seems to be an interplay of positive and negative affect responsivity.

This process might be less reasonable for the positive affect joy. Whereas happiness and love are more enduring affective states, the affect category joy refers more to short-term emotions that are less enduring. This assumption is supported by differences in the mean values of the mean level variables: 2.47 for love and 3.06 for happiness but only 1.97 for joy. Thus, joy is less enduring, and processes concerning the maintenance of positive affect might be of minor importance for this category. Furthermore, joy might be more linked to emotion-eliciting situations than happiness and love, which are partly linked to more stable aspects of life (e.g., being in a harmonious relationship). Interindividual differences in the variability of joy might therefore be partly due to interindividual differences in the intensity of reactions to joy-eliciting situations. This assumption is supported by the fact that the mean level as well as the variability scores of joy showed the highest correlations with extraversion, and extraversion is linked to higher reactivity levels to positive stimuli (Larsen & Ketelaar, 1991). The other positive emotions, however, had larger (absolute) correlations with neuroticism than with extraversion. In conclusion, there are several hints why a multidimensional model of affect variability is preferable to the one-dimensional model assumed in previous studies.

Intraindividual Variability and the Five-Factor Model of Personality

The fourth major advantage of our study is that we included a wider range of personality variables than previous studies on variability in affect, which focused only on Eysenck's personality system. Our analyses show that the five-factor model offers more insight into the personality correlates of mean level scores; not only neuroticism and extraversion, but also agreeableness and conscientiousness, were significantly related to affect categories. The most intriguing finding is that the mean value variable of only one positive emotion (joy) had a larger (absolute) correlation with extraversion than with neuroticism. For the other two positive emotions, this relation was reverse, and for love the correlation of the mean level variable with extraversion was not even significantly different from zero. This result is obviously in contrast to the assumption that extraversion is a personality factor of positive affect and neuroticism is a personality factor of negative affect (for an overview, see Diener & Lucas, in press). Our results reveal that extraversion might be a stronger predictor only for more emotionlike affect variables such as joy, whereas neuroticism might be a more important predictor of more steady-state affect variables such as happiness or love.

In terms of variability in affect, only neuroticism and extraversion played a significant role, the former being more important than the latter. The other personality variables of the five-factor model are unimportant for predicting interindividual differences in intraindividual affect. Thus, taking a broader range of personality variables into account, our analyses (a) corroborate Eysenck's assumption that neuroticism is a factor of emotional instability (e.g., Eysenck & Eysenck, 1985) and (b) demonstrate that openness, agreeableness, and conscientiousness are unimportant in predicting the specific portion of variability that is not explained by mean level scores.

Personality and mean level variables explain a significant amount of variance in interindividual differences in intraindividual affect. But there is nevertheless a large amount of variance unexplained by these variables. This unexplained variance might be due

to situation-specific determinants (e.g., events and emotional stimuli), biological rhythms, or other personality variables (e.g., affect regulation traits; Salovey, Mayer, Goldman, Turvey, & Palfai, 1995). These variables might be particularly important for intraindividual variability in positive affects, because the variance explained by the traits of the five-factor model was relatively low for these emotions. Furthermore, for positive emotions, the associations between the mean levels and the variability scores were relatively small, and the personality correlates differed more between mean levels and variability scores. Because the discriminant validity coefficients were so large, it is worthwhile to give the analysis of intraindividual variability in positive affect more scientific attention than it has been given up to now. This study focused on day-to-day fluctuations in affect. Future research can profit from analyzing shorter time periods (e.g., fluctuations within days) and comparing the results with those reported here. The methodology proposed in this article can be applied as well to analyzing fluctuations across shorter time periods.

The high reliability, consistency, and factor correlations of the variability scores might be criticized because these scores were not corrected for their dependency on mean values. It could be argued that the curvilinear relations between the variability and mean level variables were an artifact due to floor and ceiling effects caused by response scales with a limited range of values. Because the mean values were highly correlated, it might furthermore be argued that the correlations of the variability scores were "artificially" high (Penner et al., 1994). The problem of an artificially restricted variability coefficient, however, can arise only if the extreme scale categories are anchored in a way that could allow floor or ceiling effects (i.e., category labels that do not mark the lowest and highest possible values). But this was not the case in the current study; participants who never or always experience a feeling cannot show any variability at all. Therefore, from a theoretical point of view, a high correlation between two variability scores is a true phenomenon and not an artifact. Consequently, we did not correct variability scores for the reliability, stability, and dimensionality analyses. This was confirmed by an empirical analysis in which we corrected the variability scores by subtracting from each variability score the score predicted by the mean levels in a curvilinear regression analysis. This residual variable was uncorrelated with the mean level variable by definition. We tested the effects of the correction just mentioned on the correlations of the variability scores for four variables: depression and sadness, which had skewed distributions and showed an important linear trend in their regressive dependency on the mean values, and contentment and happiness, which were relatively symmetrically distributed and did not show a linear dependency on the mean values. The correlations between the variability scores of the same affect category were .66 for the two negative affect variables before the correction and .66 after the correction. For the positive affect variability scores, the corresponding correlations were .76 (before) and .73 (after). Hence, the reliabilities of the original and the residualized variability scores will not differ much, and the reliabilities of the uncorrected variability scores are not artificially high. The same argument holds for the stability and dimensionality analyses.

In addition to the dependency of the variability scores on the mean levels, there might be another criticism concerning the standard deviation as a variability index: A high variability value could indicate not only day-to-day fluctuations but also the situation in which a participant is characterized by two affect values (e.g., a very high value in the first half of the study period and a very low one in the second half). This situation is an example of trait change rather than of state variability (Eid & Hoffmann, 1998). To assess the validity of the intraindividual standard deviation as a measure of variability, we computed the difference scores for 2 adjacent days and for each affect category (for a similar approach, see Leiderman & Shapiro, 1962). Next, we took the absolute values of these scores and summed all absolute difference scores of each affect category. Correlations between these mean absolute day-to-day differences and the intraindividual standard deviations were between .86 (love) and .95 (shame). Taking into account that these correlations were affected by measurement error, these high associations show that it is not reasonable to assume that interindividual differences in intraindividual variability reflect the change pattern that is characteristic of trait change.

Conclusion

In conclusion, our findings show that intraindividual variability in affect is a multidimensional construct that is sufficiently stable to be considered a psychological trait and can be reliably measured by the intraindividual standard deviation. Furthermore, intraindividual variability is a valid indicator of the predictability of future states. Finally, intraindividual variability shows convergent validity with mean level scores and neuroticism, but it is sufficiently distinct to be considered a unique trait. This was particularly true of intraindividual differences in positive emotions, because only about 10% of the variance could be accounted for by mean affect levels and personality variables of the five-factor model of personality. An important goal for future research will be to explore the causes of individual differences in affect variability.

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Appendix

Reliability, Consistency, and Specificity of Two Aggregated Test Halves (Aggregation Within Each Week k)

Define

$$V_{*k} = .5(V_{1k} + V_{2k}),$$

$$T = .5(\lambda_{1k}T_1 + \lambda_{2k}T_2),$$

$$W_{*k} = .5(\delta_{1k} + \delta_{2k})W_k, \text{ and}$$

$$E_{*k} = .5(E_{1k} + E_{2k}).$$

Because $\text{Cov}(T_i, W_k) = \text{Cov}(T_i, E_{ik}) = \text{Cov}(W_k, E_{il}) = 0$, for all i, k, and l, and $\text{Cov}(E_{ik}, E_{jl}) = 0$ for $(i, k) \neq (j, l)$, it follows that $\text{Var}(V_{*k}) = \text{Var}(T) + \text{Var}(W_{*k}) + \text{Var}(E_{*k})$.

Hence,

$$\text{Rel}(V_{*k}) = 1 - [\text{Var}(E_{*k})/\text{Var}(V_{*k})],$$

$$\text{Con}(V_{*k}) = \text{Var}(T)/\text{Var}(V_{*k}), \text{ and}$$

$$\text{Spe}(V_{*k}) = \text{Var}(W_{*k})/\text{Var}(V_{*k}), \text{ with}$$

$$\text{Var}(T) = .25(\lambda_{1k})^2\text{Var}(T_1) + .25(\lambda_{2k})^2\text{Var}(T_2) + .5\lambda_{1k}\lambda_{2k}\text{Cov}(T_1, T_2),$$

$$\text{Var}(W_{*k}) = .25(\delta_{1k} + \delta_{2k})^2\text{Var}(W_k), \text{ and}$$

$$\text{Var}(E_{*k}) = .25\,\text{Var}(E_{1k}) + .25\text{Var}(E_{2k}).$$

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