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Trait Personality and State Variability: Predicting Individual Differences in Within- and Cross-Context Fluctuations in Affect, Self-Evaluations, and Behavior in Everyday Life

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We embrace the values of openness and transparency in science (Schönbrodt, Maier, Heene, & Zehetleitner, 2015; osf.io/4dvkw). We therefore follow the 21-word solution (Simmons, Nelson, & Simmonsohn, 2012), or refer to complete project documentations in the OSF. We furthermore publish all raw data necessary to reproduce reported results and provide scripts for all data analyses reported in this manuscript (see Geukes, et al., 2016; osf.io/57rhy/).

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Abstract

Prior research on the effects of personality on the variability of states has either not assessed states in real-life contexts or not incorporated meaningful contextual information when analyzing state variability. Providing an integrated contextualized approach, we introduce the Within and Across Context (WAC) Variability framework that disentangles real-life within-person fluctuations occurring within and across real-life contexts. To illustrate the utility of this framework, we investigated effects of Big Five personality traits on the level and the within- and cross-context variability of experience-sampled states (affect, self-esteem, behavior) of psychology freshmen (N = 118). Results provide initial empirical support for the meaningful separation of within- and cross-context variability and their distinct relations to personality.

Word count: 112

Highlights:

- Individuals meaningfully differ in the level and variability of states
- Prior research has focused on global analyses of state variability
- The contextualized WAC framework disentangles within- and cross-context variability
- Affect, self-esteem, and behavior were examined in everyday social interactions
- Within- and cross-context variability were differentially linked to personality

Keywords: within-person variability, state fluctuations, cross-context variability, cross-role variability, self-esteem fragility, behavioral consistency

Trait personality and state variability: Predicting individual differences in within- and cross-context fluctuations in affect, self-evaluations, and behavior in everyday life

Advances in theory (e.g., Fleeson 2012; Fleeson, & Jayawickreme, 2015; Mischel & Shoda, 2008; Tett & Guterman, 2000), assessment (e.g., Wrzus**,** & Mehl, 2015), and data analyses (e.g., Baird, Le, & Lucas, 2006; Hedeker, Demirtas, & Mermelstein, 2008; Wang & Grimm, 2012) over the last decades have led personality psychologists to become increasingly interested in the study of states—that is, in how individuals feel, think, and behave at the moment. Individuals differ in states in regard to two aspects: first, in how they feel, think, and behave on average (i.e., mean level; Diener, Smith, Fujita, 1995; Fleeson, 2007; Fleeson & Gallagher, 2009; Greenier et al., 1999; Greenier, Kernis, & Waschull, 1995; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; Larsen & Diener, 1987; Watson & Tellegen, 1985) and, second, in how they fluctuate in these states across time and situations (i.e., within-person/intra-individual variability; e.g., Cervone & Shoda, 1999; Eid & Diener, 1999; Fleeson, 2004; Fleeson & Wilt, 2010; Jordan & Zeigler-Hill, 2013; Kernis, 2003; 2005; Kuppens et al., 2007; Moskowitz & Zuroff, 2004). Both, the mean level and the within-person variability of states have been found to reflect meaningful individual differences and to be stable over time, so that they can be considered as trait-like personality characteristics (cf. Baird et al., 2006; Eaton & Funder, 2001; Eid & Diener, 1999; Fleeson, 2001; Kernis, 1993, 2003; Kernis, Cornell, Sun, Berry, & Harlow, 1993).

The investigation of within-person variability is typically done using one of two standard approaches: For the first approach (i.e., the experience-sampling approach), researchers assess persons' states repeatedly in (usually time-based) experience-sampling designs. Subsequently, within-person variability is calculated as a statistical index of variation (e.g., standard deviation, variance, or mean-corrected standard deviation) across these repeated assessments. Persons with higher fluctuations in their states, therefore, have higher values on these variability indices. This approach bases the assessment of within-person

variability on direct and real-life state reports, representing a contextualized way of assessing variability. Its analysis, however, is typically (though not always) de-contextualized because context information remains unconsidered. As context information[1] (i.e., inferred by situational information) is usually not assessed, it cannot be integrated into the calculation of such indices. Although contexts are generally considered as meaningful source of systematic intra-individual variation (Champagne & Pervin, 1987; Furr & Funder, 2004; Fleeson, 2001; Lord, 1982; Orom & Cervone, 2009; Sheldon, Ryan, Rawthorne, & Ilardi, 1997; Sherman, Nave, & Funder, 2010; Stryker, 2007; Zayas, & Shoda, 2009), this approach neglects this information by calculating variability across all observations irrespective of their respective contexts.

Within the second approach (i.e., the cross-role approach), within-person variability is operationalized as a person's variation over a number of personality trait self-reports, each of them completed for a different social role (e.g., as a student, friend, romantic partner, family member, or worker; see Baird et al., 2006; Donahue & Harary, 1998; Donahue, Robins, Roberts, & John, 1993; Roberts & Donahue, 1994)[2]. Subsequently, within-person variability is calculated as a statistical index of variation (e.g., unexplained variance of the first factor in a Principle Component Analysis, cross-role standard deviation, or mean-corrected standard deviation) across these role-specific self-reports. Individuals who describe themselves as more diverse across roles, thus, have higher values than individuals who describe themselves as relatively consistent across roles. While this approach directly considers intraindividual variation across contexts (i.e. roles), the assessment of individuals' states for each role is rather de-contextualized as they are not captured within the real-life contexts in which they emerge.

Given the limitations of both approaches that a comprehensive integration of person and context information is not realized, we argue for an integrative approach to within-person variability that considers contextualized person information *and* respective context

information, thereby providing access to real-life within-person variability (cf. Geukes & Back, 2015; Roberts, 2008). We introduce the Within and Across Context (WAC) Variability framework that systematically disentangles different types of within-person variability, their associations to trait predictors, and potential processes that underlie these associations. Most importantly, the WAC distinguishes (a) within-person variability occurring *within* contexts (i.e., within-context variability) and (b) within-person variability occurring *across* contexts (i.e., cross-context variability). In a first empirical application, we apply this framework to experience-sampled, real-life expressions of affect, self-esteem, and social behavior. Using these three domains of state variables as illustrations, we demonstrate that intra-individual state variability is indeed a composite measure of within- and cross-context variability, and explore the distinct links of these types of variability to personality traits.

Trait Personality and the Level of States

Prior research on the effects of personality traits on affective, self-evaluative, and behavioral states has primarily focused on the mean levels in these states. Here, the empirical experience-sampling approach as well as respective evidence appears rather unanimous with trait-state associations that are well established (e.g., Diener et al., 1995; Kuppens et al., 2007; Sherman, Rauthmann, Brown, Serfass, & Jones, 2015; Watson & Tellegen, 1985). Concerning state affect level, referring to how people feel at the moment on average, previous research has consistently found that neurotic persons experience more negative affect while extraverted and agreeable persons are characterized by positive affectivity (e.g., Costa & McCrea, 1980; Larsen & Ketelaar, 1991; Lucas & Baird, 2004; Lucas, Le, & Dyrenforth, 2008; Watson, 2000; Rusting & Larsen, 1997).

Self-esteem reflects persons' representations of their global feelings of self-worth (James, 1890; Kernis, 2005; Leary & Baumeister, 2000; Rosenberg, 1965) and can be operationalized as a trait and a state (e.g., Donnellan, Kenny, Trzesniewski, Lucas, & Conger, 2012, Hutteman, Nestler, Wagner, Egloff, & Back, 2015; Kernis, 2005; Rosenberg, 1986;

Wagner, Lüdtke, & Trautwein, 2016). Predicting state self-esteem level through trait personality revealed a similar pattern of results as for state affect. Neurotic persons reported lower levels of state self-esteem, while extraverted, agreeable, and conscientious persons describe higher self-esteem levels. Openness was found to be largely unrelated to state self-esteem level (e.g., Meier, Orth, Denissen, & Kühnel, 2011; Zeigler-Hill et al., 2015).

Turning to behavioral state expressions, prior research has demonstrated that the Big Five personality traits are systematically associated with state expressions of behavior (Ching et al., 2014; Church et al, 2013; Fleeson, 2001, 2007; Fleeson & Gallagher, 2009; Judge, Simon, Hurst, & Kelley, 2014; Sherman et al., 2015). Neurotic persons, for example, behave more nervous, extraverts more sociable, open persons act in a more self-revealing way, agreeable persons act more friendly, and conscientious persons act more reliable (cf. Fleeson & Gallagher, 2009 for a meta-analysis see; Fleeson, & Wilt, 2010).

Trait Personality and Within-Person Variability

Within previous experience-sampling research, investigations targeted the links between personality traits and the variability of affective, self-evaluative, and behavioral states across time and situations. Neuroticism was typically related to increased variability in affect, self-esteem, and behavior. In contrast, extraversion, agreeableness, and sometimes conscientiousness were often found to relate to reduced variability in affect and self-esteem and, if related to behavioral variability, these associations were found to be moderate (Ching et al., 2014; Church et al, 2013; Costa & McCrae, 1980; Eid & Diener, 1999; Erickson, Newman, Peterson, & Scarsella, 2014; Fleeson & Gallagher, 2009; Hepburn & Eysenck, 1989, Lucas & Baird, 2004; Meier et al., 2011; Moskowitz & Zuroff, 2004; Oosterwegel, Field, Hart, & Anderson, 2001; Kuppens, Oravecz, & Tuelinkx, 2010; Miller, Vachon, & Lynam, 2009; Sherman et al., 2015; Watson, 2000; Zeigler-Hill et al., 2015). Openness (or intellect) was found to be largely unrelated to variability in affect and self-esteem (e.g., Meier et al., 2011; Zeigler-Hill et al., 2015). Sometimes, however, openness served as a positive

predictor of fluctuations in behavioral states (Erickson et al., 2014; Fleeson, 2001; Fleeson & Gallagher, 2009; Moskowitz & Zuroff, 2004; Sherman et al., 2015).

Cross-role approach investigations focused on individual differences in the variation of self-reports completed for a variety of different social roles rather than on the within-person variability in states. Donahue et al. (1993) refer to this type of variability as self-concept differentiation (SCD) reflecting individual differences in the extent to which one's social identities are differentiated vs. unitary. Thus, persons with higher cross-role variation have a more differentiated self-view, whereas persons with lower cross-role variation integrate their social identities into a more unitary self (cf., Block, 1961). Relating this type of variability to the Big Five trait dimensions, prior research found that neuroticism was typically related to more differentiated (i.e., more variable) self-views, while extraversion and sometimes also agreeableness and conscientiousness were related to more unitary (i.e., less variable) self-conceptions. Openness, finally, was unrelated to cross-role variations (Baird et al., 2006).

Findings within experience-sampling studies rely on estimations of within-person variability based on repeated, real-life assessments of states (e.g., Church et al, 2013; Greenier et al., 1995; Kernis et al., 1993; Kernis et al., 1989; Kernis, Grannemann, & Mathis, 1991; Kuppens et al., 2007; Zeigler-Hill et al., 2015). This approach provides direct access to how individuals actually feel, think, and behave in specific situations. Contextual information describing the specific situation in which a state was experienced or expressed is only rarely assessed (for exceptions see Fleeson, 2007; Sherman et al., 2015). As a consequence, the analysis and interpretation of within-person variability necessarily remains de-contextualized, as this approach does not integrate person and context information. The assessed within-person "overall" variability, however, incorporates information regarding two distinct aspects of variability (see Figure 1):

First, overall variability entails information about the internal inconsistency[3] (e.g., instability, lability, fragility) of feelings, cognitions, and behaviors as individuals might differ in the mere tendency of being variable—even across, theoretically speaking, identical (or similar) situations[4]. Accordingly, internal inconsistency refers to within-person variability within the same context, across similar situations. Here, similar situations means that they share important features, such as the role a person has (e.g., friend, worker, mother) or the context a person acts in (e.g., going out, at work, at home). Imagine the two friends Anna and Betty. At work, Anna is always happy while Betty changes from happy to unhappy (and back) from one work situation to the next. This example refers to their inconsistency, their within-context variability in the work context. Here, Anna is a rather consistent person but Betty is inconsistent.

Second, overall variability also entails information about individuals' responsiveness of feelings, cognitions, and behaviors. Individuals might differ in their tendency of responding to situational demands, describing a variability that is externally triggered by situational, and thus context-specific, properties (cf., Greenier et al., 1999). From this perspective, variability is systematic as it results from systematic responses to situational forces. In line with research on the interplay of persons and situations on states (e.g., Endler, 1981, 1993; Funder, 2006; Fleeson, 2004; Fleeson & Noftle, 2009; Kenrick & Funder, 1988; Sherman et al., 2015) and on situational similarity being linked to behavioral coherence (e.g., Furr & Funder, 2004; Krahé, 1986; Magnussen & Ekehammer, 1978; Sherman et al., 2010), we assume that situations (i.e., contexts) play a central role in determining states. Thus, a variation of means across contexts cannot be interpreted as an unsystematic, internal fragility but rather as a type of responsiveness to situational forces. Turning back to Anna and Betty: Anna reports that, together with her family, she is far less happy than at work. And when being with her friends, her happiness even exceeds the one she experiences at work. Betty, in contrast, is similarly happy on average in each context, irrespective of being at work, with her family, or with her

friends. This example refers to cross-context variability, where Anna is more variable than Betty.

A Contextualized Approach to Within-Person Variability: The Within and Across Context Variability Framework

The overall within-person variability (see Figure 1, first row) typically investigated in experience-sampling studies, hence, necessarily confounds two types of variability that are non-redundant and logically independent: within-context variability represented by the average state variability for each context (see Figure 1, second row) and cross-context variability represented by the variability across mean states per context (see Figure 1, third row). The latter type of within-person variability (cross-context variability) is conceptually equivalent to what is typically investigated as cross-role variability: It represents how much individuals vary across situations with different social affordances (e.g., Baird et al., 2006; Church et al, 2013; Donahue et al., 1993; Roberts & Donahue, 1994). The assessment of this type of variability in previous cross-role research, however, was rather decontextualized as role-specific trait self-reports were completed independent from the real-life situations in which personality is acted out. Importantly, cross-role variability is independent of individuals' variability within contexts and roles, respectively, which was not considered within this approach. In sum, intraindividual variations in real-life states can be decomposed into within- and cross-context variations. In the following we outline an integrative framework targeted at understanding individual differences regarding both types of within-person variability.

We introduce the Within and Across Context Variability Framework (i.e., WAC; see Figure 2) that integrates the experience-sampling and the cross-role approaches. The WAC framework provides a contextualized approach to the assessment and analyses of within-person variability separating overall variability (Figure 1; first row) into how variable people

are within contexts (within-context variability; second row) and in how variable people are across contexts (cross-context variability; third row).

How are individual differences in within- and cross-context variability related to trait personality? Generally, personality traits should predict the within- or cross-context variability, or both, when they are related to those kinds of processes that make individuals vary within and across contexts, respectively. There might be a number of relevant types of processes that underlie intra-individual fluctuations within contexts, across contexts, or both. Here, we refer to three exemplary classes of processes: (a) inconsistency, (b) responsiveness, and (c) rigidity. In Figure 2, we depict a working model of the WAC framework incorporating the relationships between personality traits and the two types of within-person variability via these three kinds of processes.

By inconsistency we refer to internal sources of variation that are free from systematic external, situational-specific, or context-specific causes. Interestingly, in prior research, overall variability was often interpreted as stemming from such an internal inconsistency, so that individuals with high scores fluctuate a lot but do so without obvious external reasons (cf., Greenier et al., 1999; Jordan & Zeigler-Hill, 2013; Miller et al., 2009). Following the WAC framework, inconsistency should specifically enhance within-context variability, as individuals with a higher internal inconsistency should fluctuate in their states despite being in similar social contexts. Assuming that internal inconsistency enhances variation in each context similarly, it should not affect cross-context variability. Personality traits that are assumed to be related to some form of internal inconsistency of feelings, cognitions, and behaviors (e.g., high neuroticism; e.g., Kuppens et al., 2007, 2010; Meier et al., 2011; Zeigler-Hill et al., 2015) might therefore be particularly related to within-context variability.

Following the WAC framework, responsiveness should uniquely increase cross-context variability. Highly responsive individuals are those who react more flexibly in the sense that they more strongly respond to the unique situational characteristics of different

social situations. This way, responsiveness should lead to a higher cross-context variability. Personality dispositions that are conceptually related to a more flexible responding given different situational affordances (e.g., high openness; e.g., John, Naumann, & Soto, 2008; McCrae & Costa, 1997) might, therefore, be particularly related to cross-context variability.

Rigidity as the third class of processes refers to strong internal rules of feeling, thinking and behaving. A high rigidity should lead to a more consistent affective, cognitive, and behavioral reactions across all kinds of social situations (irrespective of whether the context varies or not). According to the WAC, rigidity should, thus, decrease both types of variability. Personality traits that are conceptually related to strict social scripts (e.g., high conscientiousness; e.g., Roberts, Walton, & Bogg, 2005; Roberts, Jackson, Fayard, Edmonds, & Meints, 2009; Robinson, 2009) might, therefore, be related to both, a lower within-context variability and a lower cross-context variability.

To sum up, the WAC Framework separates overall within-person variability into (a) within-context variability and (b) cross-context variability and describes their conceptual relations to potential trait predictors via three exemplary classes of processes.

The Present Study

The purpose of the present study was to investigate the effects of the Big Five personality traits on the level and variability of states within and across contexts. To allow for a broad overview of these effects we included affective, self-evaluative, and behavioral states. Following the WAC framework, we aimed at (1) a contextualized assessment of these states immediately in real-life social interactions and (2) a contextualized analysis of within-person variability by separating between within- and cross-context variability. A sample of psychology freshmen provided their trait personality in an online questionnaire and repeatedly reported on their states in an event-based experience-sampling assessment directly after social interactions with fellow students. They also provided information about the social context of

these interactions enabling us to differentiate individual differences in variability within contexts from variability across contexts.

This study provides a first step towards a differentiation of individual differences in within- and cross-context variability in social action. Given the exploratory nature of this study, we refrain from making strong theoretical predictions. Nevertheless, on the basis of prior findings and of the exemplary classes of processes outlined in the WAC framework, we do formulate several working hypotheses for the Big Five dimensions. Specifically, for the level of affective, self-evaluative, and behavioral states, we expect to replicate the well-established associations between the Big Five dimensions and average state expressions, underlining the central roles of neuroticism (associated with negative affect, low self-esteem) and extraversion (associated with positive affect, high self-esteem, expressive behavior). Regarding the overall variability in affect, self-esteem, and behavior, we generally expect neuroticism and openness to relate to increased variability while extraversion, agreeableness, and conscientiousness should relate to reduced overall variability. Within-context variability might be particularly triggered by neuroticism (due to individual differences in internal inconsistency), while cross-context variability might be associated with higher scores in openness (due to a higher responsiveness). Higher scores in conscientiousness might lead to a reduced within-context and cross-context variability (due to a higher rigidity).

Method

Data collection was part of the CONNECT Study (for a detailed overview see Geukes, Breil, Hutteman, Küfner, Nestler, & Back, 2016; for a detailed documentation of this project see osf.io/2pmcr). In the following, we report how we established our final sample and refer to the documentation of all measures examined as part of this project (cf. Simmons, Nelson, & Simonsohn, 2012).

Participants

The initial sample we targeted consisted of 140 psychology freshmen who started their studies at the University of Münster, Germany, in October 2012; 131 of them agreed to participate. For the present study, we only included those participants who provided data in an online survey and at least five reports in in the event-based assessment, resulting in a final sample of 118 participants. Mean age of the final sample was 21.01 years (*SD* = 3.65; range from 18 to 42) and 81% (*N* = 96) of the students were women. All students participated in exchange for course credit or received monetary compensation (up to €260 for the whole large scale investigation). The University of Münster's institutional review board approved all procedures of data collection.

Procedures

For the purpose of the present study, we used self-reported personality trait measures obtained in an online survey during the first week of CONNECT (October 2012) and event-based personality state assessments, realized with a smartphone app. The online survey involved the assessment of a wide variety of personality traits. The event-based assessment took place during the initial three weeks of the semester in October 2012, a fourth week in early December 2012, and a fifth week in late January 2013. Participants were asked to complete an online questionnaire for smartphones (Qualtrics, Provo, UT, www.qualtrics.com) after every social interaction with their fellow students. An interaction was defined as "an encounter with one or more people that lasts for at least 5 minutes and in which one responds to the behavior of the other persons" (see Nezlek, Schütz, Schröder-Abé, & Smith, 2011; Reis & Wheeler, 1991 for a similar procedure). After each interaction with one or more fellow students, participants were to report on who their interaction partner(s) was or were (on the basis of their portraits and first names), the number of interaction partners, the duration of the interaction, the situation (17 categories), their own affect and self-evaluations, and on their own and the interaction partners' behaviors. An offline paper-and-pencil version of the smartphone application was provided for cases in which participants did not have internet

access after an interaction. Participants reported a total of 5,414 interactions, with the number of interaction reports per participant ranging from 6 to 112 (*M* = 45.88; *SD* = 20.94; median = 47.00).

Measures

We only report those measures used for the analyses in this study. All procedures and further measures included in the CONNECT project can be found at osf.io/2pmcr. Descriptive statistics, reliabilities, and intercorrelations of all personality trait and state measures relevant to this study (i.e., the Big Five dimensions, affect, self-evaluation, and behavior variables) can be found in Table 1.

Trait measures.

Big Five. The Big Five personality traits were assessed with the Big Five Inventory-SOEP (BFI-S; Schupp & Gerlitz, 2008) consisting of three items per dimension. Due to the typically low reliability of brief agreeableness scales (Hahn, Gottschling, & Spinath, 2012; Lang, John, Lüdtke, Schupp, & Wagner, 2011), we added two additional agreeableness items. These items were "I am a person who easily trusts others and believes other people are good.", "I am a person who tends to criticize others." and supplemented the 15-item scale to a total of 17 items. Items were answered on 7-point scales ranging from 1 (*does not apply at all*) to 7 (*applies perfectly*).

State measures.

Affect. Within the event-based assessment, participants reported on their state affect during social interactions on four bipolar adjective scales from 1 to 7 anchored with "*in a good mood*" vs. "*in a bad mood*" (reversed), "*bored*" vs. "*activated*", "*nervous*" vs. "*relaxed*" (reversed), and "*inhibited*" vs. "*determined*" (reversed). Reversed coded items were recoded prior to further calculations and analyses. On the basis of bivariate correlations, we formed two affect aggregates combining (1) "*in a good mood*" and "*activated*" (i.e., positive affectivity) and (2) "*nervous*" and "*inhibited*" (i.e., negative affectivity), respectively.

Self-evaluation/Self-esteem. Within the event-based assessment, participants also reported on their state self-esteem on a bipolar adjective scale from 1 to 7 with the anchors "*satisfied with myself*" vs. "*dissatisfied with myself*" (reversed).

Behaviors. Participants also described their interpersonal behavior within each social interaction. All behaviors were rated on bipolar scales from 1 to 7, anchored with "*sociable*" vs. "*reclusive*", "*friendly*" vs. "*unfriendly*", "*arrogant*" vs. "*modest*", "*exploiting*" vs. "*cooperative*", and "*self-revealing*" vs. "*reserved*". All items were reversed prior to further calculations and analyses. On the basis of their conceptual overlap and bivariate correlations, we regarded a total of two behavior variables, with (1) an aggregate of "*sociable*", "*friendly*", and "*self-revealing*" behaviors (i.e., expressive behaviors), and (2) an aggregate of "*arrogant*" and "*exploiting*" behaviors (i.e., antagonistic behaviors).

Context measures.

Situation variables. Within each event-based report (N = 5,414) on interactions, participants indicated the specific social situation they interacted in by answering the question "In which situation did the interaction take place?" with one of 17 forced choice options. Extensive pre-testing identified these situations as reflecting representative situational samples of the social (professional and private) life of students at the University of Münster, Germany (see Table 2)[5].

Context categorization. To allow for the analysis of state variations within and across context categories, we assigned 15 of the situations to three psychologically meaningful context categories outlined by Watson, Clark, McIntyre, and Hamaker (1992; see also Lucas, Le, & Dyrenforth, 2008; see Table 2). These contexts were Social Entertainment (n = 2,497; meetings at or outside Uni, meeting/conversation outside, cultural activities, shopping), Active Participation (n = 1,256; eating together in canteen/restaurant, party, sports, shopping), and Social Responsibility (n = 1,661; study- and work-related interactions). Two situations that involved mediated communication (phone calls and Email/Facebook/SMS) could not be

unequivocally assigned to one of the three context categories and were, thus, not included in the present analysis.

Analytical strategy

The present research examines between-person differences in within-context variability and in cross-context variability, respectively, and how these differences are related to the Big Five personality traits. To investigate this question, we decided to use an extension of the mixed-effects location scale model[6] (i.e., MLSM; Hedeker, Demirtas, & Mermelstein, 2009; for a recent application see Geukes, et al., 2016). The MLSM was developed to model between-person differences in intra-individual variability in the case of two-level data with repeated observations (level 1) nested within individuals (level 2) in one step. Here, we extend this model to three-level data (see Li & Hedeker, 2012, for a similar approach) as the current data are repeated observations (level 1) nested within situation contexts (level 2) which are nested in individuals (level 3). The basis for the extended Three-Level MLSM (henceforth: TL-MLSM) is that the repeated observations of person *i* within context *s* are modeled as a function of a time variable:

$$y_{is} = b_{1is} + b_{2is} \cdot time_{is} + e_{is}. \quad (1)$$

Here, y_{is} is a vector that contains the repeated observations of person *i* in context s, *time* is a timing variable, b_{1is} is the intercept for person *i* within context *s* and b_{2is} is the slope for person *i* that denotes the rate of change of *i* in context *s*. Finally, e_{is} is a vector that contains the residual terms of person *i* within situation context *s*. The variance of these residuals, $\sigma_{\varepsilon i}^2$, captures a person's variability within a context.

The intercept term in Equation 1 contains the level of person *i* (e.g., the average affect of person *i* across observations and situation contexts) and a random component that explains the deviation of a person's within-context mean from this average judgment:

$$b_{1is} = b_{1i} + u_{1is}, \quad (2)$$

Here, b_{1i} is the level of person *i* and u_{1is} is the aforementioned random component. The variance of u_{1is} is σ_{ui}^2. It represents the variability of the within-context means around a person's level. It is thus a measure of the cross-context variance of that person.

On the third level, finally, the average judgment b_{1i} can be written as the sum of an overall average judgment and a random component that explains the deviation of a person's mean from this overall average:

$$b_{1i} = \gamma_1 + u_{2i}, \quad (3)$$

where γ_1 is the overall average across persons, contexts, and observations, and u_{2i} is the random component. The variability of u_{2i} across persons is a measure of between-person differences in the level. In a two-level model, this variance would be the random intercept variance.

Typically, it is assumed that the variance of the residuals, $\sigma_{\varepsilon i}^2$ and the variance of the situation means, σ_{ui}^2 are constant for all participants. The TL-MLSM weakens this assumption by allowing between-person heterogeneity in $\sigma_{\varepsilon i}^2$:

$$\sigma_{\varepsilon i}^2 = \exp(w_1 + w_2 \cdot X_2 + \cdots + w_m \cdot X_m + \tau_{\varepsilon i}), \quad (4)$$

and between-person heterogeneity in σ_{ui}^2

$$\sigma_{ui}^2 = \exp(v_1 + v_2 \cdot X_2 + \cdots + v_m \cdot X_m + \tau_{ui}). \quad (5)$$

Here, $w_1,\ldots, w_m$ ($v_1,\ldots, v_m$) are comparable to regression weights with w_1 (v_1) defining the average within-context variance (cross-context variance) and $w_2,\ldots, w_m$ ($v_2,\ldots, v_m$) denoting the influence of person-level covariates $X_2, \ldots, X_m$ (e.g., the extraversion values of the participants) on the respective variance parameter. $\tau_{\varepsilon i}$ and τ_{ui} are the random person effects that are responsible for individuals' variation around the average within-context variance, w_1, and the average cross-context variance, v_1. Please note that w_1 (v_1) are similar to the average within-context variance (average cross-context variance) that one would obtain when one

would compute the variance for each person in each context (the variance for each person across contexts) and then would average the resulting values across persons and contexts (across persons). However, in contrast to this potentially error-prone two-step approach, the TL-MLSM estimates both parameters in one step.

Another advantage of the TL-MLSM is that it assumes all person-specific random effects, that is, the effects that influence an individual's level, slope, within-context variance, and cross-context variance, to be correlated variables. This assumption allows considering the correlation between persons' mean level and their within-context variability, persons' mean level and their cross-context variability, and their within-context and their cross-context variability during the model estimation. This is important, for example, as individuals with high mean levels tend to have smaller variances (see Baird et al., 2006), and not accounting for this ceiling effect may lead to biased results.

Furthermore, the model includes a timing variable, allowing for the control of any longitudinal within-person changes that may occur. Finally, the influence of covariates on between-person differences in the intercept, the slope of the timing variable, the within-context variance, and the cross-context variance are estimated in one model.

To contrast the results for overall variability obtained in MLSMs (without extension) with those differentiating between within- and cross-context variability obtained in TL-MSLMs, we report both. In each case, we, first, calculated respective null-models (i.e., no personality predictors). Second, we calculated respective (TL-) MLSMs for each of the Big Five traits separately (i.e., single prediction) and then models in which all of Big Five traits were entered simultaneously as predictors (i.e., joint prediction)[7].

Results

Overall variability (Mixed Effect Scale Location Models)

MSLMs null-models. Results of the null models indicate that individuals significantly differed from each other in the level of affect, self-esteem, and behavior as well as in the

overall variability for all investigated variables. Additionally, higher levels of positive affectivity, self-esteem, and expressive behaviors and lower levels of negative affectivity and antagonistic behaviors variability went along with decreased variability (see Table 3).

MSLMs including the Big Five dimensions as predictors. Table 4 presents the results of the Mixed Effect Scale Location Models for affect, self-esteem, and behavior and the Big Five dimensions as single predictors and as joint predictors.

Predictors of state level. Of all considered states, neuroticism only negatively predicted the level of self-esteem. Extraversion, in contrast, was negatively associated with the levels of negative affectivity and positively with the levels of self-esteem and expressive behaviors. While openness was unrelated to any of these states, agreeableness positively predicted the levels of positive affectivity, self-esteem, and expressive behaviors and negatively antagonistic behaviors. Conscientiousness predicted all states. It was positively related to positive affectivity, self-esteem, and expressive behaviors, and negatively to negative affectivity and antagonistic behaviors. All effects but the ones for agreeableness pertained when entering the Big Five simultaneously as predictors (joint prediction).

Predictors of overall state variability. Neuroticism was the main predictor of variability. It positively predicted the variability in negative affectivity, self-esteem, and in expressive behaviors. Extraversion was only negatively related to the variability in negative affect. Similarly to neuroticism, openness played an important role in predicting variability. It predicted a higher variability in positive affectivity, negative affectivity (only in the joint analysis), and in self-esteem. Agreeableness was negatively related to variability in negative affectivity and antagonistic behaviors (both effects only in the single analyses) and conscientiousness related to a higher variability in positive affectivity.

Within- and Cross-Context Variabilty (Three Level-Mixed Effect Scale Location Models)

TL-MSLMs null-models. Results of the null models indicate that individuals significantly differed from each other in the level of affect, self-esteem, and behavior in within- and cross-context variability for all investigated variables. Additionally, level and within-context variability as well as level and cross-context variability were significantly correlated. As identified in the overall null-models, these correlations were negative for positive affectivity, self-esteem, and expressive behaviors and positive for negative affectivity and antagonistic behaviors. Within- and cross-context variability were positively associated. That is, those individuals who fluctuated to a large degree within contexts also tended to show these fluctuations across situations (see Table 5).

TL-MSLMs including the Big Five dimensions as predictors. Table 6 presents the results of the TL-MSLMs for affect, self-esteem, and behavior and the Big Five dimensions as single predictors and as joint predictors.

Predictors of state level. Effects of the Big Five on the level of state affect, self-evaluations, and behavior were similar to those identified in the MSLMs (see Table 6 and description above).

Predictors of within-context variability. Neuroticism predicted a higher within-context variability in negative affecticity, self-esteem, and expressive behaviors. Extraversion, in contrast, was associated with a lower variability in negative affectivity. Openness was positively related to variability in positive affectivity, self-esteem and expressive behaviors within contexts. Agreeableness and conscientiousness were both negatively associated with within-context variability. Agreeableness had stabilizing effects on the within-context variability in negative affectivity and antagonistic behaviors and conscientiousness on the variability in positive affectivity within contexts.

Predictors of cross-context state variability. Neuroticism predicted a lower variability in positive affectivity and expressive and antagonistic behaviors across contexts, while it was positively associated with cross-context variability in negative affectivity and self-esteem.

Extraversion was negatively associated with the variability of antagonistic behaviors across contexts. Openness had largely positive effects on the cross-context variability in self-esteem and expressive as well as antagonistic behavior. Its relation to the variability in negative affectivity across contexts, however, was negative, i.e., open persons reported a lower variability. Also, agreeableness was related to a lower variability in negative affectivity across contexts and to higher variability in self-esteem. Finally, conscientiousness was related to lower variability in positive and negative affectivity and higher variability in expressive behaviors across contexts.

Discussion

The aim of the present study was to outline and apply a contextualized approach to investigating individual differences in within-person variability. We introduced the WAC framework that disentangles state-variability within versus across contexts, links these types of variability to personality traits, and proposes three exemplary processes underlying these relationships. In an initial empirical application of this framework, we related Big Five traits to experience-sampled affective, self-evaluative, and behavioral state variability. Results of this exemplary investigation (a) revealed initial evidence for the meaningful separation of individual differences in within- and cross-context state variability, (b) point at unique as well as shared processes underlying both types of variability, and (c) provide a number of prospects for the future investigations of individual differences in intraindividual state variations.

Individual Differences in the Variability of Real-Life Social Interaction States

The present results add to the few previous investigations on personality and state variability in real-life contexts. When looking at overall variability, the most consistent pattern of results emerged for neuroticism and openness. Both traits were positively related to state variability for affective, self-evaluative, and behavioral state indicators. More domain-specific negative effects on state variability emerged for extraversion (negative affectivity),

agreeableness (negative affectivity and antagonistic behaviors), and conscientiousness (positive affectivity).

Importantly, when disentangling within-context and cross-context variability, a more nuanced pattern of results emerged. Some trait effects were found for both within- and across-context variability. Both within and across contexts, neurotic individuals showed more fluctuations in negative affectivity and self-esteem, open individuals were more variable in expressive behaviors, agreeable individuals were less variable in negative affectivity, and conscientious individuals had a lower variability of positive affectivity. The majority of effects, however, emerged for either within-context variability or cross-context variability. Neuroticism was opposingly related to the two types of variability in expressive behaviors. Neurotic individuals experienced increased fluctuations within contexts but decreased variability across contexts. Extraversion was related to decreased variability in negative affectivity within contexts and to increased variability in self-esteem as well as decreased variability in antagonistic behaviors across contexts. Openness was related to an increased variability in positive affectivity and self-esteem within contexts and an increased variability in negative affectivity and antagonistic behaviors across contexts. Agreeableness was related to a decreased variability in antagonistic behaviors within contexts. Finally, conscientiousness was related to a decreased variability of negative affectivity and to an increased variability of expressive behaviors across contexts. In sum, the separation of variability into its within-context and cross-context subcomponents identified numerous effects that were undetected in the overall variability analyses.

These findings highlight that the exclusive consideration of overall variability, which reflects a composite measure of within-context and cross-context variability, might disguise the differentiated effects of these two distinct (though positively correlated) types of within-person variability.

Processes Underlying Individual Differences in Within- and Cross-Context Variability

The revealed effects of personality traits on different types of within-person variability provide initial support for the general utility of the WAC framework and point at shared as well as distinct processes underlying the associations between Big Five traits and both kinds of state variability.

On the one hand, both variability indices (i.e., within and across contexts) were positively correlated, indicating that individuals who fluctuate more within contexts do so also across contexts. Moreover, some of the associations with personality were revealed for both kinds of within-person variability. From the perspective of the WAC these shared effects and the positive relation between within- and cross-context variability might be particularly due to a process that we labeled as rigidity: individual differences in strong internal rules of affective, cognitive, or behavioral responding, irrespective of the social situation. On the other hand, the association between within- and cross-context variability was far from being perfect and many of the associations to personality were unique to either within-context or cross-context variability. Following the WAC, these differentiated effects might be particularly due to processes we labeled as internal inconsistency (individual differences regarding an internal fragility that causes fluctuations despite being in similar situations, thereby uniquely affecting within-context variability) and responsiveness (flexible responding to different situational affordances uniquely affecting cross-context variability).

How to interpret the results of our initial empirical investigation with regard to the three outlined classes of processes? The associations found in this study revealed a complex pattern of effects that did not perfectly match our working hypotheses and were moreover different for different kinds of state modalities (i.e., affect, self-evaluations, behaviors). In the following, we discuss potentially involved processes while acknowledging that these considerations are highly speculative. Neuroticism was not only related to a higher within-context variability but also to a higher cross-context variability for negative affectivity and self-esteem. In addition it was related to a lower cross-context variability for positive

affectivity and expressive and antagonistic behavior. From the perspective of the WAC, this pattern might be explained by linking neuroticism to all three kinds of processes. Neurotic individuals might be chronically unstable particularly regarding their self-esteem and negative affectivity and also respond particularly strong to situational cues relevant to both states (e.g., stress, self-relevance). At the same time they might be characterized by a certain degree of rigidity (particularly behavioral rigidity), which might partially counteract their higher within-context variability and even lead to a lower behavioral variability across contexts.

As hypothesized, openness was related to a higher cross-context variability but this was mainly true for fluctuations in expressive and antagonistic behaviors as well as negative affectivity. In addition, openness was related to a higher variability within contexts for state self-esteem and positive affectivity. Thus, for these states openness might also be related to a certain internal inconsistency.

Conscientiousness was indeed associated with a decreased variability within and across contexts but only for positive affectivity. The rigidity related to conscientiousness might be specific to the display and experience of positive affectivity. For the variability in negative affectivity a negative association was found only across contexts. In addition, conscientiousness was related to an increased variability in expressive behavior across contexts. These results might be explained by the additional role of responsiveness processes. Maybe conscientious individuals are specifically more (or less) expressive in certain situations as compared to other situations (e.g., particularly less expressive in work-related situations) while they more strongly than other individuals refrain from reporting and showing negative affect, even when the situational context warrant such reactions.

Only few, domain-specific effects emerged for extraversion and agreeableness. Specifically, both traits were related to a lower variability in negative affectivity and this effect was more pronounced for within-context variability for extraversion and for cross-context variability for agreeableness. In addition, agreeableness was related to a lower within-

context variability in antagonistic behaviors. When relating these few stabilizing effects to the processes described in the WAC framework, they might be explained by a mixture of a higher rigidity and a lower internal inconsistency (i.e., a higher consistency) of responding, related to extraversion and agreeableness in the domain of negative affect and interpersonal behavior.

Of course all of these specific results need to be carefully replicated before strong conclusions can be drawn. The complex pattern of results revealed in this initial study, however, already shows that a systematic understanding of the relation between personality traits and state fluctuations "in social action" needs to account for the context-sensitivity (i.e., different effects for within and cross-context variability) as well as the domain-specificity (i.e., different effects for different state modalities) of all effects. More detailed conceptual analyses for the processes that underlie trait-specific effects for each state domain are needed as well as more empirical studies allowing for a larger data basis and replications across labs and research contexts. To zoom into the complex processual dynamics causing within-person variability within and across contexts, it is thereby crucial to conduct longitudinal, event-based, experience-sampling field studies that integrate detailed information on persons as well as situations (cf. Wrzus**,** & Mehl, 2015).

Further Limitations and Future Directions

This study served as a first step to empirically illustrate the necessity for the conceptual and empirical separation of contextualized types of within-person variability. However, several limitations need to be considered that point to multiple fruitful directions for future research.

First, important limitations of this study regard the assessment of situations, which could be extended and be more elaborate. The situation assessment could be extended insofar as within this study the focus was deliberately on social situations, i.e. situations that by definition involve the direct or indirect (e.g., Email, short message, phone call) presence of others. Situations in which the participants were alone have not been part of the study. It is an

empirical question whether the restriction to social situations might have led to rather conservative estimations of effects in this study. Because the investigated situations a priori shared a sociality attribute that lied in the presence of others, this might have reduced the actual diversity of the broad range of situations individuals experience in their daily lives. Future research might therefore include solitary as well as social situations to investigate a more representative set of situations capturing more aspects of our daily lives. The situation assessment could be more elaborate insofar as in the present study, we aimed at a representative sampling of the situational classes that are distinguishable based on objective situational features (e.g., at home, during class). This procedure has the advantage of clearly disentangling objective situational characteristics from subjective situational perceptions, and these in turn from the affective, self-evaluative and behavioral states within each situation. This approach does, however, not directly capture psychological representations of each situation (i.e., situation perceptions; Frederiksen, 1972; Magnussen, 1971; Rauthmann et al., 2014; Rauthmann, & Sherman, 2016; Reis, 2008), which are likely involved in the processes underlying the level and (different types of) variability of states. In our view, future research should preferably assess both objective situational features as well as psychological representations of each situation (i.e., situation perceptions) in event-based experience sampling studies to get real-life access to the complex interplay of objective situational features, their subjective perceptions, and corresponding affective, self-evaluative, and behavioral state dynamics.

Second, this study was based on a specific type of situation assessment. Specifically, we opted for the assessment of situation classes distinguished by objective situation characteristics as opposed to a dimensional assessment of subjective perceptions of situation characteristics. As there is no consensus on how to study situations, we, moreover, needed to decide for one specific taxonomy, and decided for the taxonomy by Watson et al. (1992). Many other—presumably equally suitable and justifiable—taxonomies would have been

available (Saucier, Bel-Bahar, & Fernandez, 2007; van Heck, 1984) that might or might not have affected the results. Future research might consider the dependency on situation taxonomies, compare results based on different taxonomies, and compare categorical solutions against dimensional ones (DIAMONDS; e.g., Rauthman, et al., 2014; Rauthman & Sherman, 2015).

Third, even though the simultaneous analysis of within- and cross-context variability using the TL-MSLM is an important advancement in research of personality effects on different types of within-person variability, its application is limited with regard to two important aspects: (a) Within-context variability was modeled as *one* variability—as the average of within-context fluctuations (aggregated across all contexts). Individuals might, however, vary to a different degree within different contexts. Anna, for example, might be rather stable in her happiness when with friends but might fluctuate a lot when at work. These context-specific differences in within-context variability were unconsidered in the models. (b) The estimation of cross-context variability realized in the present study relied on the variability of three values (i.e., one mean value per context). From methodological research on intra-individual variability indices (e.g., Wang & Grimm, 2012) we know that, to gain a robust and reliable estimation, a higher number of observations is preferable. Thus, a more narrow definition of situational contexts resulting in a heightened number of contexts might lead to more reliable estimations of cross-context variability and provide additional insights into the interplay of individuals with contexts and resulting state expressions.

Fourth, the experience-sampling data of this study relied on data of three measurement bursts—the first burst involved the first three weeks of the semester, followed by two further weeks about a month and two months later. To analyze sufficient data points to estimate both types of variability, we could not consider the bursts separately. Future research might investigate data from intensive longitudinal, event-based experience-sampling studies that

involve several bursts to address the reliability of the variability estimation and to consider their stability vs. change.

Fifth, and in line with the previous point, if within-person variability is indeed a trait-like characteristic (Baird et al., 2006), it will be an exciting endeavor for future research to investigate the development of within- and cross-context variability components in the same way personality development is analyzed across the life span for any other trait (e.g., the Big Five traits, cf. Roberts & DelVecchio, 2000; Roberts, Walton, & Viechtbauer, 2006; self-esteem; Orth, Robins, Widaman, 2012; Orth, Trzesniewski, & Robins; Wagner, Gerstorf, Hoppmann, & Ram, 2015; Wagner, Lüdtke, Jonkmann, & Trautwein, 2013). Research on personality development shows mean-level personality changes across the lifespan in the direction of greater maturity (increases in social dominance, conscientiousness, and emotional stability; Roberts et al., 2006, Roberts & Wood, 2006, and increases in self-esteem, Wagner et al., 2013, 2015) and increases in rank-order stability (Roberts & DelVecchio, 2000). Similarly, maturity might be expected to be associated with decreased fluctuations within contexts as promoted by increasing emotional stability. At the same time, however, maturity could potentially lead to increased variability across contexts as roles become more differentiated (i.e., caring mother vs. tough business women). Thus, individuals might learn to adjust their states to these roles and respective expectations, which might go along with larger instead of fewer variations. Research questions could broadly regard the typical development of within-person variability (Do we all become more stable in states within and across contexts with age?),individual differences in these changes (e.g., Hutteman, Bleidorn, Keresteš, Brković, Butković, & Denissen, 2014; Lüdtke, Roberts, Trautwein, & Nagy, 2011; Neyer, & Lehnart, 2007; Specht, Egloff, & Schmukle, 2011), and (individual differences in) the development of within- and cross–context variability (Do we all become particularly stable within and across contexts with age?/Who becomes particularly stable within and across contexts with age?).

Sixth, a separation of within- and cross-context variability of states could provide differentiated answers to further long-standing fundamental questions, such as the (mal-)adaptiveness of within-person variability. Previous research on the intra- and interpersonal consequences of within-person variability potentially confounded effects of within- and cross-context variability. Research on self-esteem variability for example reveals that being variable has important correlates such as lowered psychological adjustment (cf. Kernis, 2003; Paradise, & Kernis, 2002; Zeigler-Hill & Wallace, 2012), heightened levels of anger, hostility, and aggression (Kernis, Grannemann, & Barclay, 1989; Webster, Kirkpatrick, Nezlek, Smith, & Paddock, 2007), a dominant interpersonal style (Zeigler-Hill, Clark, & Beckman, 2011), poorer academic performance and higher academic disengagement (Zeigler-Hill et al., 2013; see Jordan & Zeigler-Hill, 2013). A contextualized approach towards within-person variability might therefore disentangle fragile and inconsistent forms from flexible and responsive forms of variability and can ultimately lead to the identification of important boundary conditions that determine within-person variability's adaptiveness vs. maladaptiveness.

Conclusion

Following a contextualized approach outlined in the WAC framework, this study served as a first step towards a conceptual and empirical differentiation of individual differences in within- and cross-context variability of states. We investigated the effects of the Big Five personality traits on the level and on different types of within-person variability in states (i.e., overall variability, within-context variability, cross-context variability). In an event-based experience-sampling study, students provided information on (a) their affective, self-evaluative, and behavioral states during social interactions with fellow students and (b) on the context of that interaction. This enabled us to separate state variability within contexts from state variability across contexts. Findings indicate that the Big Five dimensions are differentially related to the level and variability of states. Importantly, the distinct associations

found underline that the differentiation between different types of within-person variability can help to disentangle distinct processes that underlie the one, the other, or both types of within-person variability.

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Footnotes

[1]We refer to "context" in a rather broad sense. Contexts are classes of situations that are characterized by similar situational attributes. We are aware that this broad conceptualization leaves room for discussion about which criteria are necessary and sufficient to consider two situations as similar, as stemming from the same context. However, we believe that the conceptual idea of this manuscript can well be followed on the basis of this broad conceptualization.

[2]There are more approaches towards the investigation of self-concept differentiation, sense of coherence, or cross-role variation (see McReynolds, Altrocchi, & House, 2000; Church et al., 2008, Campbell, Assanand, & DiPaula, 2003; Diehl, Hastings, & Stanton, 2001; Sheldon et al., 1997; Suh, 2002). We refrain from describing their variety in detail in favor of conciseness and clarity.

[3]We are aware that the terminology regarding within-person variability often goes along with at least implicitly positive (e.g., flexibility, responsiveness) or negative connotations (e.g., inconsistency, instability, lability, fragility, rigidity). Therefore, we like to stress that, if not explicitly indicated differently, we refer to these terms as mere descriptions of empirical patterns of variability in states rather than as evaluative propositions about the potential (non-)functionality or (mal-)adaptivity of these patterns.

[4]We acknowledge that situations cannot be identical. Even though two situations might be identical from an objective perspective, the individual and subjective perception of these situations would always be different: The first situation is new and the second is not. Consequently, we refer to *similar* situations rather than to identical ones.

[5]The pilot-testing of the situation assessment based on the investigation of 20 psychology students at the University of Münster, the University/city where CONNECT actually has taken place. Over one week, participants of the pilot study were asked to report on every interaction with fellow students or with peers of the same age. After each interaction

participants reported on the situation with (a) referring to the activity (e.g., learning, playing soccer, eating) and to the place (e.g., at Uni, on the soccer field, in the kitchen of the shared flat). They were additionally informed that interactions via SMS, Email, or phone call are also subject of the study and reports should be completed afterwards. Subsequently, these open answers on the situation information (20 persons, 7 days) were clustered into categories, the 17 most frequent ones were used in CONNECT. For further details see the Connect Codebook at osf.io/2pmcr, event-based assessment, p. 22 and pp. 74-76.

[6]An intuitive approach to investigate these questions would be to compute individual variance parameters for each situation context and to use the average of these within-context variance parameters as a measure of a person's within-context variability. Furthermore, as a measure of an individual's cross-context variability we might use the variance of the within-context means. Although this approach seems straightforward, it has a number of disadvantages: First, in this approach, the basis for all calculations is a longitudinally assessed variable. Given that there may be systematic intra-individual developments across assessments, both variance parameters are sensitive to these changes. Second, when relating the within-context variance or the cross-context variance, respectively, in one variable (e.g., affect) to another variable of interest (e.g., extraversion), one needs to rely on a three-step approach. In the case of the within-context variance, for example, one has to compute a variance parameter for each context (step 1), has to average the resulting values (step 2), and to relate these person-specific averages to the variable of interest (step 3). This approach is problematic as it assumes that the respective parameter (e.g., the within-context variance) is estimated without error. However, each estimate is a composite of the true variance and measurement error. This analytic approach would not consider this error in the final step of the analysis, so that their results may not be trustworthy as the standard errors may be biased. We therefore decided to extend the mixed location scale model that was suggested by

Hedeker and colleagues and that is able to overcome these limitations (MLSM; e.g., Hedeker et al., 2009; see also Rast et al., 2012; Wang, Hamaker & Bergeman, 2012).

[7]A Bayesian approach was employed to estimate model parameters (see Gelman & Hill, 2007; Hoff, 2009). Uninformative prior distributions were assigned to model parameters to ensure that the observed data has a strong influence on the posterior distribution. For the means of the intercept, the within-context variance (i.e., residual variance on level 1), and the cross-context variance parameter (variance of the means on level 2) a multivariate normal distribution was used with zero means and variances of 104. An inverse Wishart-distribution was specified as the prior distribution for the variance of these three parameters with a scale matrix containing 10^{-2} as values. Furthermore, prior analysis showed that there were essentially no between-person differences in the regression coefficient of the timing variable (i.e., the slope). Therefore, we decided to model the influence of time as a fixed effect (i.e., the same slope parameter was estimated for all participants). For this regression parameter as well as for the coefficients of the covariates (i.e., personality predictors of between-person variability in the intercept, the within-context and cross-context variance), we used univariate normal distributions as priors with a mean of zero and a variance of 104.

A frequent problem in Bayesian analysis is that the joint posterior distribution of the parameters is not available because the distribution is difficult to derive. In practice, Markov chain Monte Carlo methods (MCMC) such as Gibbs sampling are often used to approximate the distribution. The WinBUGS software (Spiegelhalter, Thomas, Best, Lunn, 2003) automatically implements such a Gibbs sampler for a specified model. We used WinBUGS via the R-package "RtoWinBUGS" (Sturtz, Ligges, & Gelman, 2005) to fit our extended mixed-effects location scale model to the data. The model was estimated using a Gibbs sampler with a chain of 30,000 iterations with a burn-in period of 5,000 iterations and a thinning factor of 50. To evaluate the convergence behavior of the Markov chains, we inspected the trace plots and the autocorrelation functions of all estimated parameters. Both

diagnostic criteria indicated that the MCMC chains converged and that the chosen burn-in iterations were sufficient. The R-/WinBUGS-code, the trace plots as well as the autocorrelation plots can be obtained upon request.

Tables

Table 1

Means, Standard Deviations, Reliabilities, and Intercorrelations of the Big Five Dimensions and the (Aggregated) Affect, Self-Esteem, and Behavior Variables

	M	*SD*	α	2	3	4	5	6	7	8	9	10
1 Neuroticism	4.61	1.27	.76	-.13	-.08	-.16	-.10	-.03	**.23**	**-.35**	.01	-.13
2 Extraversion	5.12	1.12	.86		**.26**	**.24**	.00	**.25**	**-.29**	**.24**	**.31**	-.02
3 Openness	5.13	1.15	.73			.12	.04	-.02	-.06	-.02	.09	-.09
4 Agreeableness	4.99	0.78	.57				**.27**	.12	**-.19**	.15	.13	**-.25**
5 Conscientiousness	5.44	1.06	.73					**.22**	**-.27**	**.33**	**.22**	**-.28**
6 Positive Affect	5.52	0.94	.69						**-.53**	**.43**	**.59**	**-.34**
7 Negative Affect	2.60	0.97	.54							**-.52**	**-.53**	**.38**
8 Self-Esteem	5.31	1.29	--								**.42**	**-.25**
9 Expressive Behaviors	5.59	0.80	.72									**-.39**
10 Antagonistic Behaviors	2.63	0.87	.65									

Note: N = 118 participants, 5,414 interactions; the correlations with affect, self-esteem, and behavior were calculated on the basis of the mean state per person across his/her reported interactions.

Table 2

Number of Reports and Categorization of Situations in the Event-Based Assessment

	n	*Category*
Uni: Bistro/ Canteen	758	AP
Meeting/ Conversation restaurant	178	AP
Celebration/Party	276	AP
Sports	33	AP
Romantic Activity	11	AP
Uni: Outside class	1,430	SE
Meeting/Conversation at home	443	SE
Meeting/ Conversation outside	284	SE
Chance meeting	200	SE
Television/DVD/ Cinema	54	SE
Cultural Activities	47	SE
Shopping	39	SE
Uni: During class	1,405	SR
Learning/ Uni-Activities	250	SR
Voluntary Activities	6	SR
Total Number of Situations	5,414	
AP – Active Participation	1,256	
SE – Social Entertainment	2,497	
SR – Social Responsibility	1,661	

Note: Participants could also decide for two further situation categories involving mediated communication that were not included into the analyses of this study: (1) SMS/Email/ Facebook (n = 635) and (2) Phone call (n = 62).

Table 3

Null-Models of the Mixed Effect Location Scale Models

DV	Parameter	EAP	BCI
Positive Affect	b_{0i}	5.47	5.36, 5.58
	σ^2_{iw}	-0.58	-0.67, -0.49
	Var(b_{0i})	0.33	0.23, 0.44
	Var(σ^2_i)	0.29	0.22, 0.36
	Cov(b_{0i}, σ^2_i)	-0.09	-0.15, -0.03
Negative Affect	b_{0i}	2.62	2.47, 2.76
	σ^2_{iw}	-0.90	-1.00, -0.80
	Var(b_{0i})	0.74	0.56, 0.97
	Var(σ^2_i)	0.39	0.30, 0.49
	Cov(b_{0i}, σ^2_i)	0.11	0.01, 0.21
Self-Esteem	b_{0i}	5.38	5.19, 5.57
	σ^2_{iw}	-0.16	-0.29, -0.04
	Var(b_{0i})	1.03	0.76, 1.34
	Var(σ^2_i)	0.65	0.51, 0.82
	Cov(b_{0i}, σ^2_i)	-0.12	-0.26, 0.03
Expressive Behaviors	b_{0i}	5.67	5.54, 5.79
	σ^2_{iw}	-1.15	-1.25, -1.05
	Var(b_{0i})	0.44	0.33, 0.57
	Var(σ^2_i)	0.38	0.29, 0.47
	Cov(b_{0i}, σ^2_i)	-0.05	-0.13, 0.02
Antagonistic Behaviors	b_{0i}	2.45	2.31, 2.59
	σ^2_i	-1.36	-1.48, -1.26

$Var(b_{0i})$	0.66	0.50, 0.86
$Var(\sigma^2_i)$	0.45	0.35, 0.56
$Cov(b_{0i}, \sigma^2_i)$	0.07	-0.02, 0.17

Note. N = 118; b_{0i} = Intercept; σ^2_{iw} = Variability; $Var(b_{0i})$ = Variance of Intercepts; $Var(\sigma^2_i)$ = Variance of Variability; $Cov(b_{0i}, \sigma^2_i)$ = Covariance of Intercept and Variability; EAP = Expected a Posteriori or Bayes Mean Estimate; BCI = Bayesian Confidence Interval.

Table 4

Results of the Mixed Effect Location Scale Models: Effects on State Level and Overall State Variability

			Single Prediction		Joint Prediction	
DV	Parameter	Big Five Trait	EAP	BCI	EAP	BCI
Positive	b_{0i}	N	-.032	-.134, .073	-.001	-.094, .095
Affect		E	.072	-.032, .171	.063	-.036, .170
		O	-.016	-.114, .082	-.046	-.145, .051
		A	**.127**	.030, .226	.077	-.029, .184
		C	**.186**	.090, .279	**.164**	.063, .262
	σ^2_i	N	.029	-.061, .119	.014	-.071, .103
		E	-.046	-.134, .043	-.078	-.170, .009
		O	**.130**	.045, .214	**.158**	.070, .243
		A	-.064	-.154, .027	-.033	-.122, .056
		C	**-.122**	-.209, -.031	**-.121**	-.207, -.033
Negative	b_{0i}	N	.128	-.010, .259	.103	-.016, .222
Affect		E	**-.153**	-.283, -.022	**-.138**	-.267, -.005
		O	-.001	-.128, .129	.058	-.064, .178
		A	**-.146**	-.275, -.014	-.047	-.184, .092
		C	**-.227**	-.354, -.097	**-.210**	-.338, -.079
	σ^2_i	N	**.214**	.118, .308	**.187**	.096, .286
		E	**-.174**	-.275, -.079	**-.168**	-.268, -.071
		O	.037	-.065, .140	**.100**	.008, .195
		A	**-.114**	-.217, -.013	-.046	-.149, .054
		C	-.080	-.185, .018	-.059	-.156, .038

Self-	b_{0i}	N	**-.277**	-.429, -.124	**-.228**	-.358, -.100
Esteem		E	**.180**	.021, .328	**.176**	.035, .317
		O	-.015	-.167, .136	-.098	-.234, .033
		A	**.173**	.022, .325	.038	-.114, .193
		C	**.361**	.209, .500	**.334**	.194, .472
	σ^2_i	N	**.226**	.100, .349	**.225**	.104, .351
		E	-.098	-.225, .028	**-.129**	-.260, -.002
		O	**.141**	.016, .263	**.186**	.066, .308
		A	-.029	-.155, .098	.004	-.130, .135
		C	-.004	-.133, .122	.005	-.119, .135
Expressive	b_{0i}	N	.009	-.105, .126	.043	-.057, .143
Behaviors		E	**.113**	.006, .215	**.119**	.009, .221
		O	.005	-.103, .111	-.035	-.135, .066
		A	.084	-.027, .195	.016	-.095, .131
		C	**.194**	.083, .300	**.195**	.089, .302
	σ^2_i	N	**.118**	.020, .216	**.114**	.014, .219
		E	-.061	-.162, .036	-.080	-.186, .023
		O	.085	-.011, .180	**.114**	.016, .217
		A	-.018	-.121, .087	.010	-.099, .113
		C	-.025	-.123, .075	-.026	-.125, .079
Antagonistic	b_{0i}	N	-.082	-.215, .040	-.114	-.234, .006
Behaviors		E	.016	-.113, .135	.051	-.077, .172
		O	-.029	-.155, .096	-.032	-.152, .082
		A	**-.169**	-.295, -.041	-.135	-.265, .002
		C	**-.252**	-.379, -.131	**-.230**	-.356, -.105

σ^2_i	N	-.006	-.119, .101	-.034	-.136, .083
	E	-.085	-.197, .026	-.078	-.192, .035
	O	.053	-.053, .156	.085	-.023, .191
	A	**-.157**	-.260, -.051	**-.154**	-.266, -.039
	C	-.032	-.143, .072	-.001	-.109, .110

Note. N = 118; b_{0i} = Intercept; σ^2_i = Variability; N = Neuroticism; E = Extraversion; O = Openness; A = Agreeableness; C = Conscientiousness; EAP = Expected a Posteriori or Bayes Mean Estimate; BCI = Bayesian Confidence Interval; bold figures are significant with a BCI not including zero.

Table 5

Null-Models of the Three Level Mixed Effect Location Scale Models

DV	Parameter	EAP	BCI
Positive Affect	b_{0i}	5.65	4.37, 5.56
	σ^2_{iW}	-0.61	-0.69, -0.53
	σ^2_{iA}	-2.85	-3.11, -2.48
	$Var(b_{0i})$	0.22	0.16, 0.28
	$Var(\sigma^2_{iW})$	0.28	0.21, 0.36
	$Var(\sigma^2_{iA})$	0.27	0.10, 0.64
	$Cov(b_{0i}, \sigma^2_{iW})$	-0.08	-0.13, -0.03
	$Cov(b_{0i}, \sigma^2_{iA})$	-0.22	-0.35, -0.12
	$Cov(\sigma^2_{iW}, \sigma^2_{iA})$	0.10	-0.06, 0.28
Negative Affect	b_{0i}	2.58	2.48, 2.69
	σ^2_{iW}	-0.85	-0.95, -0.75
	σ^2_{iA}	-4.49	-5.25, -3.93
	$Var(b_{0i})$	0.39	0.30, 0.49
	$Var(\sigma^2_{iW})$	0.40	0.31, 0.49
	$Var(\sigma^2_{iA})$	0.67	0.15, 1.27
	$Cov(b_{0i}, \sigma^2_{iW})$	0.11	0.05, 0.17
	$Cov(b_{0i}, \sigma^2_{iA})$	0.42	0.22, 0.64
	$Cov(\sigma^2_{iW}, \sigma^2_{iA})$	0.33	0.07, 0.61
Self-Esteem	b_{0i}	5.38	5.26, 5.50
	σ^2_{iW}	-0.12	-0.25, 0.00
	σ^2_{iA}	-4.48	-5.92, -3.51
	$Var(b_{0i})$	0.49	0.37, 0.63

	$Var(\sigma^2_{iW})$	0.65	0.51, 0.83
	$Var(\sigma^2_{iA})$	1.28	0.23, 3.09
	$Cov(b_{0i}, \sigma^2_{iW})$	-0.24	-0.36, -0.14
	$Cov(b_{0i}, \sigma^2_{iA})$	-0.67	-1.18, -0.23
	$Cov(\sigma^2_{iW}, \sigma^2_{iA})$	0.59	0.25, 1.05
Expressive	b_{0i}	5.64	5.56, 5.73
Behaviors	σ^2_{iW}	-1.12	-1.22, -1.02
	σ^2_{iA}	-4.01	-4.42, -3.76
	$Var(b_{0i})$	0.26	0.20, 0.33
	$Var(\sigma^2_{iW})$	0.36	0.28, 0.44
	$Var(\sigma^2_{iA})$	0.24	0.06, 0.59
	$Cov(b_{0i}, \sigma^2_{iW})$	-0.04	-0.10, 0.01
	$Cov(b_{0i}, \sigma^2_{iA})$	-0.16	-0.36,-0.01
	$Cov(\sigma^2_{iw}, \sigma^2_{iA})$	0.17	-0.03, 0.33
Antagonistic	b_{0i}	2.54	2.44, 2.64
Behaviors	σ^2_{iW}	-1.27	-1.38, -1.17
	σ^2_{iA}	-5.52	-5.78, -5.18
	$Var(b_{0i})$	0.42	0.33, 0.51
	$Var(\sigma^2_{iW})$	0.43	0.34, 0.54
	$Var(\sigma^2_{iA})$	0.45	0.12, 1.50
	$Cov(b_{0i}, \sigma^2_{iW})$	0.07	0.00, 0.15
	$Cov(b_{0i}, \sigma^2_{iA})$	-0.07	-0.32, 0.24
	$Cov(\sigma^2_{iW}, \sigma^2_{iA})$	0.32	0.02, 0.75

Note. N = 118; b_{0i} = Intercept; σ^2_{iw} = Variability within Contexts; σ^2_{iA} = Variability across Contexts; Var(b_{0i}) = Variance of Intercepts; Var(σ^2_{iw}) = Variance of Variability within Contexts; Var(σ^2_{iA}) = Variance of Variability across Contexts; Cov(b_{0i}, σ^2_{iw}) = Covariance of Intercept and Variability within Contexts; Cov(b_{0i}, σ^2_{iA}) = Covariance of Intercept and Variability across Contexts; Cov(σ^2_{iw}, σ^2_{iA}) = Covariance of Variability within Contexts and Variability across Contexts; EAP = Expected a Posteriori or Bayes Mean Estimate; BCI = Bayesian Confidence Interval.

Table 6

Results of the Three Level Mixed Effect Location Scale Models: Effects on State Level, Within-Context State Variability, and Across-Context State Variability

			Single Prediction		Joint Prediction	
DV	Parameter	Big Five Trait	EAP	BCI	EAP	BCI
Positive Affect	b_{0i}	N	.001	-.081, .078	.027	-.049, .110
		E	**.135**	.060, .221	**.151**	.074, .229
		O	-.013	-.101, .073	-.060	-.136, .021
		A	.065	-.014, .148	.005	-.079, .083
		C	**.118**	.036, .201	**.123**	.041, .203
	σ^2_{iW}	N	.066	-.022, .154	.058	-.025, .147
		E	-.064	-.153, .023	-.090	-.190, .003
		O	**.109**	.022, .202	**.146**	.058, .234
		A	-.076	-.167, .021	-.041	-.135, .054
		C	**-.119**	-.211, -.031	**-.104**	-.189, -.014
	σ^2_{iA}	N	**-.379**	-.682, -.138	**-.400**	-.680, -.090
		E	-.067	-.342, .271	-.034	-.356, .330
		O	.041	-.190, .290	.193	-.103, .456
		A	-.102	-.320, .122	-.085	-.342, .185
		C	**-.328**	-.536, -.072	**-.328**	-.630, -.020
Negative Affect	b_{0i}	N	**.142**	.039, .239	**.090**	.000, .180
		E	**-.202**	-.297, -.101	**-.168**	-.263, -.079
		O	-.046	-.137, .045	.012	-.077, .096
		A	**-.133**	-.233, -.033	-.034	-.126, .055
		C	**-.170**	-.270, -.062	**-.150**	-.241, -.059

	σ^2_{iW}	N	**.207**	.111, .305	**.178**	.084, .279
		E	**-.174**	-.272, -.066	**-.150**	-.255, -.049
		O	.018	-.084, .127	.077	-.020, .177
		A	**-.119**	-.216, -.021	-.043	-.145, .064
		C	-.082	-.178, .019	-.051	-.155, .057
	σ^2_{iA}	N	**.733**	.440, 1.501	**.623**	-.079, 1.414
		E	-.063	-.423, .261	-.149	-.506, .323
		O	**.930**	.534, 1.238	**1.450**	.730, 2.274
		A	**-.983**	-1.266, -.506	**-.748**	-1.607, -.282
		C	**-.661**	-1.378, -.143	**-.865**	-1.369, -.356
Self-Esteem	b_{0i}	N	**-.246**	-.351, -.138	**-.236**	-.342, -.135
		E	**.184**	.059, .314	**.160**	.049, .272
		O	-.013	-.130, .101	-.080	-.184, .021
		A	**.119**	.006, .246	.008	-.103, .115
		C	**.258**	.144, .374	**.238**	.128, .346
	σ^2_{iW}	N	**.228**	.101, .350	**.230**	.108, .354
		E	-.105	-.237, .021	-.134	-.262, .000
		O	**.142**	.022, .257	**.197**	.074, .321
		A	-.037	-.169, .093	.003	-.129, .140
		C	-.005	-.134, .135	.009	-.121, .142
	σ^2_{iA}	N	**.727**	.416, 1.027	**1.166**	.467, 1.768
		E	-.041	-.504, .554	**.798**	.013, 1.513
		O	-.282	-.947, .178	-.039	-.557, .484
		A	.037	-.202, .363	**1.858**	1.019, 2.514
		C	.011	-.494, .589	-.302	-.907, .139

Expressive	b_{0i}	N	.009	-.076, .094	.045	-.033, .123
Behaviors		E	**.165**	.091, .243	**.162**	.081, .245
		O	.052	-.029, .140	.004	-.077, .085
		A	.079	-.007, .158	.013	-.072, .092
		C	**.124**	.042, .201	**.120**	.036, .203
	σ^2_{iW}	N	**.139**	.045, .225	**.134**	.025, .235
		E	-.054	-.158, .037	-.071	-.177, .027
		O	.080	-.013, .176	**.112**	.021, .204
		A	-.032	-.129, .059	-.007	-.114, .100
		C	-.030	-.133, .067	-.024	-.126, .079
	σ^2_{iA}	N	**-.333**	-.631, -.031	-.264	-.699, .111
		E	-.020	-.285, .463	.370	-.429, 1.110
		O	**.530**	.230, .847	**.695**	.068, 1.252
		A	.016	-.239, .236	.207	-.224, .850
		C	**.406**	.089, .866	.418	-.054, .728
Antagonistic	b_{0i}	N	-.087	-.184, .014	**-.127**	-.216, -.024
Behaviors		E	-.020	-.121, .084	.018	-.089, .122
		O	-.057	-.149, .041	-.049	-.142, .048
		A	**-.171**	-.279, -.077	**-.148**	-.244, -.046
		C	**-.183**	-.280, -.083	**-.154**	-.250, -.060
	σ^2_{iW}	N	-.012	-.123, .097	-.046	-.162, .060
		E	-.062	-.171, .050	-.032	-.154, .081
		O	.040	-.063, .135	.056	-.054, .172
		A	**-.161**	-.269, -.055	**-.168**	-.284, -.051
		C	-.012	-.121, .095	.030	-.084, .142

σ^2_{iA}	N	**-.432**	-.892, -.047	.226	-.243, .675
	E	-.317	-.749, .160	**-.788**	-1.284, -.245
	O	.413	-.135, .799	**2.272**	1.547, 2.823
	A	-.117	-.428, .175	.302	-.161, .690
	C	.367	-.318, 1.184	-.111	-.821, .781

Note. N = 118; b_{0i} = Intercept; σ^2_{iW} = Variability within Contexts; σ^2_{iA} = Variability across Contexts ; N = Neuroticism; E = Extraversion; O = Openness; A = Agreeableness; C = Conscientiousness; EAP = Expected a Posteriori or Bayes Mean Estimate; BCI = Bayesian Confidence Interval; bold figures are significant with a BCI not including zero.

Figures

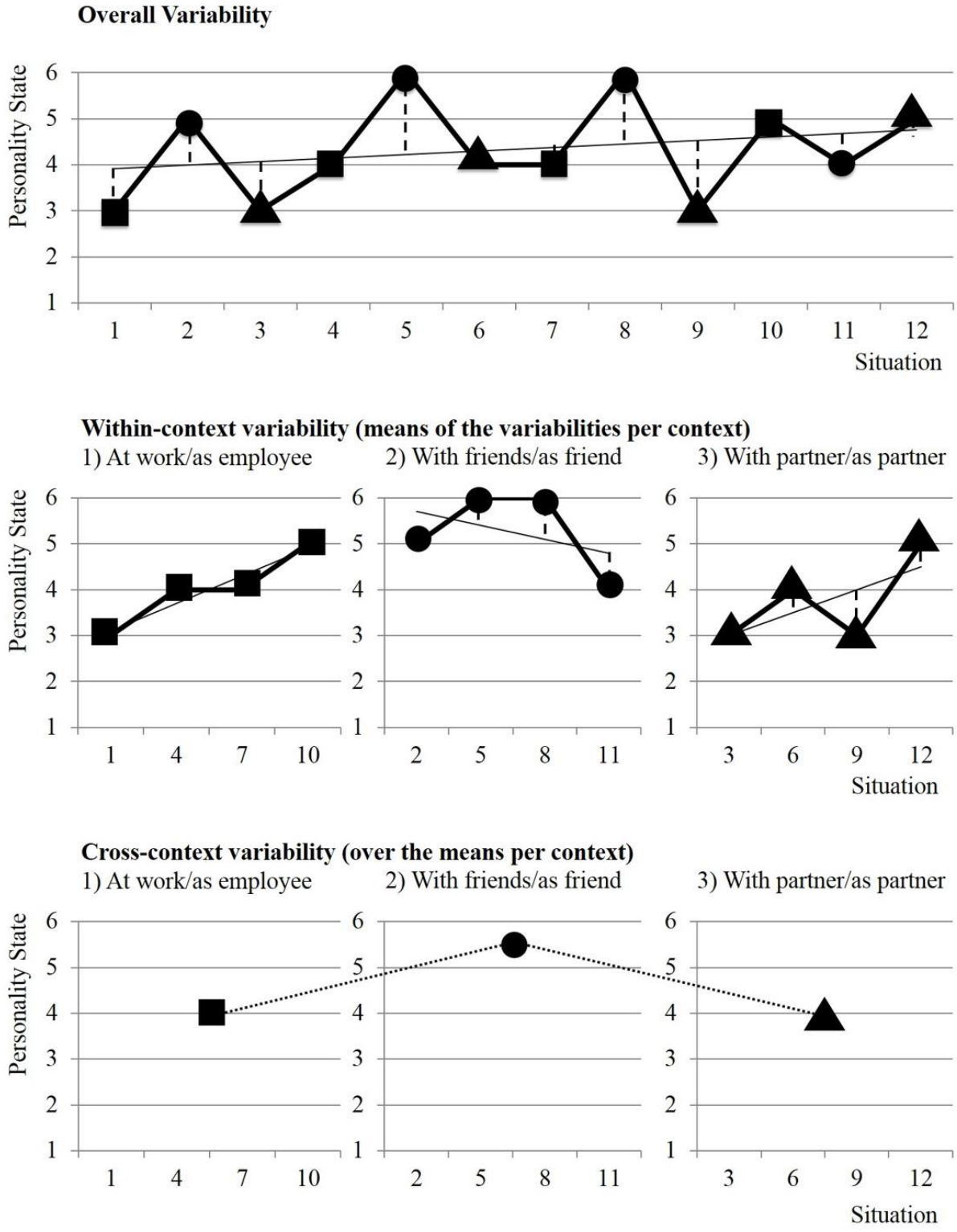

Figure 1. Overall variability, within-context variability, and cross-context variability

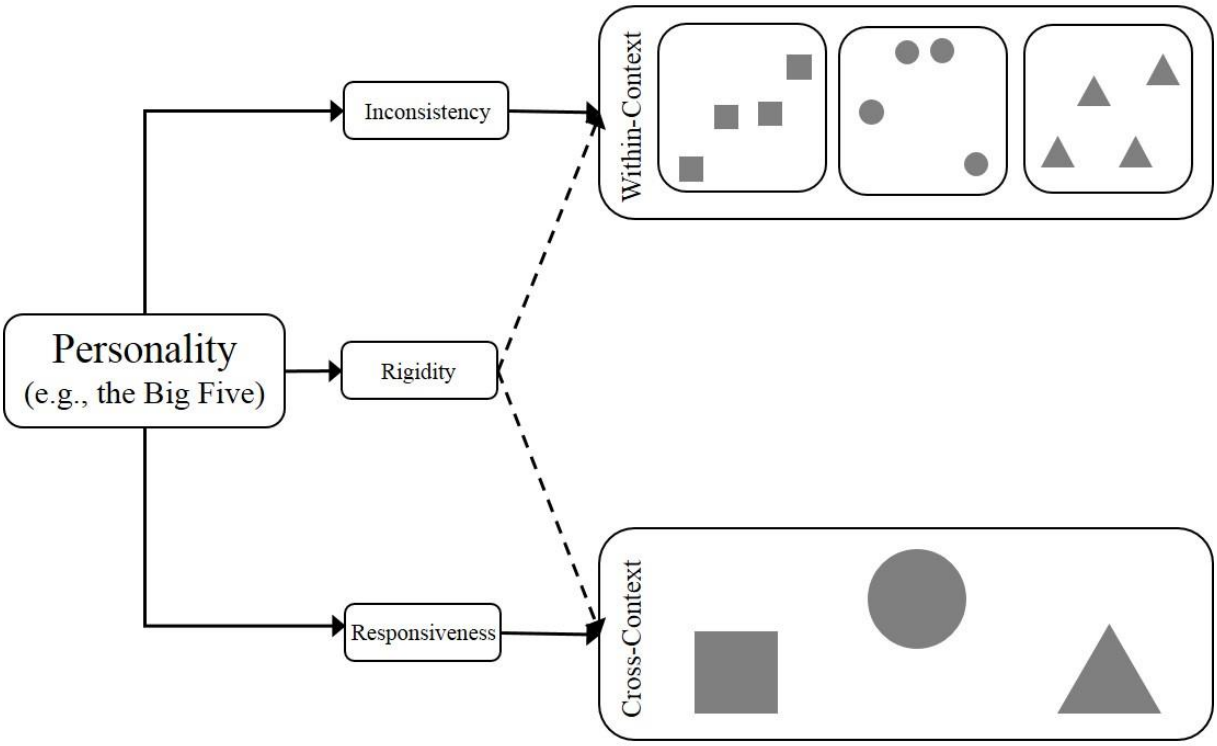

Figure 2. The Within, and Across Context (WAC) Variability Framework illustrating potential processes underlying the relationship between personality and within- and cross-context variability.