Flux, Pulse, and Spin: Dynamic Additions to the Personality Lexicon

D. S. Moskowitz and David C. Zuroff
McGill University

Personality constructs were proposed to describe intraindividual variability in interpersonal behavior. *Flux* refers to variability about an individual's mean score on an interpersonal dimension and was examined for the 4 poles of the interpersonal circumplex. *Pulse* and *spin* refer to variability about an individual's mean extremity and mean angular coordinate on the interpersonal circumplex. These constructs were measured using event-contingent recording. Latent state–trait analyses indicated high stability of flux in submissive, agreeable, and quarrelsome behaviors and some stability in the flux of dominance. Further analyses indicated moderate to high stability in pulse and spin. Neuroticism predicted greater pulse, spin, and submissive behavior flux. Extraversion predicted greater flux in agreeable behavior. In contrast, Agreeableness predicted reduced spin and quarrelsome behavior flux. Social environmental variables predicted greater flux in dominant behavior. Flux, pulse, and spin provide reliable and distinctive additions to the vocabulary for describing individual differences.

The language of personality description leans heavily on everyday language for encoding how people are similar to and different from one another. The reliance on everyday language accounts for the success of the lexical approach in providing robust broad factors for describing individuals (Goldberg, 1993). A limitation in developing a systematic language of description based on ordinary language is that dimensions to which humans are not sensitive do not become encoded in the language. Simplification is a key characteristic of human social cognition. For example, people may generate vocabulary that allows them to schematically represent consistent characteristics of persons. Inconsistencies may be ignored to simplify cognitive representations. Yet variability in behavior exists; manifest behavior is not always consistent with traits. The goal of the present study was to conceptualize several types of variability in interpersonal behavior that represent stable and distinctive features of individuals.

An individual generates a stream of behavior occurring within interpersonal events that occur across time. Most commonly, the stream of behavior is characterized by a mean level, such as when behaviors are aggregated across events (e.g., Epstein, 1979, 1980; Moskowitz, 1988; Moskowitz & Schwarz, 1982). It is also possible to characterize the stream of behavior in terms of regular cycles, such as the weekly cycles that occur in interpersonal behavior (Brown & Moskowitz, 1998). It may also be illuminating to characterize the stream of behavior in terms of its variability, the extent of fluctuations that occur within individuals across events.

The present research focuses on the extent of temporal stability in intraindividual variability in interpersonal behaviors and the predictors of these intraindividual variability variables. We introduce three new kinds of constructs: *flux,* variability about an individual's mean score on an interpersonal behavior sampled from the interpersonal circumplex, such as dominance, submissiveness, agreeableness, and quarrelsomeness; *pulse,* variability about an individual's mean extremity of behavior scores on the interpersonal circumplex; and *spin,* variability about an individual's mean angular coordinate on the interpersonal circumplex. We investigate the reliability and the predictors of flux, pulse, and spin. The study considers whether flux, pulse, and spin have potential as new kinds of personality constructs for representing behavioral differences among individuals and, thereby, deserve entry into the personality lexicon.

Fluctuation as an Individual Difference Variable

Theoreticians concerned with traits, affect, self-concept, social cognitions, and behavior (e.g., Eid & Diener, 1999; Kernis, Granneman & Barclay, 1989; Roberts & Nesselroade, 1986) have suggested that the extent of fluctuations within the individual on various dimensions constitute meaningful variables to characterize individuals. Several approaches have been used to examine the reliability of these variability scores.

D. S. Moskowitz and David C. Zuroff, Department of Psychology, McGill University, Montreal, Quebec, Canada.

The contributions of the authors to this study were equal. Some of the results reported in this article were previously presented at the annual meeting of the Society for Multivariate Experimental Psychology in Charlottesville, Virginia (October 2002). This research was supported by grants from the Social Sciences and Humanities Research Council of Canada and Fonds Pour la Formation de Chercheurs et l'Aide à la Recherche du Québec. We extend our appreciation to Eun Jung Suh and Ximena Bernardin for their assistance with the data collection and to Stéphane Côté and Marc Fournier for their comments.

Correspondence concerning this article should be addressed to D. S. Moskowitz or David C. Zuroff, Department of Psychology, McGill University, 1205 Dr. Penfield Avenue, Montreal, Quebec, H3A 1B1 Canada. E-mail: dsm@ego.psych.mcgill.ca or zuroff@ego.psych.mcgill.ca

Journal of Personality and Social Psychology, 2004, Vol. 86, No. 6, 880–893

0022-3514/04/$12.00 DOI: 10.1037/0022-3514.86.6.880

Following the lead of Cattell (1963), Nesselroade and colleagues have studied the invariance of factor structures across time. For example, Roberts and Nesselroade (1986) demonstrated that the factor structure of items representing perceptions of internal locus of control in parents of young children remained stable over twice-daily recording during a 2-week period. Bath, Daly, and Nesselroade (1976) demonstrated the replicability across a 60-day time period of factor structures representing affect in schizophrenic patients.

Studies have also examined the reliability of temporal intraindividual variability by using a standard deviation to represent intraindividual variability and then correlating two sets of intraindividual variability scores. Sometimes the two sets of scores are collected concurrently, as in studies of internal locus of control in the elderly (Eizenman, Nesselroade, Featherman, & Rowe, 1997) and of behaviors reflecting the five-factor traits (Fleeson, 2001). Reliability of temporal variability has also been assessed using sets of scores collected during consecutive periods of time, as in Larson's (1983) study of affect variability among adolescents. The stability of temporal intraindividual variability collected during consecutive periods is typically lower than the stability of intraindividual variability assessed with concurrent sets of scores (e.g., Penner, Shiffman, Paty, & Fritzche, 1994).

A different approach was taken by Shoda, Mischel, and Wright (1994), who examined the patterning of behaviors in response to situations. They randomly divided in half a set of observations collected during a 6-week period in a sample of children and young adolescents with behavior problems. They found that the patterns of aggressive and compliant behaviors in response to situations such as being teased by another child and being warned or punished by adults that were identified using one set of scores were correlated with a similarly constructed pattern of responses to situations using the second set of scores. Thus, using observed scores collected at different times during a concurrent period, there was evidence that situationally linked variability in aggression and compliance was a reliable feature of the individual.

Although each of the previous studies provided some information about the reliability of variability scores, there are also limitations to the information provided about the stability of temporal intraindividual variability. Factor analysis of the items over time provides information about the structure of the constructs but does not directly address the stability of intraindividual variability scores for individuals. The use of correlations to assess reliability over occasions within a time period does not provide information about stability across periods of time. The use of correlations to compare intraindividual variability across time periods does not permit the analysis of the extent to which correlations are attenuated by actual temporal instability or by measurement error.

Eid and Diener (1999) noted that a precise estimate of the stability of temporal intraindividual variability requires the separation of the extent of fluctuations from measurement error. They conducted a confirmatory factor analysis (CFA) of latent trait and latent state variables to examine whether parameters (factor loadings) representing the influence of traits of intraindividual variability on observed variability in different weeks were greater than parameters representing week-specific influences on intraindividual variability. They focused their analysis on specific positive and negative affects and found that temporal intraindividual variability was very stable in love, happiness, and sadness. There was also some stability in the intraindividual variability of anger, fear, and shame, but less than that for the positive affects or for sadness.

In contrast to previous research, which has not examined the intraindividual variability of normal adult interpersonal behavior, the present research examined intraindividual variability in interpersonal behaviors sampled from the domain of social behavior using the interpersonal circumplex model. According to this model, interpersonal behavior can be organized around a circle characterized by the two orthogonal dimensions of agency and communion (Kiesler, 1983; Wiggins, 1979, 1991). Communal behaviors can be conceptualized as behaviors that promote interpersonal ties; agentic behaviors can be conceptualized as behaviors that assert status relative to other individuals. Communion is represented by a bipolar axis ranging from agreeable behavior to quarrelsome behavior. Agency is represented by a bipolar axis ranging from assertive–dominant behavior to passive–submissive behavior (Wiggins, 1991).

Three types of intrapersonal variability were examined: flux, pulse, and spin. Flux refers to variability about an individual's mean score on an interpersonal dimension. A standard deviation about the mean was used to operationalize flux. Four flux variables were calculated corresponding to the four poles of the interpersonal circumplex: dominance, submissiveness, quarrelsomeness, and agreeableness.

Information from all four poles of the interpersonal circumplex was combined to create pulse and spin scores. The dimensions of agency and communion can be thought of as a Cartesian (x, y) coordinate system defining the space of interpersonal behavior. Polar coordinates of extremity and angular displacement (r, θ) have also been used by circumplex researchers to define the space of interpersonal behavior. Figure 1 illustrates the relation between the two systems. Social behavior during an interaction is shown as a vector from the origin to the point in interpersonal space (x, y) corresponding to the observed levels of agency and communion. Alternatively, the vector can be characterized in terms of its degree of rotation (angular displacement, θ) from the horizontal axis and its length (r). The θ coordinate indicates the interpersonal style

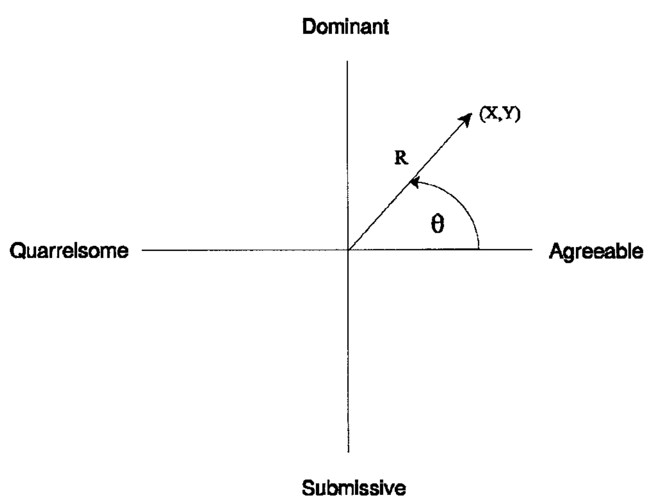

Figure 1. Representation of behavioral extremity (vector length, r) and interpersonal style (angular rotation, θ).

during an interaction. The *r* coordinate, vector length, indicates the overall extremity of behavior. The vector in Figure 1 represents interpersonal behavior of moderate extremity whose overall style falls in the dominant–agreeable quadrant.

Spin was defined as the variability (standard deviation) of the angular coordinate about the individual's mean value for θ (θ_m). Pulse was defined as the variability (standard deviation) of the extremity coordinate about the individual's mean value of r (r_m). Figure 2 uses vectors from three social interactions to illustrate, in a simplified manner, patterns of behavior corresponding to low spin and low pulse (upper left panel), low spin and high pulse (upper right panel), high spin and low pulse (lower left panel), and high spin and high pulse (lower right panel). Variability in vector length (short, medium, and long) implies high pulse, whereas variability in angular displacement (behaviors falling in different quadrants of the circumplex) implies high spin.

Predicting Intraindividual Variability

Trait Influences

Five-factor traits are related to mean levels of interpersonal circumplex traits and behaviors. Extraversion and Agreeableness are the two traits from the five-factor model that identify the interpersonal plane of personality, but Neuroticism also has interpersonal correlates (Gilbert & Allan, 1994; McCrae & Costa, 1989; Trapnell & Wiggins, 1990). Côté and Moskowitz (1998) examined the relations of these traits with interpersonal behaviors during social interactions. The trait of Extraversion was related to agreeable behaviors. Five-factor Agreeableness was correlated, in a negative direction, with quarrelsome behaviors. Neuroticism was associated with submissive behavior and negatively related to agreeable behavior. Given these findings relating traits to mean levels of behavior, it was necessary to examine the relation of personality traits with flux, pulse, and spin in interpersonal behavior, controlling for the relations between these traits and mean level on the social behavior. This would indicate that trait variables not only predict mean levels in interpersonal behavior but also predict variability in social behavior.

It was also expected that examination of the correlations with Neuroticism and with Extraversion would clarify the adaptive significance of variability. In the present study, scores on Neuroticism were used as an indicator of the possibility of problems with poor adjustment, such as vulnerability to psychopathology (Costa & Widiger, 1994) and vulnerability to stress (Bolger & Schilling,

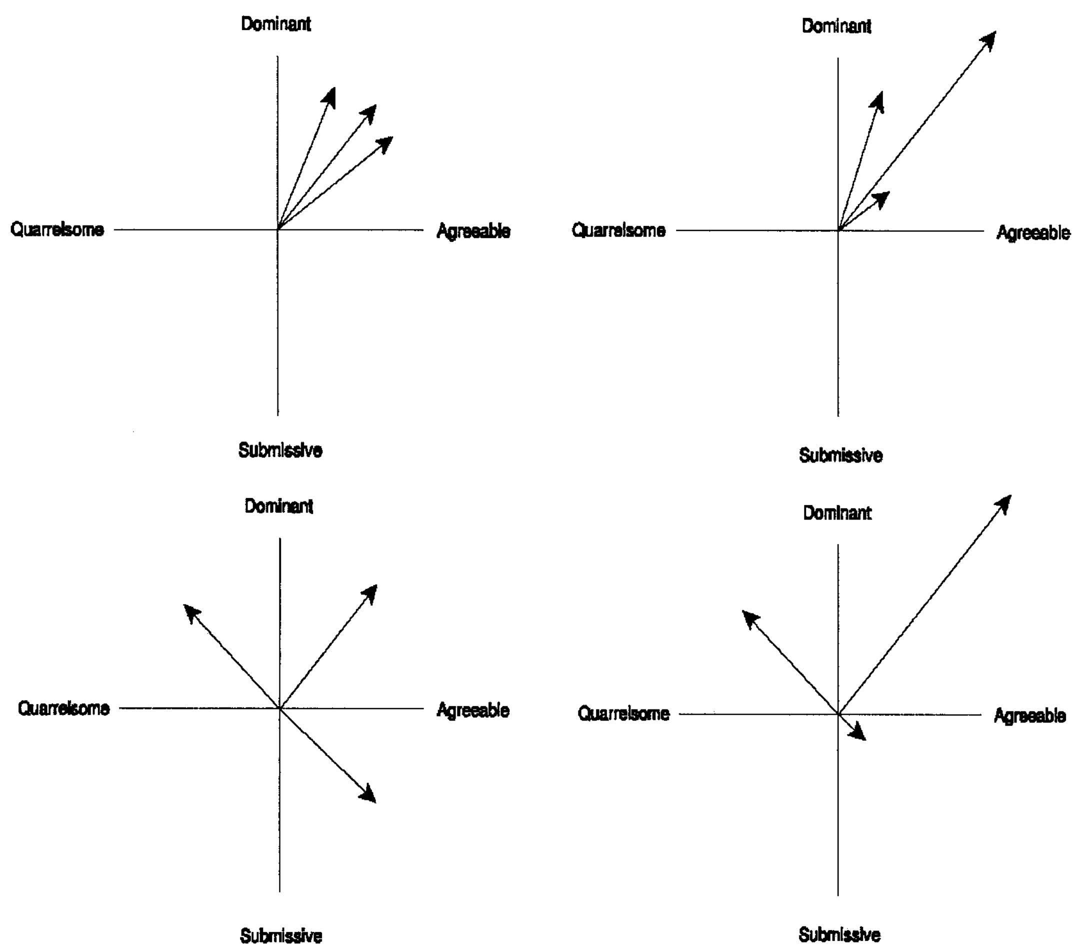

Figure 2. Representations of combinations of pulse and spin using vectors from three events: low spin and low pulse (upper left panel), low spin and high pulse (upper right panel), high spin and low pulse (lower left panel), and high spin and high pulse (lower right panel).

1991). Neuroticism was examined as a predictor of flux, pulse, and spin. A positive relation between Neuroticism and pulse, spin, or one of the flux variables would be considered an indication that high levels of flux, pulse, or spin reflect behavioral lability, variability in interpersonal behavior that is not well-controlled.

Alternatively, it could be argued that variability is an indicator of behavioral flexibility and may indicate the capacity of the person to respond effectively to variation in environmental and interpersonal events. Some variability in behavior is likely to be adaptive as individuals react to changing current circumstances, such as the behavior of others, and consequently, behavioral flexibility may be related to subjective well-being and positive affect. Extraversion has been associated with positive affect and socially skilled behavior (McCrae & Costa, 1999; Watson & Clark, 1997). Positive relations of Extraversion with flux, pulse, or spin might indicate the ability to adapt behavior to the other to maintain or enhance interactions.

Environmental Influences

Intrapersonal variability may be related to characteristics of the environment in addition to personality traits. Although environmental characteristics may be another class of person variables because of the influence of the individual on the kind of environment chosen and created (Buss, 1987; Wachtel, 1973), it is possible to define environmental characteristics separately from personality traits, and characteristics of the environment may provide additional information relevant to intraindividual variability beyond that which can be accounted for by personality traits. Hence, several characteristics reflecting fluctuations in the environment were identified for study.

The first environmental variable was the number of unique partners with whom the individual had interacted. Individuals who interact with more individuals may exhibit a greater variety of behaviors in response to variability in others' behaviors. Responsiveness to these others would lead to greater variability in their own behavior. Thus, individuals reporting more unique partners might exhibit greater behavioral variability.

The second environmental variable was variability in hierarchical role. Hierarchical role differences at work influence interpersonal behavior and responses to the behavior of others (Fournier, Moskowitz, & Zuroff, 2002; Moskowitz, Pinard, Zuroff, Annable, & Young, 2001; Moskowitz, Suh, & Desaulniers, 1994). Consequently, individuals who frequently move through the hierarchical status roles of supervisor, co-worker, and supervisee may evince greater intraindividual variability in behavior.

The third environmental variable reflected differences in personal relationships. Previous research (Suh, Moskowitz, Fournier, & Zuroff, 2004) indicated that the social roles of friend and romantic partner differ in closeness and in the kinds of behavior evoked. Hence, frequently moving among personal relationships varying in closeness might effect greater intrapersonal variability in behavior.

The fourth environmental variable was gender balance. There is evidence that many individuals have work lives in which they primarily interact with individuals of the same gender (Reskin, 1984). However, individuals may differ in the extent to which their lives are gender segregated or gender integrated. Gender segregation would indicate that the participant had interacted primarily with others who were of one gender; typically these individuals would be of the same gender as the participant. Gender integration would indicate that individuals had interacted approximately equally with others who were male and others who were female. Given differing responses to others as a function of their gender (Moskowitz et al., 1994), gender integration may produce greater intraindividual variability in interpersonal behavior than a gender-segregated environment.

Overview

In summary, the present study examined several types of fluctuations in normal adults' interpersonal behavior using behaviors broadly and systematically sampled from the interpersonal circumplex model. The fluctuation variables were constructed to assess fluctuations in mean levels (flux), fluctuations in overall extremity of behavior (pulse), and fluctuations in variability in position of the behavior around the interpersonal circumplex (spin). These variables were examined with respect to their stability, the extent to which they could be predicted by the three five-factor traits generally found to be related to interpersonal behavior, and the extent to which they could be predicted by environmental predictors.

Method

Sample

Participants were drawn from the community. Advertisements in newspapers recruited individuals holding paid employment to take part in a study of social interaction. The first 50 male callers and the first 50 female callers were invited to participate. To increase the number of participants with stable romantic relationships for the purposes of another study (Suh et al., 2004), we recruited an additional 24 romantically committed individuals through the same selection procedure. Of these 124 individuals, 119 individuals completed the study. Two individuals were omitted because they did not complete the revised NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992). The final sample was composed of 55 men and 62 women ranging in age from 20 to 69 years. The first language for 86 participants was English (74%); the first language for 29 participants was not English (25%), and 2 participants did not indicate their first language (2%). Forty-five participants (38%) lived alone; 59 participants (50%) lived with a spouse, life partner, or family; 10 participants (9%) lived with friends; and 3 participants (3%) were in some other living situation. Individuals held a variety of occupations (e.g., engineer, teacher, data analyst, secretary).

Previously reported results using this sample include studies of the relation of mean levels of behavior and affect to dispositional differences and the effects of threat and hierarchical work situations on behavior (Côté & Moskowitz, 1998; Fournier & Moskowitz, 2000; Fournier et al., 2002; Zuroff, Moskowitz, & Côté, 1999).

Procedure

Participants first attended a meeting during which procedures for the study were explained. They were informed of their responsibility to complete event-contingent recording forms to monitor their social interactions every day for 20 days. Participants were asked to complete a form for each significant interpersonal interaction as soon as possible after the occurrence of the interaction. An interaction was considered significant if it lasted at least 5 min. Participants were provided with 10 forms per day; they were asked to distribute the completion of forms evenly throughout the day. Participants completed an average of 125 forms, or slightly more than 6 forms each day.

Participants were also given beepers and told that they would be signaled three times per day during the week and twice per day on the weekend. Individuals did not complete forms when they were signaled. Rather, beepers were used to remind individuals of their responsibility to complete forms regularly; it was not expected that the completion of forms would match the signals. Participants were asked to record the times of the signals on a separate daily form. Records of signal times were kept so we could be assured that participants were keeping records for the study throughout the day. Records of signals were approximately 81% accurate. Participants mailed each day's forms on the day following their completion. After instructions for the event-contingent recording part of the study were given, participants completed several questionnaires. After the 20-day testing period, participants were given $100 compensation for their participation.

Measures

Trait measure. The NEO-FFI was administered to measure the traits of Neuroticism, Extraversion, and Agreeableness. The NEO-FFI consists of five scales of 12 items each to measure the five-factor model of personality. Reliability of the trait measures used in this study was calculated using Cronbach's coefficient alpha. Coefficient alphas were .84 for Neuroticism, .63 for Extraversion, and .78 for Agreeableness.

Event-contingent recording. Event-contingent recording forms requested information about the characteristics of the social environment and included measures of interpersonal behavior and affect.

Social environment. Individuals were asked to describe with whom they were interacting by indicating whether the other person was male or female, whether the person had a work relationship with the research participant, and whether the person had a personal relationship with the research participant. There were three work relationships, boss, coworker, supervisee, and three personal relationships, acquaintance, friend, or romantic partner.

Behavior. Forty-six behavior items were derived from a study by Moskowitz (1994). There were 12 items for each of the four dimensions of interpersonal behavior. One item was used for both the dominant and the quarrelsome behavior scales (i.e., "I criticized the other"), and one item was used for both the submissive and the agreeable behavior scales (i.e., "I went along with the other"). Examples of items measuring agreeable behavior were "I smiled and laughed with others" and "I expressed reassurance." Quarrelsome behavior was measured by items such as "I made a sarcastic comment" and "I confronted the others about something I did not like." Dominant behavior was measured by items such as "I asked the other to do something" and "I made a suggestion." Examples of items measuring submissive behavior were "I gave in" and "I avoided taking the lead or being responsible." Moskowitz (1994) described the development of the item pool and presented the complete list of items used for the behavior scales. Each item was reliably rated by expert judges and nonexpert judges as representing a particular dimension of behavior.

Validity evidence for the scales includes demonstrations that the items produce behavior scale scores that generally conform to the interpersonal circumplex model and that converge with a traditional self-report measure of interpersonal circumplex variables, and that changes in scale scores in response to different situations can be theoretically predicted (Moskowitz, 1994; Moskowitz & Côté, 1995; Moskowitz et al., 1994).

On each form, participants were asked to check the behavior items they had engaged in during the social interaction being recorded. Preliminary work had indicated that when participants were asked to complete the same form every day, they quickly adopted response sets. Therefore, four different versions of the form were used. Participants were given Form 1 on Day 1 to complete for all interactions on that day, Form 2 on Day 2, Form 3 on Day 3, and Form 4 on Day 4, and the rotation was repeated for the 20 days of the study. The items representing dominant, agreeable, submissive, and quarrelsome behaviors were divided equally among the four forms. On the basis of previous work (Moskowitz, 1994), the items were distributed onto the four forms to balance frequency of endorsement and item-total correlation with the behavior scale. Items from the four behavior scales were embedded in a list that included several extra items not used in the present research.

Construction of event-specific behavior scale scores. A score for each behavior scale was calculated for each participant for each episode. First, behavior scale scores were created for each event by calculating the mean number of items (between 0 and 3) that were checked which corresponded to that dimension of behavior. Then, these scores were ipsatized to correct for individual differences in rates of checking items. An ipsatized score was constructed by subtracting the mean score for all the behavior scales for that event from each behavior scale score. Ipsatizing was performed because previous work suggested that individual differences in response rates for checking items exist. Ipsatized behavior scores reflect the frequency with which behavior items were checked adjusted for a person's rate for endorsing items (cf. Horowitz, Rosenberg, Baer, Ureño, & Villaseñor, 1988). Validity evidence has been established based on the ipsatized scores.

An agency score for each event was calculated by subtracting the submissive score for the event from the dominance score for the event. A communion score for each event was similarly constructed by subtracting event-specific quarrelsome behavior from event-specific agreeable behavior. Given the way these variables were calculated, the agency and communion scores were not ipsatized (e.g., agency = [dominance − ipsatized mean] − [submissiveness − ipsatized mean] = dominance − submissiveness).[1]

Construction of mean-level behavior scale scores. To construct behavior scale scores aggregated across the 20 days of the study, we averaged ipsatized behavior scale scores across all events for each participant.

Construction of flux scores. To assess flux for each behavior dimension for each individual, we calculated a standard deviation across all events for each of the four behavior scales.

Construction of pulse and spin scores. Communion and agency for each interaction were treated as Cartesian coordinates (x, y) and then transformed to polar coordinates (r, θ). θ was expressed in radians; r was calculated as square root ($\text{agency}^2 + \text{communion}^2$). Means for θ and r were calculated over all 20 days, as well as within weeks. Pulse was the standard deviation of the values of r around the participant's mean (r_m). Conceptually, spin was the standard deviation of the values of θ. Calculations of the mean and standard deviation of θ were based on Mardia's (1972)

[1] A reviewer suggested that we recalculate ipsatization using the mean based on all events rather than a within-event mean. A disadvantage of this procedure is that different event-level scores would be obtained depending on the sample of events included in a study. For example, Fournier, Moskowitz, and Zuroff (2002) used events at work. Suh, Moskowitz, Fournier, and Zuroff (2004) used events involving a friend or a romantic partner. We adopted the procedure of within-event ipsatization to retain comparable event level scores across different analyses. Scores are comparable using the two methods of ipsatization. In the present sample, correlations between scores using the two types of ipsatization were .85 for flux in dominant behavior, .94 for flux in submissive behavior, .76 for flux in agreeable behavior, and .94 for flux in quarrelsome behavior. Pulse and spin scores are independent of the ipsatization process because they are based on the dimensions of agency and communion, which are not ipsatized.

formulas for the circular mean and circular standard deviation.[2] Pulse and spin calculated over 20 days were independent, $r(115) = .14$, $p > .10$.

Construction of weekly temporal intraindividual variability scores. For the CFA used to estimate consistency and specificity and for the analyses of the generality of flux, spin, and pulse across weeks, scores specific to each week of the study were required. Scores for Week 1 and Week 2 were each based on a 7-day period; scores for Week 3 were based on a 6-day period. Weekly flux, pulse, and spin scores were constructed for each individual using the behavior scores for all events during the week.

Validity of the event-contingent recording method for assessing behavior. Past research on a sample separate from the one used here (Moskowitz, 1994) presented considerable evidence for the convergent and discriminant validity of the event-contingent recording method used to measure interpersonal behavior. The pattern of correlations between interpersonal behavior scales generally corresponded to structural predictions based on the interpersonal circumplex. Moskowitz (1994) also provided evidence for the reliability of the behavior items. In addition, the behaviors scores responded to predicted differences in situations varying in status (Moskowitz et al., 1994, 2001).

Environmental variables. To assess variability in the environment, we constructed four measures: number of partners, variability in status, variability in closeness, and gender balance in partners. These variables were computed for each of the 3 weeks of the study as well as over 20 days. The means and standard deviations of these variables are presented in Table 1.

Number of partners was calculated by summing the number of different partners reported by an individual during a week of the study or throughout the 20 days of the study. Total number of partners reported ranged from 3 to 93.

To calculate variability in status, we assigned each event a value corresponding to the hierarchical role of the participant: 1 = *supervisee,* 2 = *coworker,* 3 = *supervisor.* If hierarchical role information was not reported for an event, then the value was coded as missing. Variability in status was the standard deviation in hierarchical roles calculated across each week of the study and across the 20 days of the study.

To calculate variability in personal relationships, we assigned each event a value corresponding to the closeness of the role: 1 = *acquaintance,* 2 = *friend,* 3 = *romantic partner.* If closeness role information was not reported for an event, than the value was coded as missing. Variability in closeness was the standard deviation in closeness roles calculated across each week of the study and across the 20 days of the study.

To calculate gender balance in partners, we assigned each event a code corresponding to whether the interaction partner was male (1) or female (2). Gender balance was the standard deviation across this dichotomous variable calculated across each week of the study and across the 20 days of the study. Larger standard deviations indicate greater balance in interacting with both men and women; smaller standard deviations indicate that the participant primarily interacted with one gender, either men or women.[3]

Table 1
Means and Standard Deviations for Variables Computed Over 20 Days

Variable	*M*	*SD*
Personality		
Neuroticism	22.40	8.81
Extraversion	29.87	5.60
Agreeableness	30.47	7.13
Environment		
Variability in status	0.41	0.17
Variability in closeness	0.52	0.19
Number of partners	35.56	15.80
Gender balance	0.47	0.04
Intraindividual variability		
Flux in dominant behavior	0.22	0.02
Flux in submissive behavior	0.21	0.04
Flux in agreeable behavior	0.22	0.02
Flux in quarrelsome behavior	0.18	0.04
Flux in agentic behavior	0.37	0.06
Flux in communal behavior	0.34	0.05
Pulse	0.26	0.03
Spin	1.00	0.24
Means for interpersonal behavior		
Dominant behavior	0.08	0.06
Submissive behavior	−0.07	0.05
Agreeable behavior	0.15	0.06
Quarrelsome behavior	−0.16	0.06
Agentic behavior	0.14	0.10
Communal behavior	0.31	0.12
Vector length (r_m)	0.56	0.10
Angular rotation (θ_m)	0.45	0.26

Results

The analyses are presented in three sections. First, we examine the stability of flux, pulse, and spin in interpersonal behavior. Second, we report multiple regression analyses that examine the relations between flux, pulse, and spin and the three five-factor traits: Neuroticism, Extraversion, and Agreeableness. In the last section, we report multiple regression analyses that examine the relations between flux, pulse, and spin and features of individuals' social environments.

Stability of Flux, Pulse, and Spin

Using the program AMOS 4.0 (Arbuckle & Wothke, 1999), we conducted latent state–trait analyses for the agentic and communal

[2] Mardia (1972) developed descriptive and inferential statistics for situations in which observations are vectors rather than scalars. The circular mean angle is the angle corresponding to the resultant vector of the unit vectors associated with each observation (see Mardia, 1972, section 2.2.2). The circular variance (Formula 2.3.4) and the circular standard deviation (Formula 2.3.12) index the variability of the unit vectors about the circular mean angle. Calculation of the circular standard deviation begins with the quantity R, which is the length of the resultant of the unit vectors. $\bar{R}$ is the mean of R and ranges from 0 to 1; if there is no variability in the direction of the unit vectors, $\bar{R} = 1$. If the directions are widely dispersed, the unit vectors tend to cancel one another out and $\bar{R}$ approaches 0. The circular variance is defined as: $S_0 = 1 - \bar{R}$. The circular standard deviation, s_0, which ranges from 0 to ∞, is calculated as $\{-2\log_e(1 - S_0)\}^{1/2}$.

[3] We used a standard deviation to assess variability for environmental variables such as status and closeness, variables for which we assumed ordinal measurement. A reviewer suggested that we should instead assume a nominal scale and use a variability index for categorical variables, specifically Wickens's (1989) concentration coefficient. Use of this coefficient was problematic because we had to omit participants with missing data (e.g., for individuals who did not have a supervisee). However, the use of the standard deviation may require stronger measurement assumptions for some environmental variables than our data support. To examine the magnitude of the problem, we first calculated the correlation between the concentration coefficient and the standard deviation for the gender balance variable, for which there were no missing data. The correlation was .99. We then correlated the concentration coefficient and standard deviation for hierarchical role in a reduced sample; the correlation was .94. Thus, despite their different measurement assumptions, the standard deviation and the concentration coefficient yielded highly similar results. Consequently, we chose to conduct analyses using the standard deviation so that we did not have to omit participants.

dimensions of interpersonal behavior. The analyses were modeled on those of Eid and Diener (1999). In each analysis, two correlated latent trait variables were assumed, either (a) flux in dominant and submissive behaviors or (b) flux in agreeable and quarrelsome behaviors. Each CFA also included three latent state variables representing the effects of Week 1, Week 2, and Week 3 on flux. The state variables were assumed to be uncorrelated. The measures of observed variability were the six flux scores, that is, intraindividual standard deviations for the two traits over each of the 3 weeks. As in Eid and Diener, the unstandardized factor loadings of the state variables were set to one; in other words, it was assumed that the week-specific influences on the two traits in each model were equal. The unstandardized factor loadings of the trait variables were also equated across the 3 weeks. The resulting model for agentic behavior is presented in Figure 3.

Factor loadings on a latent trait variable indicate the extent to which observed weekly variability can be explained by an underlying trait of variability. Conversely, loadings on the latent state variables indicate the extent to which observed weekly variability measures reflect week-specific influences. Following Eid and Diener (1999), we used the factor loadings to calculate reliability, consistency, and specificity for each week of the study. Consistency is the square of the standardized factor loading on the latent trait and represents the proportion of variance in the weekly measure of intraindividual variability that is accounted for by the trait. Specificity is the square of the standardized factor loading on the latent state variable and represents the proportion of variance in the weekly measure of intraindividual variability that is accounted for by the week-specific influence. Reliability is the sum of the consistency and specificity values and is interpreted as the proportion of explained variance in observed intraindividual variability, that is, the proportion of the variance that is not attributable to random influences.

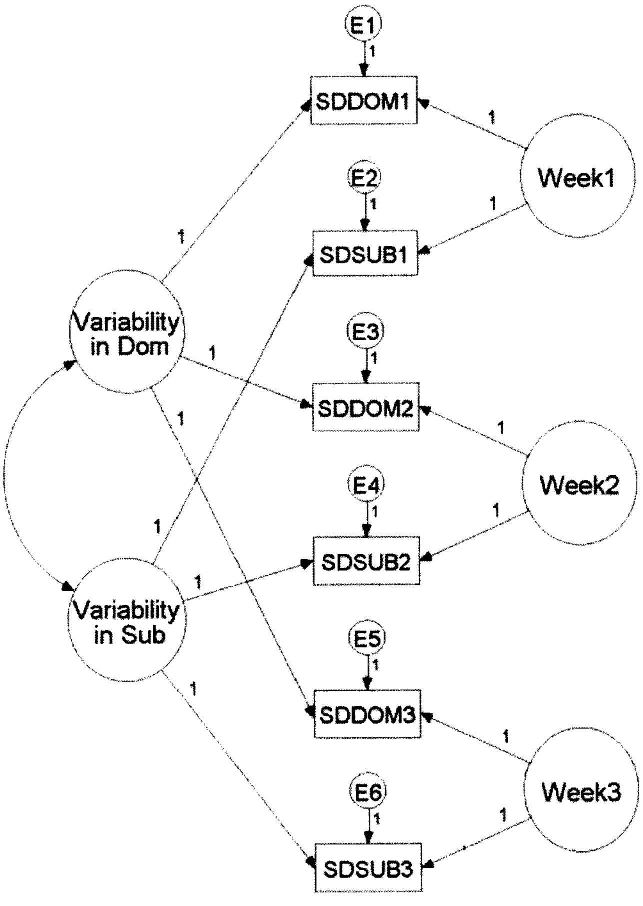

Figure 3. Model used in latent state-trait analyses for the agentic dimension of interpersonal behavior (Dom = dominant behavior; Sub = submissive behavior; SDDOM = standard deviation of dominant behavior during a specific week; SDSUB = standard deviation of submissive behavior during a specific week).

Agentic behavior. The hypothesized model provided a satisfactory fit to the data, $\chi^2(9, N = 118) = 6.60$, $p > .50$, $\chi^2/df = .73$, goodness-of-fit index (GFI) = .98, comparative fit index (CFI) = 1.00. Although the latent traits of flux in dominance and flux in submissiveness were significantly correlated, $r = .83$, critical ratio (c.r.) = 5.13, $p < .001$, the results for dominance and submissiveness were interestingly different. As can be seen from Table 2, flux in submissiveness was characterized by moderately high consistency (range from .59 to .65) and low specificity (range from .08 to .16). Thus, flux in submissiveness could be described as a stable trait.

There was also evidence of a trait for flux in dominance. However, the week-specific influences on flux in dominance were slightly larger (range from .16 to .31) than for submissiveness, and the consistency coefficients were notably smaller (range from .30 to .35). As a result, the reliability coefficients for dominance were lower than those for submissiveness, implying that intraindividual variability in dominance was less predictable from trait and state influences and more subject to random influences or influences not specified in the present model.

Communal behavior. The hypothesized model provided a satisfactory fit to the data, $\chi^2(9, N = 118) = 3.12$, $p > .50$, $\chi^2/df = .35$, GFI = .99, CFI = 1.00. The latent trait of flux in agreeable behavior was significantly correlated with the latent trait of flux in quarrelsome behavior, $r = .65$, c.r. = 4.20, $p < .001$. Evidence for the stability of intraindividual variability was obtained for both agreeable and quarrelsome behaviors, but trait effects were somewhat stronger for quarrelsome behavior. Flux in quarrelsomeness, like flux in submissiveness, was characterized by low specificity (range from .06 to .08) and moderately high consistency (range from .45 to .59). Flux in agreeableness displayed slightly higher specificity (range from .13 to .14) and somewhat lower consistency (range from .29 to .41).

Latent state–trait models could not be estimated for flux in agency, flux in communion, pulse, and spin because in each case only a single manifest variable was available. Instead, temporal stability was estimated using Cronbach's alpha applied to scores for agency flux, communion flux, pulse, and spin computed within the first, second, and third weeks of the study. The pairwise correlations for agency flux were .49, .50, and .57, all $ps < .001$. The pairwise correlations for communion flux were .44, .46, and .47, all $ps < .001$. The pairwise correlations for pulse were .24, $p < .01$, .33 and .37, $ps < .001$. The pairwise correlations for spin were .72, .63, and .70, all $ps < .001$. Bearing in mind that the size of alpha is influenced by the number of scores, and in this case there were a small number of scores (i.e., three), alphas for agency flux, for communion flux, and for spin were high (.76, .71, and .86, respectively); alpha for pulse was moderate (.58).[4]

The corresponding alphas for flux on the four behavior dimensions indicated the same pattern of reliability as in the state–trait analyses; the coefficient alphas indicated high reliability for flux in submissive (.83) and quarrelsome behavior (.77) and moderate reliability for flux in dominant (.59) and agreeable behavior (.60). Thus, the temporal stabilities of flux in agency and in communion were approximately midway between their constituent components. Flux in submissive behavior and spin displayed the highest levels of temporal stability.

Personality Trait Predictors of Flux, Pulse, and Spin

Mean scores for the Neuroticism, Extraversion, and Agreeableness scales of the NEO-FFI are presented in Table 1, along with descriptive statistics for the measures of interpersonal behavior. Table 3 presents correlations of the NEO-FFI scales with the mean levels of the interpersonal behaviors and with the flux, pulse, and spin variables calculated over 20 days. Each mean interpersonal behavior was predicted by one or more of the NEO-FFI variables, primarily Neuroticism and Agreeableness. With respect to the intraindividual variability scores, Neuroticism was significantly positively correlated with flux in agency and its component, flux in submissive behavior. Neuroticism was also significantly positively correlated with flux in quarrelsome behavior and with spin. Extraversion was significantly positively related to flux in agreeable behavior and negatively related to spin. Agreeableness was significantly negatively related to flux in submissive behavior, flux in quarrelsome behavior, flux in communion, and spin.

Hierarchical nonlinear multiple regression analyses were conducted to determine the unique effects of each NEO-FFI variable. The measures of flux, pulse, and spin were the dependent variables. As in Eid and Diener's (1999) analyses, the mean level of the interpersonal measure and the square of the mean level (to control for possible floor or ceiling effects on variability) were entered first and second in each analysis except that for spin. Because of the circular nature of the polar coordinate system, the angular coordinate cannot be said to have a floor or ceiling; variability about a mean angle near 0 radians is not constrained in the way that variability about a mean behavior score near 0 is constrained. Consequently, neither mean nor quadratic level of the angular coordinate was controlled in the analysis for spin. Sex, Neuroticism, Extraversion, and Agreeableness were entered as a block in the final step of all analyses. These analyses are summarized in Table 4.[5]

Sex predicted one intraindividual variability variable. Men showed less flux in submissive behavior than women.

The mean level of the variable predicted flux in agentic behavior, flux in submissive behavior, and pulse. More submissive individuals had higher levels of flux in submissive behavior. Individuals with more extreme behavior had higher levels of variability in the extremity of their social behavior.

Significant effects of the squared-mean level were found for four of seven analyses: agency flux, submissive flux, agreeable

Table 2
Latent State–Trait Analysis of Variability Variables: Reliability, Consistency, and Specificity Estimates

Variable and week	Reliability	Consistency	Specificity
Dominant behavior			
Week 1	.51	.35	.16
Week 2	.61	.30	.31
Week 3	.47	.30	.17
Submissive behavior			
Week 1	.73	.65	.08
Week 2	.75	.59	.16
Week 3	.70	.61	.09
Agreeable behavior			
Week 1	.54	.41	.13
Week 2	.43	.29	.14
Week 3	.43	.29	.14
Quarrelsome behavior			
Week 1	.65	.59	.06
Week 2	.66	.58	.08
Week 3	.52	.45	.07

Table 3
Correlations of Personality Traits With Variables Computed Over 20 Days

Variable	Neuroticism	Extraversion	Agreeableness
Dominant behavior			
M	−.25**	.09	.20*
Flux (W-S *SD*)	.08	.06	−.13
Submissive behavior			
M	.25**	−.18*	−.08
Flux (W-S *SD*)	.34***	−.07	−.18*
Agreeable behavior			
M	−.33***	.20*	.27**
Flux (W-S *SD*)	.04	.20*	−.03
Quarrelsome behavior			
M	.36***	−.13	−.40***
Flux (W-S *SD*)	.25**	.00	−.33***
Agentic behavior			
M	−.27**	.15	.15
Flux (W-S *SD*)	.24**	−.02	−.14
Communal behavior			
M	−.37***	.18†	.36***
Flux (W-S *SD*)	.15	.12	−.20*
Vector length			
M (r_m)	−.20*	.20*	.19*
Pulse (W-S *SD*)	.16	−.03	−.04
Angular coordinate			
M (θ_m)	−.06	.06	−.06
Spin (W-S *SD*)	.44***	−.19*	−.37***

Note. *M* = mean computed over 20 days; W-S = within-subject.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

[4] A reviewer recommended reporting mean correlations because Cronbach's alpha may inflate the reliability estimates when there are many items. Because the present reliability estimates are based on only three measures of intraindividual variability for each variable, there is no inflation of alpha from having a large number of items. For the sake of completeness, the pairwise correlations have also been included.

[5] Although we did not have specific hypotheses for the five-factor variables of conscientiousness and openness to experience, for the sake of completeness we conducted multiple regression analyses in which these variables were included as additional predictors. No significant effects for conscientiousness or openness to experience were obtained.

Table 4
Summary of Regression Analyses Predicting Intraindividual Variability Measures Computed Over 20 Days From Mean Levels of Behavior and Personality Traits

Dependent variable	β	sR^2	t
Flux in dominant behavior (R^2 = .04)			
M	0.04	.00	0.38
*M*M*	−0.07	.00	−0.31
Sex	−0.08	.01	−0.81
N	0.11	.01	0.98
E	0.12	.01	1.14
A	−0.10	.01	−0.92
Flux in submissive behavior (R^2 = .33)			
M	0.44	.19	5.20***
*M*M*	0.37	.04	2.39*
Sex	−0.17	.03	−2.07*
N	0.29	.06	3.01**
E	0.14	.02	1.61
A	−0.05	.00	−0.63
Flux in agreeable behavior (R^2 = .14)			
M	−0.02	.00	−0.25
*M*M*	−0.84	.07	−2.82**
Sex	−0.16	.02	−1.72
N	0.17	.02	1.54
E	0.29	.07	2.94**
A	0.05	.00	0.54
Flux in quarrelsome behavior (R^2 = .15)			
M	0.12	.02	1.34
*M*M*	−0.28	.00	−0.67
Sex	−0.10	.01	−1.03
N	0.21	.03	1.90††
E	0.12	.01	1.25
A	−0.26	.05	−2.51*
Flux in agentic behavior (R^2 = .14)			
M	−0.22	.05	−2.45**
*M*M*	0.41	.03	2.05*
Sex	−0.13	.02	−1.42
N	0.23	.04	2.15*
E	0.12	.01	1.19
A	−0.04	.00	−0.39
Flux in communal behavior (R^2 = .12)			
M	−0.08	.01	−0.82
*M*M*	−0.55	.02	−1.46
Sex	−0.14	.02	−1.48
N	0.20	.03	1.76††
E	0.23	.05	2.37*
A	−0.13	.01	−1.23
Pulse (R^2 = .22)			
M (r_m)	0.29	.09	3.28**
*M*M*	−2.19	.08	−3.36**
Sex	−0.14	.02	−1.61
N	0.23	.04	2.26*
E	0.02	.00	0.23
A	0.04	.00	0.44
Spin (R^2 = .24)			
Sex	0.06	.00	0.74
N	0.31	.07	3.11**
E	−0.05	.00	−0.54
A	−0.24	.05	−2.62**

Note. Mean levels were entered in the first step of the regression analysis. Quadratic mean levels were entered in the second step, and sex and the three personality variables were entered in the third step. For spin, sex and the personality variables were entered together in the first step. R^2 values are from the final equation. For *t* tests, $df = 110$ for all variables except for Spin; for Spin, $df = 112$. Other parameters are from the step in which the predictor was first entered. *M* = Mean level computed over 20 days; *M*M* = quadratic mean level; N = Neuroticism; E = Extraversion; A = Agreeableness.
†† $p < .06$. * $p < .05$. ** $p \leq .01$. *** $p < .001$.

flux, and pulse. There was an inverted-U-shaped effect for flux in agreeable behavior; the highest variability scores were found for persons with middle range agreeable behavior scores. Similar results were found for pulse. Pulse was greatest for participants whose mean behavioral extremity was in the middle range. An inverted-U-shaped effect was not found for agency flux or flux in submissive behavior. Instead, high variability scores were found for persons with low agency scores and high submissive behavior scores; the level of variability found was higher than would be expected based on a linear relation between variability and mean level. Flux in dominant and flux in quarrelsome behaviors were not predicted by the mean level or the squared-mean level of the corresponding behavior.

There were NEO-FFI predictors for intraindividual variability in three of the four interpersonal behaviors. Variability in each behavior was predicted by a different trait. Flux in submissive behavior was predicted by Neuroticism. Flux in agreeable behavior was predicted by Extraversion. Flux in quarrelsome behavior was negatively predicted by Agreeableness. Flux in dominant behavior was not predicted by any personality variable.

Flux in agency, like flux in its component, submissiveness, was predicted by Neuroticism. Flux in communion, like flux in its component, agreeableness, was predicted by Extraversion.

Pulse and spin were each positively predicted by Neuroticism. In addition, spin was negatively related to Agreeableness.

In summary, measures of intraindividual variability were predicted by mean level of behavior in only three of seven analyses and by squared-mean level in four of seven analyses. Seven of the eight measures of intraindividual variability were predicted by one of the NEO-FFI variables. The magnitude of these relations was generally not large. When both the mean level variables and the NEO traits were entered, R^2s ranged from .04 to .33. These results suggest that the traits of intraindividual variability were not redundant with their mean levels or with the interpersonal traits of the five-factor model.

Intraindividual Variability and the Social Environment

Four environmental variables were examined as possible predictors of intraindividual variability in interpersonal behavior: variability in status, variability in closeness, number of partners, and gender balance in partners. These variables were computed for each of the 3 weeks of the study as well as over 20 days. Descriptive statistics are presented in Table 1.

Temporal stability for the environmental variables was estimated using Cronbach's alpha applied to scores for variability in status, variability in closeness, number of partners, and gender balance in partners computed within the 1st, 2nd, and 3rd weeks of the study. The pairwise correlations for variability in status were .45, .50, and .53, all ps $< .001$. The pairwise correlations for variability in closeness were .56, .57, and .59, all ps $< .001$. The pairwise correlations for number of partners were .70, .71, and .86, all ps $< .001$. The pairwise correlations for gender balance were .42, .48, and .70, all ps $< .001$. The Cronbach's alphas for variability in status, variability in closeness, number of partners, and gender balance in partners were .73, .79, .90, and .70, respectively, suggesting that these variables were stable characteristics of individuals' social environments.

We then calculated correlations between the environmental variables assessed over 20 days and the five personality traits of the NEO-FFI. None of these correlations was significant. Thus, differences between individuals on these dimensions of the social environment were quite stable, but these differences were not attributable to differences in the five-factor traits.

Stepwise regression analyses were conducted to determine whether the environmental variables could predict intraindividual variability after accounting for the effects of the NEO-FFI variables. Six predictors were entered in the first step: mean level, quadratic mean level, sex, Neuroticism, Extraversion, and Agreeableness. As in the previously reported analyses, mean and quadratic levels were omitted for spin. Stepwise forward selection was then used to select among the four environmental variables. For six of the eight intraindividual variability measures, none of the environmental variables emerged as a significant additional predictor. However, for flux in dominant behavior, both number of partners and gender balance were significant predictors. When both were included in the regression equation, number of partners predicted greater flux in dominance, $\beta = .21$, $sR^2 = .04$, $p < .05$; greater gender balance in interaction partners, $\beta = .19$, $sR^2 = .04$, $p < .05$, also predicted greater flux in dominance. Number of partners also predicted pulse, but in a negative direction, $\beta = -.20$, $sR^2 = .04$, $p < .05$, indicating that people with more unique partners had less variability in the overall extremity of their behaviors.

We also examined the contribution of interactions between personality traits and environmental features to the prediction of the intraindividual variability variables. Stepwise forward regression analyses were conducted to determine whether any Trait × Environmental interactions added significantly to the regressions previously described. There were three traits (Neuroticism, Extraversion, and Agreeableness) and four environmental variables (total number of partners, gender balance, variability in hierarchical role, and variability in closeness of hierarchical role); so 12 two-way interactions were tested for the six flux, pulse, and spin variables. Of these 72 analyses, 2 were significant. This is less than the number that would be expected to be significant by chance; consequently, we have not described these results.

Discussion

The results indicate that temporal intraindividual variability variables assessing fluctuations in broad dimensions of interpersonal behavior are reliable dimensions of individual differences; that is, the extent of fluctuations within an individual during a specified period of time is likely to be replicable during another period of time. On the basis of coefficient alpha analyses across weeks, the stability of flux in submissive and quarrelsome behaviors was high. The stability of flux in agreeable and dominant behaviors was moderately high. Stability was high for spin reflecting variability around the interpersonal circle and moderate for pulse reflecting variability in overall extremity of behavior. The results based on the state–trait analyses revealed that trait variance in the flux of submissive, quarrelsome, and agreeable behaviors was greater than the state influences on these flux variables. These analyses also indicated that the trait influence on flux in dominant behavior was less than for the other three flux variables but was still sufficient to conclude that flux in dominant behavior, like flux in the other interpersonal behaviors, represents a stable personality characteristic.

Because concerns could be raised that the ipsatization procedure may inadvertently create some dependence among measures of flux, we also analyzed flux in agency and flux in communion, scores which were not ipsatized. The temporal stability coefficients for agency and communion were in-between the temporal stability results for each of their constituent components. The personality predictor for flux in agency was similar to its component, flux in submissive behavior, whereas the personality predictor of flux in communion was similar to flux in agreeableness. Most important, the results for temporal stability and the personality predictors did not change radically and remained fairly constant when we used the agency and communion flux variables that were not ipsatized.

A wide range of stability estimates has been reported for temporal intraindividual variability in different domains. For example, Eizenman et al. (1997) reported stability coefficients for variability in two social cognition variables, locus of control and perceived competence, that were modest (.24) to high (.87). Generally, the stability coefficients for affect variability in consecutive periods have been in the moderate to high range (Eid & Diener, 1999; Larson, 1983; Penner et al., 1994). The present results for the interpersonal behavior variables indicate that flux, pulse, and spin are in the moderate to high range, a range similar to that generally found for affect.

Behavioral Lability

It was presumed that prediction by Neuroticism would indicate whether intraindividual variability was related to the dysregulation of interpersonal behavior. Flux in submissive behavior was related to Neuroticism, after controlling for mean levels of submissive behavior, indicating that fluctuations in submissive behavior were greater for individuals with higher scores on Neuroticism. Furthermore, Neuroticism predicted greater pulse and spin. Large fluctuations in submissive behaviors and in variability in kind and extremity of social behavior appear to represent reduced behavioral modulation and may be problematic for the individual.

It has been argued that individuals who have high scores on Neuroticism are sensitive to signals of punishment (Larsen & Ketelaar, 1991). Submissive and passive behaviors function to end, reduce, and avoid interpersonal conflict and punishment. Neurotic individuals may be motivated to be passive and submissive to avoid punishment in their interpersonal environment. As soon as the perceived threat of punishment has dissipated, they may reduce their submissive behavior and perhaps try other behaviors, only to return to passive–submissive behavior when they again perceive possible punishment. Thus, it is possible that high Neuroticism individuals demonstrate flux on submissiveness that contributes to spin as neurotic individuals try other behaviors when not being submissive. In other words, the neurotic individual may retreat to submissive behavior when sensing interpersonal danger but may venture into less submissive behavior and other interpersonal realms when perceiving the interpersonal environment as safe. Consequently, neurotic individuals exhibit greater flux on the specific dimension of submissive behavior and also greater movement around the interpersonal circle.

It may be interesting in further work to consider the potential impact on interaction partners of the neurotic individual's high level of spin. Is the neurotic individual perceived as erratic and unpredictable? Do others feel that they have to continually adjust their own behavior in response to the neurotic's shifting behavioral tactics? What may be the long-term affective responses (e.g., anger, fatigue) to someone who is perceived as highly changeable?

Behavioral Flexibility

We thought that positive correlations of the flux variables with Extraversion and Agreeableness would indicate that variability on these characteristics might represent behavioral flexibility and contribute to subjective well-being. After accounting for mean levels of agreeable behavior, Extraversion predicted flux in agreeable behavior, suggesting that extraverts are flexible in their level of agreeableness. It has been suggested that extraverts are more sensitive to reward signals or positive stimuli in their environment (Larsen & Ketelaar, 1991). Engaging in agreeable behavior is associated with more pleasant affect (Côté & Moskowitz, 1998; Moskowitz & Côté, 1995), and agreeable behavior by one person is frequently reciprocated by agreeable behavior from the person with whom that person is interacting (e.g., Kiesler, 1983). It may be that extraverts are particularly responsive to agreeable behavior from others because agreeable behavior is associated with the reward of pleasant affect, leading to variability in their own level of agreeable behavior that closely depends on the agreeable behavior of others toward them. In essence, the extraverted person may seek the pleasant affect associated with being agreeable by being particularly responsive to the agreeable behaviors of others.

After controlling for mean level of quarrelsome behavior, trait Agreeableness was a predictor of flux in quarrelsome behavior. Lower levels of trait Agreeableness predicted greater variability in quarrelsome behavior. Quarrelsome behavior in others is often reciprocated by quarrelsome behavior, and there is evidence that less-agreeable individuals may be more responsive to displays of quarrelsome behaviors in others and may reciprocate even more strongly than agreeable people (cf. Foley, Fournier, Moskowitz, & Zuroff, 2001; Jensen-Campbell & Graziano, 2001). This would be consistent with findings that aggressive individuals are more likely to respond with hostile actions to insults and threats (Dodge & Coie, 1987). If low agreeable individuals are particularly responsive to perceptions of quarrelsome behavior in others, then their quarrelsome behavior may be more variable, increasing and decreasing depending on perceptions of quarrelsome behavior in the other.

It might be thought that agreeable individuals would be particularly responsive to agreeable behaviors in others. However, Foley et al. (2001) found that agreeable individuals are relatively insensitive to agreeable behavior in others; they remain agreeable even when others are not. Thus, the flux that occurs in agreeable behavior is not predictable by five-factor trait Agreeableness. The relatively low responsivity of high trait agreeable individuals may also explain the lower levels of spin in their behavior. Less contingency between their behavior and the behavior of others may reduce spin.

In summary, responsivity to different aspects of the other's interpersonal behavior may be crucial to the explanation of why traits predict behavioral variability. Neurotic individuals may be responsive to the possibility of interpersonal punishment. Extraverted individuals may be responsive to perceived agreeable behavior in others. Low agreeable individuals may be particularly responsive to perceived quarrelsome behavior in others. Whereas flux on agreeableness may be positively related to well-being through an association with Extraversion, the overall pattern of results suggest that high levels of pulse, spin, and flux on submissive and quarrelsome behavior are associated with traits (Neuroticism and low Agreeableness), suggesting poor subjective well-being and behavioral maladaptiveness.

Thus, interpersonal traits predict flux, pulse, and spin in behavior as well as mean levels of behavior. Determinants of responsivity in behavior may provide clues as to why traits predict intrapersonal interpersonal variability. However, substantial proportions of variance remain to be explained in the intraindividual variability of social behaviors even after accounting for mean levels of behavior and broad personality traits; pulse, spin, and flux in behaviors are not identical with personality traits and should be considered discriminable from the five-factor interpersonal traits.

Predicting Intraindividual Variability From the Environment

The variables characterizing the environment were notable in two regards. First, these indices were temporally reliable as reflected in the Cronbach's alphas. This evidence is not as rigorous in its analysis of sources of variability as that provided by the CFAs of fluctuations in behavior, but the index of consistency across weeks still provides evidence for the reliability of the assessment of these variables. Second, the environmental characteristics were independent of all five-factor personality traits. Thus, the environmental characteristics represented reliable variance for the individual that was not explained by the broad range of personality traits.

Despite the absence of personality traits as predictors of flux in dominant behaviors, flux in dominance was predicted by characteristics of the environment. Individuals evinced greater flux in dominant behavior if they had many unique interaction partners and if they interacted nearly equally with men and women. Flux in dominant behavior was distinctive in that it was the variable that showed the lowest level of temporal reliability and was the only variable to be predicted by environmental characteristics. Engaging in dominant behavior may be more sensitive to situational opportunities and situational restrictions than are other forms of interpersonal behavior.

Fleeson (2001) found that intraindividual variability in Extraversion was more responsive to the environmental cues of time of day and number of partners than was intraindividual variability in the other five-factor traits. Previous researchers have argued that Extraversion reflects both agreeable and dominant behaviors (McCrae & Costa, 1989; Trapnell & Wiggins, 1990). Some of the adjectives used by Fleeson represented the interpersonal aspects of Extraversion, and these interpersonal adjectives were related to dominance (e.g., assertive, talkative) rather than agreeableness. The present findings suggest that variability in Extraversion may be dependent on environmental cues to the extent that the measure of Extraversion represents dominant rather than agreeable behaviors.

Implications and Directions for Future Research

The study of temporal intraindividual variability could be refined by further elaboration and incorporation of situational variables. Shoda et al. (1994) suggested that fluctuations represent behavioral signatures reflecting patterns of behavior–situation relations within individuals. Having established that fluctuations are temporally stable information about individuals, it would be of great theoretical interest to identify variables that can group the patterns of variability for individuals over explicitly identified situations. For example, Wright, Zakriski, and Drinkwater (1999) demonstrated some specific patterns of contingent relations between problems behaviors and situations for aggressive, withdrawn, and mixed-syndrome children. Future research could search for predictors that identify patterns of within-person variation across situations for interpersonal behaviors among adults.

There also may be situations that produce greater or lesser degrees of variability across events. Larson (1983) found that adolescents who spent more time with family than friends had less variability in their affect; time with family for adolescents may be a context for emotional stability. Contexts that affect the extent of flux, pulse, and spin in interpersonal behavior could be identified. Fiske (1993) argued that individuals who have high-ranked positions pay less attention to individuating information about the other than individuals who have lower rank in an organization. It would be of interest to know how the absence of detailed attention to the other affects the intraindividual variability of these high-rank individuals. Higher status could produce less flux in behavior because of an absence of responsiveness to the details of the other's behavior. Alternatively, there could be greater flux and spin because of a release of inhibitory role restrictions. Flux in dominant behavior would be of particular interest for this line of investigation because of its apparent sensitivity to environmental cues.

The placement of the origin in the interpersonal circle could be questioned. A reviewer inquired as to the consequences of moving the origin from the center of the circle to the bottom left of the circle. In such a model, there would be two dimensions, low to high dominance and low to high agreeableness. However, the proposed transformation is not a theory-neutral rescaling of measures but, instead, a major theoretical change. In effect, it would replace the interpersonal circle with the dominant–agreeable quadrant. Stated differently, moving the origin would imply that low dominance is conceptually equivalent to high submissiveness. This formulation is inconsistent both with interpersonal theory and with studies showing that dominance and submissiveness can be examined separately and can have different influences (Moskowitz, in press). To illustrate, increasing individuals' tryptophan levels enhances the neurotransmitter serotonin that increases dominant behavior, but increasing tryptophan does not have an effect on submissive behavior (Moskowitz et al., 2001). Consequently, we chose to retain the theoretical structure of the interpersonal circumplex with its two bipolar scales and a central origin.

It could be argued that pulse and spin combine information from the flux scores such that there is no additional information in the pulse and spin scores. It is the case that pulse and spin represent mathematical transformations of information contained in the flux scores. However, it is known from other fields of science that interesting and productive phenomena emerge from mathematical transformations; examining phenomena from different mathematical perspectives provides new insights. In the case of pulse and spin, we are taking advantage of features of the interpersonal circumplex/interpersonal circle. The use of polar coordinates to represent variables on the interpersonal circle has previously been described and illustrated (e.g., Gurtman, 1992; Wiggins, 1995). The present research further develops the interpersonal circle model by examining intraindividual variability in extremity and interpersonal style.

The interpersonal circle is not the only context in which intraindividual variability in a space defined by polar coordinates could be examined. Spin (intraindividual variability in θ) and pulse (intraindividual variability in r) could also be investigated in affect circumplex models that conventionally use the Cartesian coordinates of valence and arousal (Larsen & Diener, 1992; Russell, 1980). Pulse would be analogous to variability in affect intensity. Spin in the affect realm may correspond to the concept of affect lability (cf. Harvey, Greenberg, & Serper, 1989). The transformation to polar coordinates is straightforward when the original variables have true zero-points, as is the case with circumplex models of interpersonal behavior and affect. When there is not a true zero-point, the researcher will have to carefully consider how to define the origin.

The ideas and methods developed in the present study are readily generalized to domains that are characterized by three or more dimensions rather than the two that define the space of the interpersonal circumplex. Flux variables in higher dimensional spaces would be defined in exactly the same way as in a two-dimensional space. Pulse and spin variables would require changes in the coordinate system. For example, a psychological domain that is ordinarily characterized by three orthogonal Cartesian coordinates (x, y, z) could be transformed to spherical coordinates (r, θ, ϕ) or cylindrical coordinates (r, θ, z). Which transformation to use would depend on the nature of the domain. The spherical representation would give rise to one pulse variable and two spin variables; the cylindrical representation would give rise to two pulse variables and one spin variable. To illustrate, consider the domain of pain perception, which is considered to have three dimensions (Melzack & Casey, 1968; Melzack & Wall, 1965): motivational–affective, cognitive–evaluative, and sensory–physiological. Pain experiences vary greatly over time. Flux measures could be computed to represent variability over the familiar three dimensions of pain. Alternatively, one could adopt a spherical representation and examine pulse (variability in intensity, r) and two spin variables representing variability in the two dimensions (θ, ϕ) characterizing the relative prominence of the facets of pain. Flux, pulse, and spin represent different features of a domain, and we urge researchers to retain all three kinds of constructs to explore intraindividual variability phenomena.

Conclusion

Considerable previous work has demonstrated that temporal intraindividual variability in affects is a class of individual difference variables (Eid & Diener, 1999; Larsen, 1989; Penner et al., 1994). The present results suggest that temporal intraindividual variability in interpersonal behaviors is another class of individual difference variables that may be useful for characterizing the individual and that requires further investigation. There is sufficient evidence that there are distinct predictors of the intraindividual variability in social behavior that these variables can be presumed to represent different characteristics of the individual with substantial independence from mean levels of social behaviors. Intraindividual variability can be characterized in terms of flux on specific dimensions, pulse in the overall extremity of interpersonal behaviors, and spin around the interpersonal circle. The study of fluctuations in interpersonal variables may have potential to illuminate unmodulated behavior and further illuminate the relation of behavior to situation. To understand the origins of stable individual differences in intraindividual variability in social behavior, researchers will need to investigate determinants of responsiveness to the others' behavior as well as the ways that characteristics of an individual's interaction partners produce consistency or variability in their social environments.

References

Arbuckle, J. L., & Wothke, W. (1999). *AMOS 4.0 user's guide.* Chicago: SmallWaters.

Bath, K. E., Daly, D. L., & Nesselroade, J. R. (1976). Replicability of factors derived from individual P-technique analyses. *Multivariate Behavioral Research, 11,* 147–156.

Bolger, N., & Schilling, E. A. (1991). Personality and the problems of everyday life: The role of neuroticism in exposure and reactivity to daily stressors. *Journal of Personality, 59,* 355–386.

Brown, K. W., & Moskowitz, D. S. (1998). Dynamic stability of behavior: The rhythms of our interpersonal lives. *Journal of Personality, 66,* 105–134.

Buss, D. M. (1987). Selection, evocation, and manipulation. *Journal of Personality and Social Psychology, 53,* 1214–1221.

Cattell, R. B. (1963). The structuring of change by P-technique and incremental R-technique. In C. W. Harris (Ed.), *Problems in measuring change* (pp. 167–198). Madison: University of Wisconsin Press.

Costa, P. T., Jr., & McCrae, R. R. (1992). *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (FFI) professional manual.* Odessa, FL: Psychological Assessment Resources.

Costa, P. T., Jr., & Widiger, T. A. (Eds.). (1994). *Personality disorders and the five-factor model of personality.* Washington, DC: American Psychological Association.

Côté, S., & Moskowitz, D. S. (1998). On the dynamic covariation between interpersonal behavior and affect: Prediction from neuroticism, extraversion, and agreeableness. *Journal of Personality and Social Psychology, 75,* 1032–1046.

Dodge, K. A., & Coie, J. D. (1987). Social-information-processing factors in reactive and proactive aggression in children's peer groups. *Journal of Personality and Social Psychology, 53,* 1146–1158.

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

Eizenman, D. R., Nesselroade, J. R., Featherman, D. L., & Rowe, J. W. (1997). Intraindividual variability in perceived control in an older sample: The MacArthur successful aging studies. *Psychology & Aging, 12,* 489–502.

Epstein, S. (1979). The stability of behavior: I. On predicting most of the people much of the time. *Journal of Personality and Social Psychology, 37,* 1097–1126.

Epstein, S. (1980). The stability of behavior: II. Implications for psychological research. *American Psychologist, 35,* 790–806.

Fiske, S. T. (1993). Controlling other people: The impact of power on stereotyping. *American Psychologist, 48,* 621–628.

Fleeson, W. (2001). Toward a structure- and process-integrated view of personality: Traits as density distributions of states. *Journal of Personality and Social Psychology, 80,* 1011–1027.

Foley, J. E., Fournier, M. A., Moskowitz, D. S., & Zuroff, D. C. (2001, May). *The climate of interpersonal complementarity.* Paper presented at the 4th Annual Meeting of the Society for Interpersonal Theory and Research, Montreal, Quebec, Canada.

Fournier, M. A., & Moskowitz, D. S. (2000). The mitigation of interpersonal behavior. *Journal of Personality and Social Psychology, 79,* 309–318.

Fournier, M. A., Moskowitz, D. S., & Zuroff, D. C. (2002). Social rank strategies in hierarchical relationships. *Journal of Personality and Social Psychology, 83,* 425–433.

Gilbert, P., & Allan, S. (1994). Assertiveness, submissive behaviour and social comparison. *British Journal of Clinical Psychology, 33,* 295–306.

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American Psychologist, 48,* 26–34.

Gurtman, M. B. (1992). Construct validity of interpersonal personality measures: The interpersonal circumplex as a nomological net. *Journal of Personality and Social Psychology, 63,* 105–118.

Harvey, P. D., Greenberg, B. R., & Serper, M. R. (1989). The affective lability scales: Development, reliability, and validity. *Journal of Clinical Psychology, 51,* 803–814.

Horowitz, L. M., Rosenberg, S. E., Baer, B. A., Ureño, G., & Villaseñor, V. S. (1988). Inventory of Interpersonal Problems: Psychometric properties and clinical applications. *Journal of Consulting and Clinical Psychology, 56,* 885–892.

Jensen-Campbell, L. A., & Graziano, W. G. (2001). Agreeableness as a moderator of interpersonal conflict. *Journal of Personality, 69,* 323–362.

Kernis, M. H., Granneman, B. D., & Barclay, L. C. (1989). Stability and level of self-esteem as predictors of anger arousal and hostility. *Journal of Personality and Social Psychology, 56,* 1013–1022.

Kiesler, D. J. (1983). The 1982 interpersonal transaction circle: A taxonomy for complementarity in human processes. *Psychological Bulletin, 77,* 421–430.

Larsen, R. J. (1989). A process approach to personality psychology: Utilizing time as a facet of data. In D. M. Buss & N. Cantor (Eds.), *Personality psychology: Recent trends and emerging directions* (pp. 177–193). New York: Springer-Verlag.

Larsen, R. J., & Diener, E. (1992). Promises and problems with the circumplex model of emotions. *Review of Personality and Social Psychology, 13,* 25–59.

Larsen, R. J., & Ketelaar, T. (1991). Personality and susceptibility to positive and negative emotional states. *Journal of Personality and Social Psychology, 61,* 132–140.

Larson, R. W. (1983). Adolescents' daily experiences with family and friends: Contrasting opportunity systems. *Journal of Marriage and the Family, 45,* 739–750.

Mardia, K. V. (1972). *Statistics of directional data.* New York: Academic Press.

McCrae, R. R., & Costa, P. T., Jr. (1989). The structure of interpersonal traits: Wiggins's circumplex and the five-factor model. *Journal of Personality and Social Psychology, 56,* 586–595.

McCrae, R. R., & Costa, P. T., Jr. (1999). A five-factor theory of personality. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 139–153). New York: Guilford Press.

Melzack, R., & Casey, K. L. (1968). Sensory, motivational, and central control determinants of pain: A new conceptual model. In D. Kenshalo (Ed.), *The skin senses* (pp. 423–439). Springfield, IL: Charles C Thomas.

Melzack, R., & Wall, P. D. (1965). Pain mechanisms: A new theory. *Science, 50,* 971–979.

Moskowitz, D. S. (1988). Cross-situational generality in the laboratory: Dominance and friendliness. *Journal of Personality and Social Psychology, 54,* 829–839.

Moskowitz, D. S. (1994). Cross-situational generality and the interpersonal circumplex. *Journal of Personality and Social Psychology, 66,* 921–933.

Moskowitz, D. S. (in press). Does elevated power lead to approach and reduced power to inhibition? *Psychological Review.*

Moskowitz, D. S., & Côté, S. (1995). Do interpersonal traits predict affect? A comparison of three models. *Journal of Personality and Social Psychology, 69,* 915–924.

Moskowitz, D. S., Pinard, G., Zuroff, D. C., Annable, L., & Young, S. N. (2001). The effect of tryptophan on social interaction in everyday life: A placebo-controlled study. *Neuropsychopharmacology, 25,* 277–289.

Moskowitz, D. S., & Schwarz, J. C. (1982). Validity comparison of behavior counts and ratings by knowledgeable informants. *Journal of Personality and Social Psychology, 42,* 518–528.

Moskowitz, D. S., Suh, E. J., & Desaulniers, J. (1994). Situational influences on gender differences in agency and communion. *Journal of Personality and Social Psychology, 66,* 753–761.

Penner, L. A., Shiffman, S., Paty, J. A., & Fritzche, B. A. (1994). Individual differences in intraperson variability in mood. *Journal of Personality and Social Psychology, 66,* 712–721.

Reskin, B. F. (Ed.). (1984). *Sex segregation in the workplace: Trends, explanations and remedies.* Washington, DC: National Academy Press.

Roberts, M. L., & Nesselroade, J. R. (1986). Intraindividual variability in perceived locus of control in adults: P-technique factor analyses of short-term change. *Journal of Research in Personality, 20,* 529–545.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39,* 1161–1178.

Shoda, Y., Mischel, W., & Wright, J. C. (1994). Intraindividual stability in the organization and patterning of behavior: Incorporating psychological situations into the idiographic analysis of personality. *Journal of Personality and Social Psychology, 67,* 674–687.

Suh, E. J., Moskowitz, D. S., Fournier, M. A., & Zuroff, D. C. (2004). Gender and relationships: Influences on agency and communion. *Personal Relationships, 11,* 41–59.

Trapnell, P. D., & Wiggins, J. S. (1990). Extension of the Interpersonal Adjective Scales to include the big five dimensions of personality. *Journal of Personality and Social Psychology, 59,* 781–790.

Wachtel, P. L. (1973). Psychodynamics, behavior therapy, and the implacable experimenter: An inquiry into the consistency of personality. *Journal of Abnormal Psychology, 82,* 324–334.

Watson, D., & Clark, L. A. (1997). Extraversion and its positive emotional core. In H. Hogan, J. Johnson, & S. Briggs (Eds.), *Handbook of personality psychology* (pp. 767–793). New York: Academic Press.

Wickens, T. D. (1989). *Multiway contingency table analysis for the social sciences.* Hillsdale, NJ: Erlbaum.

Wiggins, J. S. (1979). A psychological taxonomy of trait descriptive terms: 1. The interpersonal domain. *Journal of Personality and Social Psychology, 37,* 395–412.

Wiggins, J. S. (1991). Agency and communion as conceptual coordinates for the understanding and measurement of interpersonal behavior. In W. M. Grove & D. Cicchetti (Eds.), *Thinking clearly about psychology* (pp. 89–113). Minneapolis: University of Minnesota Press.

Wiggins, J. S. (1995). *Interpersonal Adjectives Scales: Professional manual.* Odessa, FL: Psychological Assessment Resources.

Wright, J. C., Zakriski, A. L., & Drinkwater, M. (1999). Developmental psychopathology and the reciprocal patterning of behavior and environment: Distinctive situational and behavioral signatures of internalizing, externalizing, and mixed-syndrome children. *Journal of Consulting and Clinical Psychology, 67,* 95–107.

Zuroff, D. C., Moskowitz, D. S., & Côté, S. (1999). Dependency, self-criticism, interpersonal behaviour and affect: Evolutionary perspectives. *British Journal of Clinical Psychology, 38,* 231–250.

Received March 27, 2003
Revision received December 9, 2003
Accepted January 2, 2004 ■