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Individual Differences in Core Affect Variability and Their Relationship to Personality and Psychological Adjustment

Peter Kuppens and Iven Van Mechelen
Katholieke Universiteit Leuven

John B. Nezlek
College of William and Mary

Dorien Dossche and Tinneke Timmermans
Katholieke Universiteit Leuven

How people's feelings change across time can be represented as trajectories in a core affect space defined by the dimensions of valence and activation. In this article, the authors analyzed individual differences in within-person affective variability defined as characteristics of core affect trajectories, introducing new ways to conceptualize affective variability. In 2 studies, participants provided multiple reports across time describing how they were feeling in terms of core affect. From these data, characteristics of participants' core affect trajectories were derived. Across both studies, core affect variability was negatively related to average valence, self-esteem, and agreeableness, and it was positively related to neuroticism and depression. Moreover, *spin*, a measure of how much people experienced qualitatively different feelings within the core affect space, was related more consistently to trait measures of adjustment and personality than other measures of within-person variability, including widely used measures of within-person single-dimension standard deviations.

Keywords: core affect, within-person variability, mood variability, psychological adjustment

A person always feels something. Be it feeling slightly pleasant to utterly depressed, an affective tone is always accessible to conscious awareness. This affective tone has been labeled core affect, "a state that is consciously accessible as a simple nonreflexive feeling that is an integral blend of valence (along the pleasure–displeasure dimension) and arousal (along the activation-deactivation dimension) values" (Russell, 2003, p. 147). Research has shown that a large part of the information conveyed in self-reported momentary emotional experience or mood can be captured by the valence and activation dimensions, and core affect is assumed to be involved in a wide range of affective phenomena, ranging from moods to discrete emotions to emotional pathology (e.g., Feldman Barrett & Russell, 1999; Kring, Feldman Barrett, & Gard, 2003). Thus, at each point in time the feeling state of an individual corresponds to a position in a two-dimensional core affect space defined by the dimensions pleasure–displeasure and activation–deactivation.

The feeling state of an individual can change over time in terms of subtle mood transitions or more sudden emotion shifts. Such changes correspond to movements of an individual's position in the core affect space. How an individual moves within the core affect space will be referred to here as the *core affect trajectory*, representing how a person's feelings change across time. Core affect trajectories can take different forms, and individuals can differ in multiple respects regarding their trajectories. Consider, for example, the core affect trajectories of two hypothetical individuals displayed in Figure 1. The movements of the first individual (shown in the left panel) are small and stay more or less in the same region, whereas those of the second individual (shown in the right panel) are larger and range over the entire two-dimensional space.

To obtain a thorough understanding of the nature and characteristics of people's core affect fluctuations, several challenges must be met. First, to understand the essence of core affect trajectories, we need to map the basic ways in which individuals' core affect movements can differ. Second, the relationships among core affect trajectory characteristics need to be understood. Finally, the relationships between individual differences in core affect trajectory characteristics and personality need to be examined, to provide more insight into the processes that might underlie movement in core affect space.

Core Affect Variability

Recently, increased attention has been paid to intraindividual variability as an individual difference variable, similar to a classically defined trait. A growing body of research points to the importance of considering within-person variability across a variety of constructs such as discrete emotions (Eid & Diener, 1999), self-esteem (e.g., Kernis, Cornell, Sun, Berry, & Harlow, 1993), basic personality dimensions (e.g., Fleeson, 2001), interpersonal

Peter Kuppens, Iven Van Mechelen, Dorien Dossche, and Tinneke Timmermans, Department of Psychology, Katholieke Universiteit Leuven, Leuven, Belgium; John B. Nezlek, Department of Psychology, College of William and Mary.

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Correspondence concerning this article should be addressed to Peter Kuppens, Department of Psychology, Katholieke Universiteit Leuven, Tiensestraat 102, 3000 Leuven, Belgium. E-mail: peter.kuppens@psy.kuleuven.be

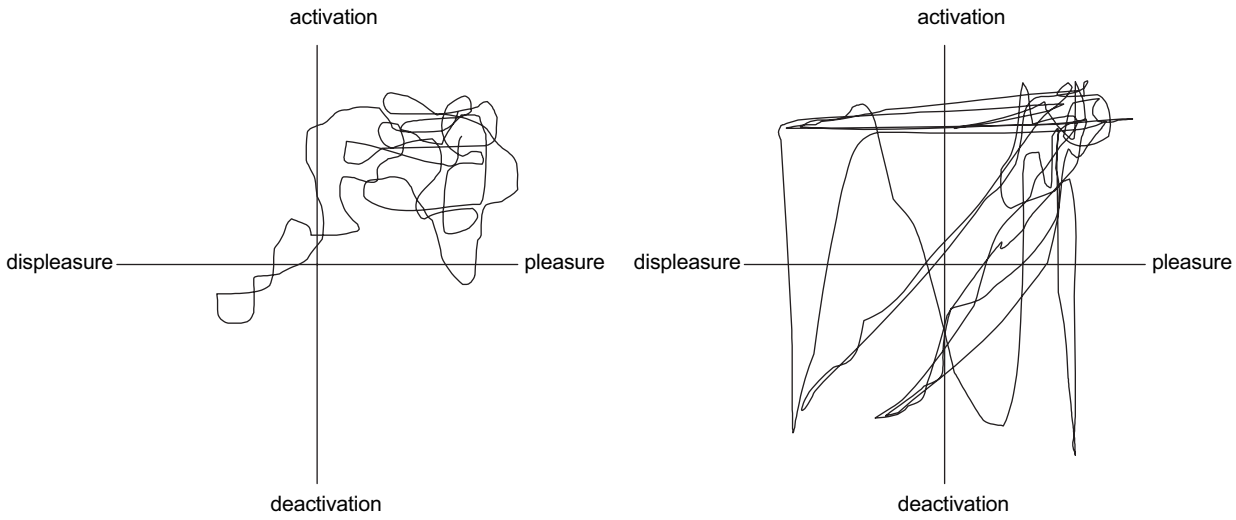

Figure 1. Core affect trajectories of two hypothetical individuals.

behavior (e.g., Moskowitz & Zuroff, 2004), and depressogenic adjustment (Gable & Nezlek, 1998). In terms of within-person variability in affective experience per se, several studies have established that individual differences in affect variability are stable across time (Eaton & Funder, 2001; Larsen, 1987; Penner, Shiffman, Paty, & Fritzsche, 1994). Moreover, Eid and Diener (1999) concluded that affect variability is sufficiently distinct from other traits to be considered a separate aspect of personality. Most research on within-person variability in affect and other psychological states has defined variability in terms of within-person standard deviations of single-dimension state level measures or some minor variant thereof (e.g., Eid & Diener, 1999; Gable & Nezlek, 1998; Kernis et al., 1993; McConville & Cooper, 1999; Penner et al., 1994; Rhodewalt, Madrian, & Cheney, 1998).[1] In a core affect context, such a conceptualization of affect variability corresponds to what can be termed *valence* and *activation variability*, calculated as the within-person standard deviations across the (Cartesian coordinates on the) respective dimensions. These types of core affect variability reflect how much an individual varies between more and less pleasant states and how much an individual varies between experiencing more and less activated states, respectively. Illustrations of valence variability and activation variability are presented in Figure 2.

In this article, we describe another way of conceptualizing within-person variability in affect. For this purpose, we rely on the fact that the two-dimensional nature of core affect space allows for examining affective variability with respect to parameters of affective feelings other than the ones explained in the previous paragraph. In particular, we focus on the length and the angle of a feeling's state position in core affect space (i.e., the polar coordinates of that position). Substantively, the length reflects intensity and the angle reflects the quality of experienced core affect (pleasant-activated, pleasant-deactivated, etc.). Variability of these aspects thus reflects how people's feelings vary in terms of affect intensity per se and in terms of changes in the quality of the feelings they experienced. This approach builds on the framework that was recently developed by Moskowitz and Zuroff (2004, 2005) to describe within-person variability in a different domain, interpersonal behavior (situated in the interpersonal circumplex space). They introduced two measures of variability, *pulse* and *spin*, and we examined the utility of such measures to the understanding of variability in affective experience.

Analogous to Moskowitz and Zuroff's concept of pulse, we examined variability in core affect intensity. Affect intensity is a fundamental aspect of any emotional experience (e.g., Larsen & Diener, 1987; Schimmack & Diener, 1997). Pulse (intensity variability) is calculated as the standard deviation across time of the length of the vectors described by an individual's core affect positions and the neutral midpoint of the core affect space. It reflects how much an individual varies between experiencing more and less intense core affect. An individual characterized by low pulse continuously experiences feelings of similar intensity, of either high, medium, or low intensity. For example, such an individual may continuously be in a core affective neutral, or "feelingless" state, or may constantly experience intense affective experiences. In turn, an individual characterized by high pulse demonstrates more strong and frequent fluctuations between neutral and more intense affective experiences. Pulse is illustrated in Figure 3. It is important to emphasize that this type of variability is independent of the quality (i.e., pleasant or unpleasant, active or deactive) of the core affect; it reflects fluctuations in the intensity of core affect regardless of the quality of the affective experiences.

Analogous to Moskowitz and Zuroff's concept of spin, we examined variability in the quality of core affect. Conceptually, spin (quality variability) is the standard deviation across time of the angles of the vectors described by the individual's core affect space positions. As such, spin reflects how much someone varies

[1] As exceptions, Hepburn and Eysenck (1989) also used an overall affect variability score that was computed as the standard deviation of the distances of the affective states of each moment to the mean affective state in a two-dimensional space defined by PA and NA. Larsen (1987) used spectral analysis to study affect variability.

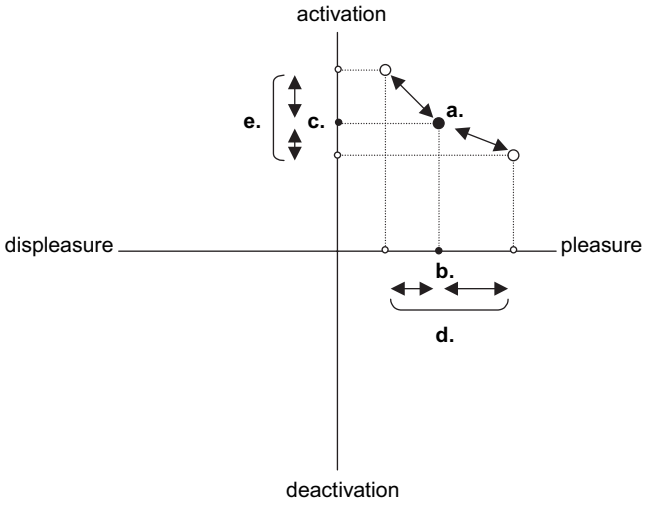

Figure 2. Graphical example of (a) mean position in core affect space, (b) mean valence, (c) mean activation, (d) valence variability, and (e) activation variability.

between different directions in the core affect space, corresponding to qualitatively different feelings and regardless of the intensity of those feelings. Individuals with high spin fluctuate between qualitatively different core affective feelings such as pleasant-activated, pleasant-deactivated, unpleasant-activated, or unpleasant-deactivated feelings, whereas individuals with low spin experience qualitatively similar affective states across time (e.g., always relaxed or always anxious). Spin is illustrated in Figure 3. It is important to note that spin reflects variability in the quality of feelings, regardless of the intensity of those feelings.

It should be clear that pulse and spin provide information that is not contained within single-dimension measures of within-person variability that have been used in the past. Moreover, by their immediate link to the key constructs of intensity and quality of affect, the newly introduced measures may constitute generic indices of affective variability that capture the essence of affective variability more fully than do measures that reflect variability in a particular dimension. In addition, an important characteristic of the newly introduced measures is that they are independent of the axes of reference chosen to define affective space. There has been ongoing discussion about whether the dimensions of valence and activation, or rather the dimensions of positive affect (PA) and negative affect (NA)—assumed to be located at an approximate 45° rotation from one another—are the best way to define affective space (Russell & Feldman Barrett, 1999; Watson, 2000). A major advantage of our new conceptualization of affective variability in terms of pulse and spin is that it is independent of the axes of reference used to construct affective space and thus circumvents the choice for a particular—debated—substantive paradigm. This allows researchers to address issues related to affective variability in ways that are not tied to a specific model of affect, hopefully grasping what lies at the core of affective variability.

In summary, we present different types of core affect variability: variability about each of the dimensions used to define affective space (valence variability, activation variability) pulse (intensity variability), and spin (quality variability). Because it cannot be assumed that the newly introduced core affect variability measures are valuable or meaningful, we evaluated the added value of pulse and spin over the traditional measures by examining the relationships between the different core affect variability measures and between these measures and various trait level variables. Hypotheses about these relationships are presented below. At present, we discuss these hypotheses in terms of core affect variability in general, without formulating expectations in terms of specific types of core affect variability.

Relationships Between Core Affect Trajectory Characteristics

We expected that core affect variability and mean valence would be negatively related. Individuals whose average affective

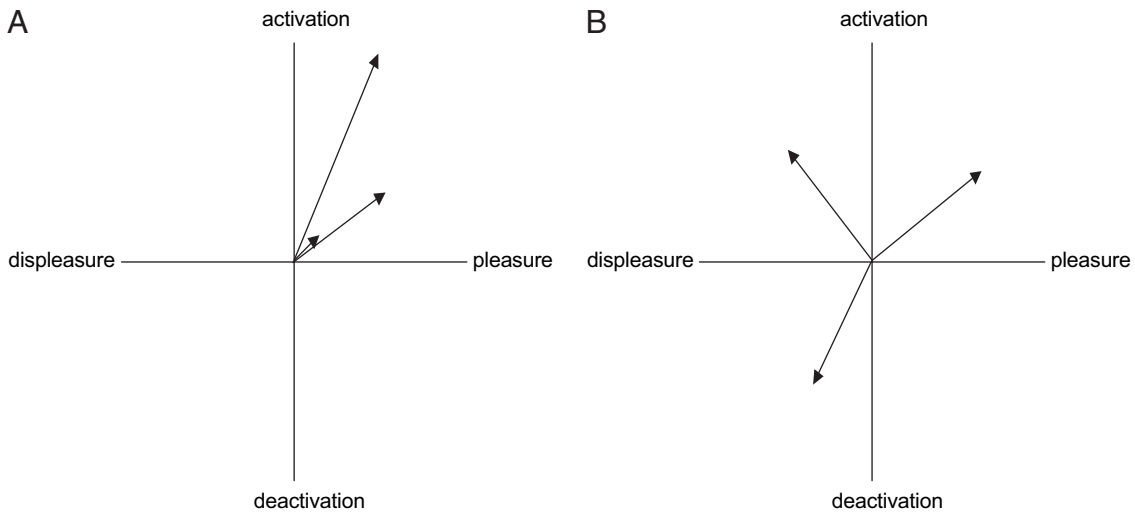

Figure 3. Graphical depictions of (a) high pulse (intensity variability) and low spin (quality variability) and (b) low pulse and high spin.

experience was more unpleasant would be more variable than individuals whose affective experience was more pleasant. This hypothesis follows from findings from research on the variability of psychological states such as specific emotions (e.g., Eid & Diener, 1999), self-esteem (e.g., Kernis, 1993), psychological well-being (e.g., Gable & Nezlek, 1998), and life satisfaction (Fujita & Diener, 2005) that has consistently found negative relationships between variability and mean levels of indicators of psychological adjustment.

Relationships With Personality Traits

Consistent with the previous hypothesis, we expected personality traits that reflect psychological adjustment or positive/pleasant emotionality to be negatively related to core affect variability. This expectation also follows from previous theorizing that poor psychological adjustment is characterized by strong negative emotional reactivity (e.g., Eysenck & Eysenck, 1985), which results in higher levels of affective variability. An important goal of the present study was to determine for which type(s) of variability this hypothesized relationship holds.

More specifically, within the Five-Factor Model of personality (FFM; McCrae & Costa, 1989), we expected that neuroticism would be positively related to core affect variability. Neuroticism has been found to be negatively related to psychological adjustment and positively related to negative emotionality (Larsen & Ketelaar, 1991). Also, prior research has indicated that neuroticism is related to affect variability (e.g., Eid & Diener, 1999; Hepburn & Eysenck, 1989; Murray, Allen, & Trinder, 2002), although some studies have failed to find such an association (Eaton & Funder, 2001; McConville & Cooper, 1992). Past research is less conclusive regarding other FFM personality dimensions. Nevertheless, some previous research suggests that extraversion (e.g., Lucas & Baird, 2004) and agreeableness (e.g., De Neve & Cooper, 1998; Watson, 2000) are related to the experience of positive emotions. Given this, we expected that extraversion and agreeableness would be negatively related to core affect variability.

Additionally, in the first study we examined relationships between core affect variability and both optimism and pessimism (operationally defined as holding negative and positive expectations about future events). Consistent with the previous argument, we expected that pessimism would be positively related to affect variability and that optimism would be negatively related to affect variability. If such relationships occur, this would provide evidence for an association between affective instability and future expectancies, extending our knowledge about the relationship between emotional and cognitive functioning. In a second study, we examined relationships between core affect variability and psychological adjustment, namely depression and self-esteem. We expected that depressive symptoms would be positively related to variability (see also the documented relationship between self-esteem variability and depression; Gable & Nezlek, 1998; Hayes, Harris, & Carver, 2004) and that self-esteem, as an indicator of psychological adjustment, would be negatively related to variability (e.g., Rhodewalt et al., 1998). Moreover, the relationship between self-esteem and variability has been discussed by Rogers (1961), who discussed how low levels of self-esteem are characterized by a less stable sense of self.

We present results from two studies in which participants reported on their core affect across multiple occasions, using different assessment methods to capture core affect. The first study used an experience sampling method (Csikszentmihalyi & Larson, 1987), in which participants reported on their momentary affective state during daily life. This method offers the advantages of not having to rely on memory, eliminating cognitive biases of information storage and retrieval (e.g., Stone et al., 1998). It allows researchers to collect data across a broad range of different circumstances, and the method is ecologically valid because data collection occurs within real-life circumstances of the participant, not in artificial contexts (Feldman-Barrett & Barrett, 2001). On the basis of these data, variability in terms of valence, activation, pulse, and spin were examined. In the second study, participants described their affective states once a day at the end of each day. This collection protocol provided similar advantages, albeit based on a different time frame and assessment method. Moreover, the measures of affective states used in this study provided the opportunity to examine variability not only in terms of valence/activation and pulse and spin, but also in terms of a PA/NA framework.

Study 1

Method

Participants

Participants were 58 students from the Katholieke Universiteit Leuven enrolled in various social sciences programs. The sample consisted of 40 women and 18 men, with a mean age of 22 years. They were recruited through the university job service and were paid for participating.

Materials

Core affect reports at each sampling moment were recorded using the *Affect Grid*, a single-item measure designed to assess core affect (Russell, Weiss, & Mendelsohn, 1989). It is a visual 9×9 two-dimensional grid, with a neutral (fifth) row and a neutral (fifth) column. Unpleasant/Pleasant Feelings forms the horizontal dimension, Arousal/Sleepiness the vertical. Endpoints and neutral points are marked with emotion words or indications to facilitate reporting. Figure 4 provides an example of the Affect Grid. Participants were instructed to mark the position in the Affect Grid that best corresponded to how they felt at each sampling moment (signaled by a beep).

Repeated Assessment of Core Affect

Participants were also asked to report the actual time they completed each form. This allowed us to compare completion times with programmed beep time, enabling us to discard forms that were filled out too long after beep time. Data were included in the analyses only if the reported time fell in a $[-5; 10]$ minutes interval around the original programmed time (Hektner & Csikszentmihalyi, 2002). In total, 94% of reports were provided within the specified timeframe.

Personality Questionnaires

FFM personality dimensions. The Dutch version of the *NEO-FFI* (Hoekstra, Ormel, & de Fruyt, 1996) was used to measure the

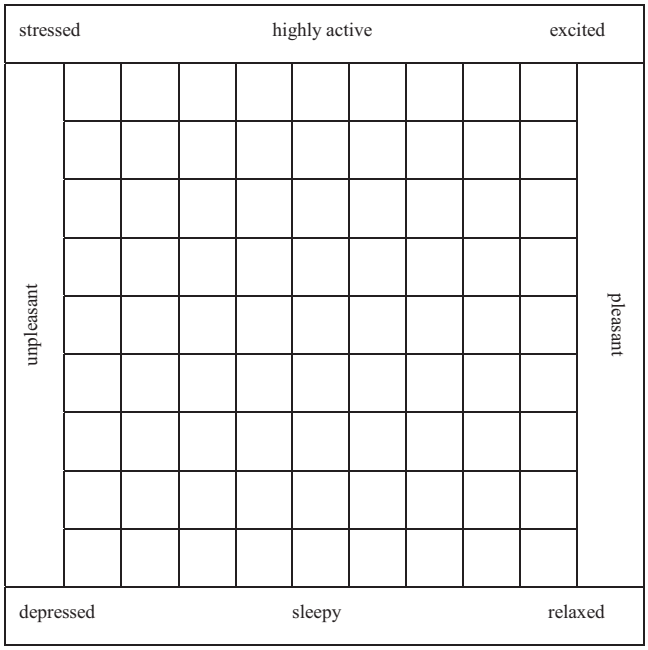

Figure 4. The Affect Grid used to assess momentary core affect in Study 1. From "Affect Grid: A Single-Item Scale of Pleasure and Arousal," by J. A. Russell, A. Weiss, & G. A. Mendelsohn, 1989, *Journal of Personality and Social Psychology, 57,* 493–502. Copyright 1989 by the American Psychological Association. Adapted with permission.

dimensions of the FFM of personality. The questionnaire consists of 60 items, subdivided into five 12–item scales assessing neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. All items were rated on a 5-point scale.

Pessimism and optimism. Participants' pessimism and optimism were measured with two short questionnaires designed for this study. The Pessimism scale consisted of three items that assessed the general tendency to believe things will take a turn for the worse ("I often expect the worst," "Usually, I fear for the worst," and "Things usually turn out bad"). The Optimism scale consisted of three items that assessed the tendency to believe that things usually will turn out right ("Usually, all things end well," "I often expect the best," and "Most situations yield positive consequences"). Items on both scales were rated on a 7-point scale. Preliminary versions of the two scales were pretested in a pilot study with 65 introductory psychology students as participants (mean age = 18 years; 4 men, 55 women, 6 did not report gender). On the basis of the results from the pilot study, some items were replaced or reformulated to form the final version. In the present study, Cronbach's alpha was .89 for pessimism and .65 for optimism.

Procedure

During an introductory session, participants received information about the study, a programmed Casio PC Unite wristwatch, and seven diary booklets (one for each day of the study, each containing nine Affect Grid items). The wristwatch was programmed to beep nine times a day for 7 consecutive days. Participants could specify a different starting time for beeps on weekdays and on the weekend, to minimize the number of missed beeps (van Eck, Nicolson, & Berkhof, 1998). Beeps during the day were semirandom. The available time was divided into equal intervals, and a random beep was scheduled in each interval.

During the introductory session, the Affect Grid was explained to participants using the instructions provided by Russell et al. (1989). To ensure that they understood the grid and how to use it, participants completed some sample grids under the supervision of the experimenter. Participants also completed the NEO-FFI questionnaire. The study began on the day following the introductory session. Participants wore their watches during their normal daytime routine, and at each beep they recorded their momentary core affect and the time of the recording.

At the end of the study, participants attended a second meeting during which they completed the scales assessing pessimism and optimism, returned their watches, and were paid. Payment was based on a variable payment scheme, which had been explained to the participants in the introductory session. They could earn a maximum of 20 €: 12 € for compliance with the procedure, plus a 1 € bonus for each day with 8 or 9 answered beeps, and another 1 € reward if this happened regularly. On average, the participants completed 59.7 of the 63 reports.

Calculation of Core Affect Trajectory Characteristics

An individual report on the Affect Grid can be used to generate two scores, one representing valence ($valence_t$) and one representing activation ($activation_t$), each ranging from −4 to 4, with a neutral midpoint of 0. For both the valence and activation scores, two summary measures were calculated across sampling moments. One represents the mean score for a participant on that dimension (i.e., mean valence and mean activation). The other represents the standard deviation of scores for each person on the dimension (i.e., the within-person standard deviation of valence and the within-person standard deviation of activation), reflecting valence variability and activation variability. On the basis of the framework introduced by Moskowitz and Zuroff (2004), pulse (intensity variability) was calculated as the within-person standard deviation of the distances between each report on the Affect Grid and the midpoint of the space (a distance being calculated as $\sqrt{valence_t^2 + activation_t^2}$), representing how an individual fluctuated between more and less intense core affect. Spin (quality variability) was defined as the circular standard deviation of responses and represented how much a person moved between different angles in the core affect space, reflecting purely qualitative changes. Its calculation can be obtained as follows: First, for each observation, the observed vector ($valence_t$, $activation_t$) has to be transformed to its corresponding unit vector $\left(\frac{valence_t}{\sqrt{valence_t^2 + activation_t^2}}, \frac{activation_t}{\sqrt{valence_t^2 + activation_t^2}}\right)$. Next, R, the resultant vector of all observations of one individual is given by

$$\left(\sum_{t=1}^{n} \frac{\text{valence}_t}{\sqrt{\text{valence}_t^2 + \text{activation}_t^2}}, \sum_{t=1}^{n} \frac{\text{activation}_t}{\sqrt{\text{valence}_t^2 + \text{activation}_t^2}} \right),$$

with

$$\frac{\|\vec{R}\|}{n} = \frac{\sqrt{\left(\sum_{t=1}^{n} \frac{\text{valence}_t}{\sqrt{\text{valence}_t^2 + \text{activation}_t^2}}\right)^2 + \left(\sum_{t=1}^{n} \frac{\text{activation}_t}{\sqrt{\text{valence}_t^2 + \text{activation}_t^2}}\right)^2}}{n}$$

being the length of R, normalized by dividing by the number of observations. Note that

$$\frac{\|\vec{R}\|}{n}$$

ranges from 0 to 1. If there is no variability in the angles of the unit vectors,

$$\frac{\|\vec{R}\|}{n} = 1.$$

If the angles are widely dispersed, the unit vectors tend to cancel one another out and

$$\frac{\|\vec{R}\|}{n}$$

approaches 0. Finally, the standard deviation of the angles of the unit vectors, denoting spin, can be calculated as

$$\sqrt{-2\ln\left(\frac{\|\vec{R}\|}{n}\right)},$$

and ranges from 0 to $+\infty$.

Results

Descriptive Statistics and Reliability

Summary statistics for the measures describing the core affect characteristics are presented in Table 1. Participants' average core affect was positively pleasant and activated. Both were significantly greater than 0; $t(57) = 9.26$, $t(57) = 3.08$, both $ps < .01$.

Regarding reliability, Spearman–Brown split-half reliability coefficients were calculated on the basis of data from the second, third, and fourth day of sampling and data from the fifth, sixth, and seventh day of sampling. These values equaled .65, .69, .66, .81, .65, and .69, for mean valence, mean activation, valence variability, activation variability, pulse, and spin, respectively, indicating good reliability.

Relationships Between Core Affect Trajectory Characteristics

In Table 1, the correlations between the core affect trajectory characteristics are presented. As can be seen in these results, mean valence and mean activation were relatively independent. In turn, the various variability measures were moderately to strongly correlated. A strong negative correlation was also found between mean valence and spin (quality variability). Weaker, but significant, negative correlations were found between mean valence and valence variability and pulse, and between mean activation and spin.

Relationships Between Core Affect Trajectory Characteristics and Personality Traits

The correlations between the characteristics of core affect trajectories and the personality variables are presented in Table 2. Mean valence was positively related to extraversion, agreeableness, conscientiousness, and optimism, and negatively to neuroticism and pessimism. Mean activation was also positively related to extraversion and conscientiousness and negatively related to neuroticism. For the variability measures, both valence variability and activation variability were negatively related to agreeableness and positively related to pessimism. There were no significant correlations between pulse (intensity variability) and the personality measures. Finally, of the variability measures, spin was most strongly correlated with the personality variables. Spin was positively correlated with neuroticism and pessimism and negatively correlated with extraversion, conscientiousness, and optimism. In general, the results confirmed our expectation that personality traits reflecting psychological adjustment or positive emotionality would be negatively related to core affect variability and vice versa.

To evaluate the added value of pulse and spin to variability defined in terms of single-dimension standard deviations, we performed regression analyses in which the personality variables were predicted on the basis of the four different types of affective variability. The results are summarized in Table 3. The results indicate quite clearly that when the different variability measures

Table 1
Means, Standard Deviations, and Correlations Between Core Affect Trajectory Characteristics (Study 1)

Characteristic	*M*	*SD*	1	2	3	4	5	6
1. Mean valence	0.89	0.73	—					
2. Mean activation	0.26	0.65	.20	—				
3. Valence variability	1.68	0.44	−.26*	−.20	—			
4. Activation variability	1.83	0.47	−.07	−.12	.66***	—		
5. Pulse	1.10	0.21	−.32*	.02	.50***	.36**	—	
6. Spin	1.35	0.43	−.72***	−.27*	.53***	.44***	.28*	—

Note. $N = 58$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2
Correlations Between Core Affect Trajectory Characteristics and Personality Traits (Study 1)

Chracteristic	N	E	O	A	C	Pess	Opt
Mean valence	−.40**	.38**	−.07	.25	.27*	−.36**	.31*
Mean activation	−.27*	.32*	.00	.23	.27*	−.19	.25
Valence variability	.23	−.04	−.07	−.29*	−.15	.36**	−.19
Activation variability	.19	−.16	−.16	−.36**	−.22	.30*	−.12
Pulse	.11	−.04	.05	−.16	.00	.02	−.01
Spin	.36**	−.37**	.05	−.21	−.28*	.41**	−.39**

Note. N = Neuroticism; E = Extraversion; O = Openness; A = Agreeableness; C = Conscientiousness; Pess = Pessimism; Opt = Optimism.
* $p < .05$. ** $p < .01$.

were considered together, spin was the strongest and the only significant predictor of neuroticism, extraversion, pessimism, and optimism.

Discussion

The results demonstrated that characteristics of an individual's core affect trajectory are meaningful descriptors of an individual's average feeling state and fluctuations of feeling states across time. In line with previous research, we found that the individual's average affective experience was pleasant and activated (e.g., Cacioppo & Gardner, 1999; Diener & Diener, 1996; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004), and that average valence and activation were unrelated (e.g., Feldman Barrett & Russell, 1999). Second, the less pleasant people felt on average, the more variable their core affect was, particularly in terms of experiencing qualitatively different feelings (corresponding to different sectors in the core affect space). Furthermore, personality characteristics that reflect poor psychological adjustment or negative emotionality (e.g., neuroticism, low agreeableness, holding negative future expectations) were positively related to core affect variability, and personality characteristics that reflect adjustment or positive emotionality (e.g., extraversion, agreeableness, holding positive future expectations) were negatively related to core affect variability. Moreover, the results suggest that these relationships are best captured by considering affective variability in terms of spin (quality variability), a type of within-person measure of affective variability that is unique to a core affect trajectory approach.

Study 2

The goals of the second study were similar to those of Study 1, to examine the characteristics of core affect variability and to examine their relationships to personality and psychological adjustment. Moreover, whereas Study 1 examined the added value of pulse and spin beyond valence and activation variability, the data from Study 2 allowed us to examine their added value beyond variability in terms of both frameworks used to characterize affective space, valence/activation, and PA/NA. Study 2 used a different method and time frame to assess core affect across time. In this study, participants' core affect positions were not assessed by means of the Affect Grid but were determined from their responses to a list of adjectives that corresponded to different positions in core affect space. Also, a different time frame was used: Participants provided one report each day about how they felt during that day. Finally, in addition to the FFM personality dimensions, measures of depression and self-esteem were included as indicators of psychological adjustment.

Method

Participants

Participants were 131 undergraduate students from the College of William and Mary who participated in the study in fulfillment of class requirements. After deleting participants with invalid data, the sample consisted of 127 participants (79 women, 48 men).

Table 3
Results From Regression Analyses Predicting Personality Traits by Means of Core Affect Variability Measures (Study 1)

Measure	N	E	O	A	C	Pess	Opt
R	.36	.43*	.23	.37	.33	.49**	.41*
Standardized β							
Valence variability	0.05	0.33	−0.05	−0.06	0.04	0.27	−0.06
Activation variability	0.02	−0.17	−0.22	−0.30	−0.17	0.07	0.06
Pulse	−0.01	−0.01	0.12	−0.01	0.12	−0.23	0.11
Spin	0.33*	−0.46**	0.14	−0.05	−0.26	0.30*	−0.42**

Note. $N = 58$. N = Neuroticism; E = Extraversion; O = Openness; A = Agreeableness; C = Conscientiousness; Pess = Pessimism; Opt = Optimism.
* $p < .05$. ** $p < .01$.

Materials

Repeated assessment of core affect. Daily affect was measured in terms of the four quadrants of the core affect space. Positive active affect (pa) was measured in terms of how enthusiastic, happy, alert, proud, and excited participants felt during the day; positive deactive affect (pd) was measured in terms of how calm, peaceful, satisfied, relaxed, and content they felt; negative active affect (na) was measured in terms of how nervous, embarrassed, upset, stress, and tense they felt; and negative deactive affect (nd) was measured in terms of how sluggish, sad, bored, depressed, and disappointed they felt. Respondents were asked, "Indicate in the space next to each word just how strongly you felt that way today. Use the following scale," referring to a scale ranging from 1 (*did not feel this way at all*) to 7 (felt this way strongly). These daily measures started with the stem, "Today, I felt . . . ."

Assessment of FFM personality dimensions, depression, and self-esteem. Participants completed the Big Five Inventory (BFI-44; John, Donahue, & Kentle, 1991), a measure of the FFM of personality, the Center for Epidemiological Studies—Depression scale (CES–D; Radloff, 1977), and the Rosenberg Self-Esteem Scale (RSE; Rosenberg, 1965). Each of these is a widely known and used measure of its respective construct. For the CES–D, participants responded using the standard 0-to-4 scale, and for the BFI-44 and RSE, they used a 1-to-5 scale. Note that the CES–D is presented as a total score across the 20 items on the scale, whereas scores for the RSE and the scales of the BFI-44 are presented as average scores across the items on each scale.

Procedure

The participants were introduced to the study in groups of 15–25. They were told that the study concerned their daily lives and how they felt each day and that they would need to provide data each day for 2 weeks. They were told to respond just before going to bed. If they missed a day, they were told not to try to recreate it but to add a day at the end of the study. Data were collected from the Internet, and participants were told how to access the Web site to provide their responses. They were also told that the date and time of all their responses would be recorded, something that, we believe, motivated them to comply with instructions more closely. Inspection of the date and time stamps of participants' data led to the deletion of all the data for 4 participants, leaving 127 participants who provided 1,645 days of data ($M = 13.0$, $SD = 2.84$).

Calculation of Core Affect Trajectory Characteristics

Each of the sets of the daily pa, pd, na, and nd items were averaged to produce a daily pa, pd, na, and nd score for each participant. From these scores, a valence and activation score was calculated for each assessment occasion. Valence was calculated as (pa + pd) − (na + nd), and activation was calculated as (pa + na) − (pd + nd). Additionally, scores reflecting positions on the dimensions of PA and NA were calculated as (pa − nd) and (na − pd), respectively. Note that, because of this subtraction method, all scores have a natural neutral midpoint of 0. On the basis of these scores, we followed the procedures used in Study 1 to calculate the scores for each participant's mean valence, mean activation, valence variability, activation variability, mean PA and NA, PA and NA variability, pulse (intensity variability), and spin (quality variability). It is important to note that pulse and spin are identical when calculated on the basis of valence and activation scores or on PA and NA scores.

Results

Descriptive Statistics

Summary statistics for the measures describing the core affect characteristics are presented in Table 4. Similar to Study 1, participants' average core affect was pleasant and slightly positively activated, both being significantly greater than 0, $t(126) = 11.61$, and $t(126) = 3.03$, $ps < .01$. In terms of PA and NA, participants felt, on average, above midpoint positive affect, $t = 12.44$, $p < .001$; and below midpoint negative affect, $t(126) = -9.35$, $p < .001$. Given the low number of within-person observations, the data from this study were not suited to compute reliability estimates for the measures.

Relationships Between Core Affect Trajectory Characteristics

The correlations between the core affect trajectory characteristics are presented in Table 4. The results are similar to those

Table 4
Means, Standard Deviations, and Correlations Between Core Affect Trajectory Characteristics (Study 2)

Characteristic	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Mean valence	2.55	2.47	—									
2. Mean activation	0.26	0.96	−.12	—								
3. Valence variability	2.81	1.08	−.17	.20*	—							
4. Activation variability	1.24	0.45	−.17	.06	.39***	—						
5. Mean PA	1.40	1.27	.93***	.26**	−.08	−.14	—					
6. Mean NA	−1.14	1.38	−.94***	.46***	.22*	.17	−.74***	—				
7. PA variability	1.47	0.57	−.20*	.11	.90***	.43***	−.15	.22*	—			
8. NA variability	1.60	0.60	−.14	.24**	.90***	.53***	−.04	.20*	.67***	—		
9. Pulse	1.86	0.56	.16	.09	.69***	.14	.19*	−.11	.62***	.58***	—	
10. Spin	0.97	0.48	−.71***	.01	.47***	.26**	−.69***	.64***	.44***	.43***	.10	—

Note. $N = 127$. PA = positive affect; NA = negative affect.
* $p < .05$. ** $p < .01$. *** $p < .001$.

obtained in Study 1. Mean valence and mean activation were relatively independent, where there was a negative correlation between mean PA and NA scores. Most of the variability measures were positively correlated. Also, mean valence and spin were negatively related. In terms of the PA/NA framework, this was echoed by a positive correlation between spin and mean NA and a negative correlation between spin and mean PA. One difference with Study 1 was that pulse was related to valence variability but not to activation variability or spin. PA and NA variabilities were strongly correlated with each other, and they were strongly correlated with pulse and spin. We do not discuss relationships between measures based on valence/activation and those based on PA/NA because the two sets of measures were calculated using the same raw data combined in different ways.

Relationships Between Core Affect Trajectory Characteristics and Personality Traits

The correlations between the core affect trajectory characteristics and personality traits are reported in Table 5. These relationships will be discussed in terms of the relationships between the FFM and core affect trajectory characteristics that were similar to those found in Study 1, those that were dissimilar to those found in Study 1, and relationships with measures that were not included in Study 1.

Overall, relationships between the FFM and core affect trajectory characteristics were similar to those found in Study 1 and were consistent with our general hypothesis that affective variability would be negatively related to psychological adjustment. Valence variability was positively correlated with neuroticism, and activation variability was negatively correlated with agreeableness and conscientiousness. Spin was positively correlated with neuroticism and was negatively correlated with agreeableness and conscientiousness.

Unlike in Study 1, in Study 2 there were significant positive correlations for extraversion with valence variability and pulse, whereas these correlations were not significant (nor near significant) in Study 1. Also, in Study 1, there was a significant negative correlation between extraversion and spin, whereas this relationship was not significant in Study 2.

Relationships between affective variability and the variables that were new to Study 2 were consistent with our hypothesis. Valence variability was positively correlated with depression scores, and activation variability was negatively correlated with self-esteem. In terms of PA and NA variability, PA variability was positively related to neuroticism and depression and negatively related to agreeableness. Also, NA variability was positively related to depression. Regardless, similar to the general results of Study 1, spin—a type of variability unique to a trajectory approach—was the type of variability that was most strongly related to the indicators of psychological adjustment added to Study 2. Spin was positively correlated with depression and was negatively correlated with self-esteem.

Finally, separate regression analyses were performed in which the personality variables were predicted on the basis of four types of affective variability. When including valence and activation variability, pulse, and spin (see Table 6), spin was a significant predictor of neuroticism, extraversion, agreeableness, conscientiousness, depression, and self-esteem. In addition, valence variability and pulse were significant predictors of neuroticism, valence variability of extraversion, and activation variability of conscientiousness. When including PA and NA variability, pulse, and spin (see Table 7), pulse and spin showed a similar profile as in the previous series of analyses, and PA and NA variability additionally emerged as significant predictors of neuroticism, and extraversion, respectively.

Discussion

In Study 2, we considered classic single-dimension variability measures both in terms of valence and activation and in terms of PA and NA next to pulse and spin. In general, the results of Study 2 were very similar to the results of Study 1. On average, an individual's core affect was pleasant and active, or moderately high in PA and low in NA. Also, as in Study 1, average pleasant core affect was negatively related to spin, which translated into a negative association between average PA and spin, and a positive association between average NA and spin. The different measures of core affect variability tended to be positively correlated, and this held equally when considering variability in terms of PA and NA.

Table 5
Correlations Between Core Affect Trajectory Characteristics and Personality Traits (Study 2)

Characteristic	N	E	O	A	C	CES–D	RSE
Mean valence	−.49***	.27**	−.10	.29**	.23**	−.58***	.58***
Mean activation	.23**	.33***	−.00	.03	.31***	.03	.00
Valence variability	.19*	.25**	.15	−.15	.04	.22*	−.11
Activation variability	.08	.08	−.02	−.18*	−.22*	.15	−.18*
Mean PA	−.39***	.15	−.10	.29**	.34***	−.55***	.57***
Mean NA	.52***	−.09	.09	−.25**	−.10	.53***	−.52***
PA variability	.20*	.13	.17	−.20*	−.02	.23**	−.12
NA variability	.15	.07	.09	−.10	.01	.20*	−.13
Pulse	−.13	.21*	.02	−.01	.13	−.17	.13
Spin	.37***	−.08	.12	−.32***	−.21*	.49***	−.37**

Note. $N = 127$. N = Neuroticism; E = Extraversion; O = Openness; A = Agreeableness; C = Conscientiousness; CES–D = CES–Depression scale; RSE = Rosenberg Self-Esteem Scale; PA = positive affect; NA = negative affect.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6
Results From Regression Analyses Predicting Personality Traits by Means of Valence and Activation Variability, Pulse, and Spin (Study 2)

Measure	N	E	O	A	C	CES–D	RSE
R	.47***	.34**	.22	.34**	.35**	.51***	.42***
Standardized β							
Valence variability	.39**	.41**	.31	.04	.24	.16	−.07
Activation variability	−.09	−.00	−.12	−.11	−.25*	.00	−.10
Pulse	−.41**	−.05	−.18	.01	.03	−.21	.23
Spin	.25*	−.26*	.03	−.31**	−.26*	.44***	−.33**

Note. $N = 127$. N = Neuroticism; E = Extraversion; O = Openness; A = Agreeableness; C = Conscientiousness; CES–D = CES—Depression Scale; RSE = Rosenberg Self-Esteem Scale.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The directions of the associations between variability and personality also showed very similar patterns. In general, negative emotionality and low psychological adjustment, in terms of neuroticism and depression, were positively related to variability, whereas positive emotionality and psychological well-being, in terms of agreeableness and self-esteem, were negatively related to variability. Results from the regression analyses demonstrated that spin was more reliably and more strongly related to these trait level measures than the other measures of within-person variability. This conclusion holds when pitting spin against single-dimension measures of variability (standard deviations) in terms of both valence/activation and PA/NA.

There were, however, a few differences between the two studies. Of particular interest, there were several results that pointed to positive associations between variability measures and indicators of adjustment in Study 2. Extraversion was positively correlated with valence variability and with pulse; valence and NA variability were predictors of extraversion; and pulse was a negative predictor of neuroticism. However, these findings are for the most part inconsistent across the correlational and regression analyses (suggesting that suppression and mediation effects come into play), which makes it difficult to draw firm conclusions. In general, the findings from Study 2 should also be interpreted in light of the limitation that they are based on a relatively small number of observations per participant.

General Discussion

We proposed a framework in which the fluctuations of an individual's feeling states across time can be conceptualized in terms of movement within a two-dimensional affective space, called core affect trajectory. We analyzed several basic characteristics of affect variability on the basis of fluctuations in the core affect space. In general, we found that these characteristics provided meaningful measures of how people's feelings change across time. Moreover, we examined core affect trajectories using multiple daily assessments (Study 1) and once-daily assessments (Study 2), and the results of the two studies were quite similar, suggesting that short-term hour-to-hour variability and longer term day-to-day variability may be governed by similar principles and individual differences.

Core Affect Variability

Individuals differed in how much and in what way they fluctuated about the core affect space. We examined several types of variability: variability in valence, in activation, in PA and NA (Study 2), in intensity (pulse), and in quality (spin). In general, we found positive relationships between the different types of core affect variability. Nevertheless, the fact that correlations between the different variability measures and the personality variables varied, combined with the results from the regression analyses, suggests that the measures possess discriminant validity.

In general, the results supported the hypothesis that individuals whose core affect fluctuates more are more poorly adjusted. Compared with their less variable counterparts, they are more neurotic, more depressed, have lower self-esteem, and hold more negative expectations for the future. Moreover, these relationships were most convincingly and consistently found for spin, which reflects fluctuations among qualitatively different affective states and

Table 7
Results From Regression Analyses Predicting Personality Traits by Means of PA and NA Variability, Pulse, and Spin (Study 2)

Measure	N	E	O	A	C	CES–D	RSE
R	.46***	.37**	.20	.35**	.26	.52***	.42**
Standardized β							
PA variability	.26*	−.04	.23	−.19	−.04	.15	−.09
NA variability	.08	.41**	−.01	−.10	.04	.04	.09
Pulse	−.37***	.02	−.13	.07	.15	−.21	.27*
Spin	.26**	−.23*	.03	−.29**	−.22*	.43***	−.32***

Note. $N = 127$. N = Neuroticism; E = Extraversion; O = Openness; A = Agreeableness; C = Conscientiousness; CES–D = CES—Depression scale; RSE = Rosenberg Self-Esteem Scale.
* $p < .05$. ** $p < .01$. *** $p < .001$.

which is unique to the core affect trajectory framework we have proposed.[2] Moreover, this type of variability was uniquely predictive of depression and self-esteem, two central parameters of psychological well-being and adjustment. This indicates that, when studying affective variability, particularly in terms of its relationship with adjustment and well-being, researchers will best understand affective variability in terms of variability between qualitatively different feelings (spin) instead of in terms of the more classic (standard deviation) formulations of variability.

Several arguments can be made for why this type of variability seems to be central to psychological well-being. It is reasonable to assume that having a stable affective trajectory may add to a sense of security and control, leading to more optimal levels of adjustment. If, on the other hand, one's emotional life is characterized by swinging between different kinds of emotions and experiences, which is what is grasped by spin, one's life becomes less predictable and coherent, which may result in expecting less positive outcomes in the future, greater depression, low self-esteem, and so forth.

Alternatively, poor adjustment may also lead to affective variability. For instance, it is plausible that a weak sense of self may make an individual more vulnerable to external influences (e.g., Rogers, 1961), resulting in higher levels of affect variability characterized by qualitatively different feelings. In contrast, a strong self may make an individual more stable and more impervious to mood-altering events. Although it could be argued that a certain level of affective variability or "flexibility" may be adaptive—reflecting responsivity instead of pathological rigidity in reaction to what happens in the environment—our results suggest that to the extent that variability is not adaptive, such relationships are best understood in terms of spin rather than other types of variability.

Finally, an essential feature of spin is that it can be considered as a generic variability measure, being independent from a particular affective dimension or axes of reference that define the affective space. The latter was demonstrated in Study 2, in which spin proved to be superior to variability defined in terms of either a valence/activation or PA/NA conceptualization of affective space. Our finding that spin best captured affective variability in relationship to these external variables, combined with its atheoretical nature, points to the advantage of this conceptualization of affective variability over standard (single-dimension) conceptualizations. Given our results, this generic type of affective variability may thus well be the central aspect of affective variability that relates to personality and well-being.

Apart from spin, valence variability was found to be positively related to neuroticism in both studies and was positively related to pessimism and depression. In turn, activation variability was negatively related to agreeableness and self-esteem and was positively related to holding pessimism. These results may suggest that neurotic and depressed individuals may be more valence focused (Feldman, 1995; Feldman Barrett & Niedenthal, 2004), meaning that they attend to and react more to valence-related information in their environment than their less neurotic and depressed counterparts, resulting in higher levels of valence variability. In contrast, individuals with low agreeableness and low self-esteem may be more arousal focused (Feldman, 1995; Feldman Barrett, Quigley, Bliss-Moreau, & Aronson, 2004), meaning that they attend more to arousal facets of emotional experience and emphasize feelings of activation or deactivation in their emotional reports, resulting in higher levels of activation variability.

Variability in core affect intensity or pulse was not or inconsistently related to the FFM personality variables. A significant but weak relationship was found with extraversion in Study 2 but not in Study 1. It is interesting that research on pulse in the domain of interpersonal behavior (reflecting variability in extremity of behavior; Moskowitz & Zuroff, 2004, 2005) also showed no consistent relations with these personality dimensions (discussed later).

Finally, the finding of positive relationships between the various variability measures may suggest the existence of a general variability disposition that is expressed in different types of variability. This would mean that, when individuals are variable in one particular way (e.g., fluctuating between more and less pleasant feelings), they will tend to be more variable in other ways as well (e.g., fluctuating between more and less activated states or between qualitatively after totally different feelings. What is particularly important about these positive correlations is that they suggest that affective variability involves variability throughout the entire core affect space, not just variability in one region. For example, if we had found low correlations between spin and valence and activation variability, this would have suggested that some people move around the origin in small shifts (reflected in low valence and activation variability but high spin). We did not find such low correlations, however, and affective variability seems to be a stable, pervasive disposition that characterizes individuals in terms of how variable or stable their affective changes are across time (e.g., Eid & Diener, 1999) and that includes fluctuations across the entire core affect space.

Relation Between Core Affect and Interpersonal Circumplex

Finally, an intriguing aspect of the present research is that the present results regarding the relationships with the FFM personality dimensions are strikingly similar to the results reported by Moskowitz and Zuroff (2004, 2005) regarding the interpersonal behavioral dimensions of agreeableness–quarrelsomeness and dominance–submissiveness (instead of the core affect dimensions of valence and activation).[3] This points to the interesting possibility that there may be

[2] When interpreting these findings, it is important to underscore that the high correlation found between spin and mean valence is not a mathematical artifact. Given that spin reflects variability in angular positions, which is independent of any axis of reference on the basis of which the angular positions are defined, there is no mathematical relation with mean valence. Moreover, on the basis of how spin is calculated, any artifactual dependency between spin and mean valence should hold equally for the relation between spin and mean activation, but such a relation is not supported by the data (rs = −.27 in Study 1 and .01 in Study 2).

[3] In studies by Moskowitz and Zuroff (2004, 2005), mean agreeableness, compared with mean valence, was negatively related to neuroticism and positively related to extraversion and agreeableness; flux quarrelsome behavior, compared with valence variability, was negatively related to agreeableness; mean dominance or low mean submissiveness, compared with mean activation, was negatively related to neuroticism and positively to extraversion; flux submissiveness, compared with activation variability, was positively related to neuroticism and agreeableness; pulse showed no relation with personality; finally, spin was positively related to neuroticism and negatively to extraversion and agreeableness.

a functional relationship or correspondence between the two circumplexes, meaning that how agreeable (vs. quarrelsome) and dominant (vs. submissive) one behaves toward others is related to how pleasant and activated one is feeling at that moment.

Such a relationship could help account for findings that, for instance, link a positive mood to increased probability of helping behavior (e.g., Isen & Levin, 1972), and conversely, research that identifies a negative mood as a sufficient condition to become angry or aggressive (e.g., Berkowitz & Harmon-Jones, 2004). In turn, how dominant (vs. submissive) one behaves toward others could be related to how activated one feels at the moment. As the similarity between our data and the data from Moskowitz and Zuroff (2004, 2005) only indirectly suggests the possible existence of such a functional relation between the two circumplexes, it would be interesting to further examine this hypothesis in future research.

Future Research

An important topic for future research lies in the study of how core affect trajectories are shaped by event-contingent, situational events. In the present study, only personality correlates of core affect trajectory characteristics were examined, but an equally challenging task lies in the identification of the types of events that drive core affect fluctuations in terms of valence, activation, intensity, and quality. Appraisals, or how events are interpreted in relation to one's own values, goals, and well-being, may play a prominent role in pursuit of such a task, as they are generally considered to be the proximal elicitors of emotional states (Scherer, Schorr, & Johnstone, 2001). Moreover, a combination of both lines of research—the study of the dispositional and of the event-contingent sources of variability in core affect trajectories—may provide insight into the degree to which core affect variability reflects dispositional lability, or reactivity to external events.

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