



DYNAMIC PERSONALITY SCIENCE. INTEGRATING BETWEEN-PERSON STABILITY AND WITHIN-PERSON CHANGE

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DYNAMIC PERSONALITY SCIENCE. INTEGRATING BETWEEN-PERSON STABILITY AND WITHIN-PERSON CHANGE

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on within- vs. between-person data, the conceptualisation and operationalization of perceived and objective change in situation variables, the malleability of personality and the potential for personality interventions. Integrative approaches using within-person designs provide new, bottom-up insights into general principles of personality that explain differences between people while reflecting the complexities of within-person personality dynamics at the level of the individual.

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Personality can be understood from at least two perspectives. One focuses on stable, between-person differences, or traits. The other perspective focuses on within-person differences and dynamics, i.e., fluctuations in personality in response to situations and across time. This Research Topic reflects recent developments in personality research to integrate both trait and dynamic perspectives. An integrated view on personality recognizes both stability in between-person differences and within-person change. Contributors are drawn from research teams across Europe, North America and Australasia, and from basic and applied fields, including organizational, educational, and clinical. The studies reported provide new evidence in support of an integrative approach, highlight currently active areas of research and propose new directions of research. Current streams of research include the study of contingent units of personality and within-person processes underlying traits, the comparisons of findings based

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Editorial: Dynamic Personality Science. Integrating between-Person Stability and within-Person Change

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Editorial on the Research Topic

Dynamic Personality Science. Integrating between-Person Stability and within-Person Change

“Personality is the dynamic organization within the individual of those psychophysical systems that determine his characteristic behavior and thought” (Allport, 1961, p. 28).

Trait theorists and social-cognitive theorists have begun to integrate their respective descriptions and explanations of personality. The new framing of personality accommodates both between-person stability and within-person variability in personality. Whilst individuals differ from each other in predictable ways—differences that can sufficiently be described by broad trait constructs such as neuroticism, conscientiousness, agreeableness, openness, extraversion, and core self-evaluations—they also vary systematically in the ways they respond to situations they encounter and change as a person over time. An integrated framework of personality raises many interesting questions. This Research Topic aims to move forward frontiers, both conceptually and empirically, for several of those questions. We provide new evidence in support of an integrated approach to personality, highlight currently active areas of research, and propose new directions of research into why individuals think, feel, and behave the way they do.

Research on the integrated approach to personality is now being conducted by research teams in Europe, the USA, and Australasia, much of which is captured by the papers in this Research Topic. Currently, there are several well-developed theoretical frameworks of integrated personality (e.g., Mischel and Shoda, 1995; Cervone, 2004; Fleenor and Jayawickreme, 2015) but empirical research is still in relatively nascent stages. There is a long way to go before the accumulated body of findings provide the level of robust support evident in trait research, particularly for the Big 5. Hopefully, the papers in this Research Topic, along with other similar offerings (e.g., special issues in *European Journal of Personality*, 2015; *Journal of Research in Personality*, 2015, *Journal of Research in Personality*, in press; *Personality and Individual Differences*, under review; *Journal of Organizational Behavior*, under review), will enable researchers to take stock and focus their research on the more important unanswered questions and speed up the accumulation of knowledge across different research agendas.

Initial steps toward the integration of traits and the systematic motivational dynamics of behavior tended to focus on the explanatory mechanisms for the impacts of traits on behavior using multi-trial experiments and field studies to capture the translation of traits into motivational states and responses. This research has a relative long tradition (e.g., Wood and Bandura, 1989) and is captured by two of the papers in this Research Topic (Cuadrado et al.; Hofmans et al.). More recently, the numbers of trials or measurement moments for within-person states have been extended through the use of digital technologies, which has enabled individual level modeling of

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the within-person dynamics. Several papers in this issue provide applications of individual level modeling in different areas of application, including the relational self (Andersen et al.), aesthetic appreciation (Fayn et al.), psychopathology (Wright et al.), situation change networks (Rauthmann and Sherman) and implicit theories (Cripps et al.).

As reflected in the opening quote, the papers in this Research Topic build on a tradition of studying personality from a within-person perspective that dates back at least to Allport (1937), who described a person-centered approach that focused on the organization of personality attributes within the individual and the development of the personality system over time (Allport, 1961). Allport's work was preceded by that of German psychologist Stern (1911), whose framework included *psychography*, which he described as the study of attributes within an individual (Asendorpf, 2015). Block (1971; Block and Block, 1980) drew a distinction between person-centered approaches that focus on the organization of traits or prototypes and variable-centered approaches that focus on the covariation of traits in the population. He identified personality prototypes derived from his theory of ego resiliency and ego control that described different configurations of Big 5 traits. The three personality prototypes identified by Block (1971), resilient, undercontrolled, and overcontrolled (also known as ARC types¹), have been widely researched and are generally considered as having the strongest theoretical foundation and empirical rigor of existing typologies for the classification of individuals as personality types (Chapman and Goldberg, 2011).

The focus in this Research Topic is data *collected across occasions* at the within-person or intra-individual level (idiographic) to come to conclusions about groups of people or the population (nomothetic). The ARC types discussed by Asendorpf (2015) and others (e.g., Chapman and Goldberg, 2011) are not based on repeated observations of individuals. They base their conclusions on the same data as between-person trait analysis (in Stern's framework "correlation research") but the data is analyzed differently using Q-sort or inverted factor analysis (in Stern's framework "comparative research").

The new approaches to measurement of personality states have also led to the introduction of new statistical methods. The earlier approaches to the integration of stable between-person traits and dynamic within-person states relied on group-level methods such as repeated measures ANOVAs and SEM (e.g., Wood and Bandura, 1989; Cuadrado et al.), which are limited in their applicability to inferences about individuals. More recently, integrative approaches have employed growth curve modeling and Bayesian techniques (e.g., Cripps et al.; Hofmans et al.) to model repeated personality responses at the individual level.

These developments within personality psychology have run in parallel with new methodologies for studying the development of types, such as the ARC types (resilient, undercontrolled, and overcontrolled), in developmental psychology (Asendorpf, 2015), and personality assessment procedures in clinical psychology

(Shedler and Westen, 2007). Asendorpf (2015) provides a critical review and recommendations for the methods and measures used in studies of ARC types that include assessments of the elevation, shape, and scatter of intra-individual personal profiles or configurations of traits. These include the Q-factor analyses pioneered by Block (1971), cluster analysis and more advanced methods such as latent cluster analysis (LCA). In clinical psychology, the Shefner-Westen Assessment Procedure (SWAP) provides clinicians with a diagnostic tool that integrates the scientific rigor of empirical approaches with the complexity and relevance required in clinical assessments. The SWAP includes a dictionary of 200 statements that provide detailed descriptions of diagnostic behaviors, including motives, functions, and contextual details, which enables clinicians to develop a profile of the patient using the Q-sort method. The SWAP has been shown to have good reliability, validity, and clinical utility (Shedler and Westen, 2007; Blagov et al., 2012) and is a measurement method that could be used in other applied areas, such as organizational psychology. However, as noted above, these data collection methods and analyses do not capture the intra-individual dynamics provided by data collected across occasions.

The areas of research identified by the papers in this Research Topic and requiring further attention include: The requirements for integration of between- and within-person factors; the conceptualization and operationalization of within-person units of personality; the study of within-person processes as antecedents and/or consequences of between-person individual differences; the comparison of within- vs. between-person personality structures and processes; the conceptualization, categorization, and measurement of situations; personality interventions based on the integrated approach; and data collection methods.

APPROACHES TO BETWEEN- AND WITHIN-PERSON INTEGRATION

A central objective of this Research Topic is to integrate and, where possible, to synthesize different conceptual and methodological approaches to the study of personality and their empirical outcomes. Work on the integrative perspective has been developing on several fronts, including: (1) A general acknowledgement that there is both stability and variability in personality and that it is worth studying both short- (state) and long-term (trait) personality change (e.g., Liu and Huang); (2) Comparison and the linking of findings from within- and between-person analyses (e.g., Wright et al.; Fayn et al.); (3) The conceptualisation of units of personality that are based on within-person data and represent individual differences in within-person structures and processes (e.g., Minbashian et al., 2010, in press); (4) Going beyond the descriptions of groups and individuals solely in nomothetic and idiographic terms, respectively (e.g., Lakey; Wright et al.; Cripps et al.).

Within-person refers to the analysis of structure and processes based on the repeated measurement of the same individual(s) over time and situations. The resulting data can be used to

¹ARC refers to Asendorpf-Robins-Caspi, who were the lead authors of three articles that reported the initial extensions of Block's types (Caspi and Silva, 1995; Robins et al., 1996; Asendorpf et al., 2001).

describe processes and structures that apply to a group of individuals (nomothetic, e.g., Minbashian et al., 2010) as well as single individuals (idiographic, e.g., Cripps et al.). Lakey demonstrates the integrated approach by using a variance partitioning approach to distinguish between Person effects (P), Situation effects (S), and $P \times S$ effects (i.e., individual profiles of responses across situations). Both S and $P \times S$ effects represent within-person variance (see also Wright et al. for nomothetic and idiographic within-person structures). Similarly, the process of transference outlined by Andersen et al. is thought to be common to all individuals (nomothetic within), whilst the underlying interpersonal knowledge structures are unique to single individuals (idiographic within). Cripps et al. demonstrate how individual growth curves (idiographic within) belong to groups based on implicit theories of ability (nomothetic).

More research on the nomothetic within-person effects that explain behavior is one path for gaining insights into general principles of personality that apply to individuals. This proposal is far from being new (e.g., see already Lamiell, 1981, 2013, 2014). However, there is now an increasing awareness of the necessity to study individuals repeatedly over time in order to adequately describe, explain, and predict the psychological processes underlying behavior (e.g., Roe, 2008, 2014; Grice, 2015; Grice et al., in press). This, together with the availability of new technology (e.g., apps and mobile devices) and statistical advances that enable researchers to collect and model extensive repeated measurement data more efficiently and effectively will allow researchers to make greater progress.

WITHIN-PERSON UNITS OF PERSONALITY

Investigation of the systematic components of within-person processes has included studies of stable between-person differences in within-person effects. Cripps et al. for example, identify different functional forms of the repeated responses for individuals with entity and incremental implicit theories (Dweck, 1999) and model their differential responses to performance setbacks. Contingent units of personality are another example. These studies are promising in that they provide evidence in support of the conceptualisation and operationalization of personality in terms of contingent, “if this ... then that ... units” or behavioral signatures of the CAPS model (see Mischel and Shoda, 1995). Contingent units of personality are trait-like in that they are relatively stable between-person constructs, however, and in contrast to other traits such as the Big Five, they represent within-person structures and processes. Specifically, contingent units of personality describe (a) within-person variation in personality states as a function of within-person variation in situation perceptions, and (b) between-person differences in the strength and direction of within-person situation-state relationships. For instance, task-contingent conscientiousness refers to individual differences in the level with which one responds to increases in task demands with increases in state conscientiousness (Minbashian et al., 2010). In contrast to the conscientiousness trait, the focus is on a person’s responsiveness to situational demands rather than their overall level of conscientiousness. Others have identified

similar situation-response contingencies for other traits (e.g., Fleeson, 2007; Berenson et al., 2011; Huang and Ryan, 2011; Judge et al., 2014; Sherman et al., 2015). However, they still await wider replication. Little is known about their positioning within a nomological network and their predictive validity. To our knowledge only one study has shown that a contingent personality unit is correlated with a performance outcome variable (Minbashian et al., 2010).

Hofmans et al. provide novel findings into the functional forms of the contingent relationships modeled in the “if this ... then that” units, which highlight the need for further research. Previous research has modeled the relationships in contingent units of personality as linear in form. Hofman and colleagues show that the relationship between work pressures and core self-evaluation (CSE) states is curvilinear. Hofman and colleagues’ argument for an inverted U shaped functional form was based on an established body of evidence, that of how the impact of work pressure on performance follows an inverted U form (Yerkes and Dodson, 1908; Gardner and Cummings, 1988). Future research utilizing contingent units of personality will need to consider theoretical arguments and empirical evidence for different functional forms based on existing research evidence for the impacts of situational variables.

WITHIN-PERSON PROCESSES

Within-person mechanisms underlying between-person differences, i.e., traits, have been studied extensively; and models of the within-person relationship between personality variables and relevant outcome variables, such as performance, have been devised for several traits. Many studies prioritize between-person differences by starting with well-established trait variables (e.g., Big Five) to then investigate underlying within-person processes that might explain why a specific trait is predictive of certain behavior. For example, Fayn et al. show that the personality domain Openness/Intellect reflects individual differences in aesthetic appreciation due to underlying appraisal-emotion contingencies that unfold at the level of the individual.

Studies have also uncovered the within-person mechanisms that link stable individual differences with behavior for traits outside the Big Five, including, in this Research Topic, dispositional prosocialness (Cuadrado et al.) and core self-evaluations (CSE, Hofmans et al.). Cuadrado et al. show how dispositional prosocialness and other dispositions are manifest as prosocial motivational states that predict levels of prosocial behavior. Consistent with theories of prosocial behavior and the conceptualizations of traits as individual differences in the sensitivity to situations (Marshall and Brown, 2006), Hofmans et al. and Cuadrado et al. provide some support for the moderation of relationships between traits and related reactions and responses. Hofmans and colleagues demonstrate that the sensitivity of individual CSE states to work pressure is moderated by levels of trait CSE. For those with low trait CSE “the depleting effect of work pressure via state CSE happens at low levels of work pressure, while for people high in trait CSE the depleting effect is located at high levels of work pressure” (Hofmans et al.).

Other authors prioritize within-person processes and start with process-level variables as antecedents of between-person individual differences. The work by Andersen et al. on the relational self provides a good example of such an approach in their application of the CAPS model of Mischel and Shoda (1995) to the interpersonal domain. The authors outline how idiosyncratic within-person knowledge structures and processes might explain the emergence of stable, between-person differences as described by specific traits such as rejection sensitivity, and potentially—though this is an open empirical question—more global interpersonal traits such as agreeableness and extraversion. Whilst it seems sensible to use the Big Five as an organizing framework from where to start (top-down), this might also be limiting. Starting with process-level investigations (bottom-up) might lead to the emergence of traits that are not covered by the Big Five. Thus, we suggest the top-down approach be complemented by a bottom-up approach.

COMPARISONS OF WITHIN-PERSON AND BETWEEN-PERSON PERSONALITY STRUCTURE AND PROCESSES

Between-person findings are often used as proxies for within-person phenomena even though it has been repeatedly demonstrated that this is inappropriate (see Lamiell, 1981, 2014; Nezlek, 2001; Borsboom et al., 2003; Molenaar, 2004; Schmitz, 2006; Grice, 2015). Within-person structures and processes may not be the same as those identified for related traits (e.g., Borkenau and Ostendorf, 1998; Grice et al., 2006; Beckmann et al., 2010). Wright et al. investigate the structure of psychopathology in individuals with personality disorder. Whilst at the between-person level they found a two-dimensional structure comprising the widely accepted broad dimensions of mental disorder (internalizing, externalizing), findings at the within-person level suggested a more differentiated four-dimensional structure of psychopathology (negative affect, detachment, hostility, impulsivity). Building on recent developments in structural equation modeling (e.g., unified SEM) they also demonstrate how modeling of the dynamic patterns of daily responding for individuals provides information about the person's psychological functioning of relevance to clinicians (see also Rauthmann and Sherman, for individual-specific situation change networks).

Another frontier is the type of statistical methods used to model within-person processes. Two of the papers in this issue use Bayesian techniques to model within-person processes (Cripps et al.; Hofmans et al.). Bayesian techniques are not widely used or understood in psychology and are not yet available in easy to use packages but offer additional flexibility in the modeling of complex and dynamic response patterns at the level of the individual. For example, they can provide an estimate of the probability with which each individual in a sample conforms to the proposed hypothesis or model. Also, because they do not assume asymptotic normality of the sample estimates, inferences about patterns

of individual responding can be made based on relatively few observations. As Bayesian and other statistical techniques become more widely available, there is no excuse for not collecting intensive repeated measurement data and modeling within-person processes longitudinally and at the level at which they occur—the individual.

SITUATIONS

Situations are central to an integrated view on personality because of the impacts they have on within-person variations in cognitive, affective and behavioral responses. This has become a very active area of research (e.g., Wood et al., 2011; Rauthmann et al., 2015). The recently introduced taxonomies provide personality researchers with tools to conceptualize, categorize, and measure situations, and a language to communicate about situations, both with regard to objective features (PERLS, Nofle and Gust, 2015) and subjective perceptions of situations (DIAMONDS, Rauthmann et al., 2014; Rauthmann and Sherman, 2016; CAPTION, Parrigon et al., 2017). An alternative approach to the study of situations is to focus on specific domains (e.g., tasks or interpersonal domains), and study them at a more fine-grained (e.g., facet) level. In the task domain, for example, this may include perceived task support, task difficulty, task urgency, task importance, and task controllability (Minbashian et al., 2010; see Judge and Zapata, 2015, for work-related context variables, and Wood (2005, Table 1) for categories of organizational events and work arrangements that stimulate and facilitate self-regulatory processes).

Regardless of the degree of specificity, study of the dynamic components of personality requires an understanding of how and why situations and perceptions of situations change and how these changes relate to short- and long-term changes in personality. Rauthmann and Sherman outline a comprehensive research programme to study situation change, including person-situation transactions, and provide preliminary data illustrating their approach at both the between- and within-person level of analysis.

Clearly, the choice of situational variables will need to be based on the theoretical arguments that link situations to responses of interest. For example, perceived collaboration in a team setting could be expected to reduce the risks associated with extraverted responses such as gregariousness and contributions to conversations. Therefore, on average, this would produce a positive relationship between perceived collaboration and state extraversion. However, assessments of risk may differ between individuals and lead to different scores for the collaboration-extraversion relationship. Established group level predictors for response states of interest—such as perceived justice as a predictor of compliance with requests—will provide a useful source of ideas for the situational variables to study.

We now consider two areas of research that we think deserve more attention. These are the malleability of personality (including the question of how to bring about personality change), and the measurement of dynamic components of personality.

PERSONALITY MALLEABILITY AND PERSONALITY INTERVENTIONS

Topics might include the trainability of personality, personality change in response to life events (e.g., work, schooling), and personality interventions for clinical and non-clinical samples (e.g., in educational, organizational settings). Whilst there is now considerable evidence of short-term within-person variability in personality states (e.g., Fleeson, 2001; Fleeson and Gallagher, 2009; Judge et al., 2014; Fleeson and Jayawickreme, 2015; Fleeson and Law, 2015), a growing literature provides evidence about long-term within-person change in personality traits in response to changes in life circumstances (e.g., Lüdtke et al., 2011; Bleidorn et al., 2016; Niehoff et al., 2017; for short-term trait change see Shields et al., 2016). For example, Liu and Huang studied personality change in the context of cross-cultural adjustment. They show that both the initial level of contextualized extraversion as well as the rate of observed change in extraversion in response to new cultural experiences predicted adjustment outcomes. Evidently, personality change was an important precursor of transition success. Individual differences in personality malleability, i.e., flexibility in personality responding, might indicate an underlying ability that enables some individuals to better adapt and adjust to various changes in life circumstances than others. To date, there are few studies of how insights about malleability can be used for training and other interventions targeting personality change. Hudson and Fraley (2015), for example, show that people can actively change their personality traits, if they are motivated to do so, and such change can be facilitated by carefully designed interventions. Hermesen et al. (2016) give an example of how providing feedback through digital technology can be used to disrupt and change habits, which may also be employed in reshaping the contingent units of personality that predict targeted behaviors.

MEASUREMENT CONSIDERATIONS

Mill et al. provide a timely reminder of potential biases in the measurement of emotions, one of the core responses in units of personality. They show how ratings of emotions that require retrospective recall ranging from 1 day to 2 weeks are more negative for older people and for those who are more tired at the time of the data collection, when compared to those who are younger and less tired. They also found that recollections of fear, sadness, anger, and happiness emotions were related to selected Big Five personality traits. The Mill et al. findings highlight the need for measurement of both trait and state emotions to take account of a range of potential biases in responses. Experience sampling measures of emotions that ask for a daily recall may also differ in systematic ways from those that collect more immediate responses multiple times each day.

More generally, work is needed to establish the psychometric quality of experience sampling personality state measures.

Researchers interested in the measurement of personality traits will find a number of validated instruments. These are much harder to find for the measurement of personality states using experience sampling designs in the field (see Finnigan and Vazire, 2017, for a recent validation study). An additional complication is that the number of items that can reasonably be presented to participants on a daily basis has to be relatively small, providing less room for exploration and testing of new questions. It also means that often only a subset of items is taken from established measures.

Second, and following from the first point, research should test the validity of more efficient measurement procedures for the collection of data used to assess dynamic components of personality. The experience sampling method that is commonly used to collect within-person data is a labor intensive procedure that might extend over several weeks. Participants sometimes find the daily requests for responses intrusive and they might not respond if they are engaged in an activity. Thus, it is worth testing alternative approaches and their validity. For example, the semantic sequential priming task might be a more efficient method to assess contingent units of personality (Moeller et al., 2010; Berenson et al., 2011).

These are exciting times for personality researchers. The integration of trait and social-cognitive theories promises to bring about a more differentiated understanding of personality, it also highlights where “blind spots” have been and data is still scarce or missing. There is also the added advantage of considering personality as a phenomenon that is, at least in principle, malleable. As more data become available on how to facilitate personality change, psychologists will be better able to support individuals to become the person they aspire to be. It is here where personality research might be most relevant and have lasting impact outside the ivory towers of academia.

In conclusion, the papers in the current issue highlight both progress toward and areas requiring further research for an integrated approach to personality. Hopefully, researchers across the different sub-disciplines of psychology, including health, educational, and organizational psychology will find ideas in the theories and approaches outlined in the papers in this Research Topic and beyond to inform their own research.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Understanding the P × S Aspect of Within-Person Variation: A Variance Partitioning Approach

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This article reviews a variance partitioning approach to within-person variation based on Generalizability Theory and the Social Relations Model. The approach conceptualizes an important part of within-person variation as Person × Situation (P × S) interactions: differences among persons in their profiles of responses across the same situations. The approach provided the first quantitative method for capturing within-person variation and demonstrated very large P × S effects for a wide range of constructs. These include anxiety, five-factor personality traits, perceived social support, leadership, and task performance. Although P × S effects are commonly very large, conceptual, and analytic obstacles have thwarted consistent progress. For example, how does one develop a psychological, versus purely statistical, understanding of P × S effects? How does one forecast future behavior when the criterion is a P × S effect? How can understanding P × S effects contribute to psychological theory? This review describes potential solutions to these and other problems developed in the course of conducting research on the P × S aspect of social support. Additional problems that need resolution are identified.

Keywords: Person × Situation, P × S, SRM, RRT, G theory, within-person variation

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We often describe people's personality characteristics. For example, I might describe David as more conscientious than Sarah. What do I mean by that? In one sense, the word conscientious organizes a group of characteristics such as diligence and frugality. So, by saying that David is more conscientious than Sarah I mean that he is more diligent and frugal. In another sense, I mean that David is more conscientious than Sarah across situations and time. Pick a group of randomly selected situations, and on average, David will be the more conscientious. This is how most people think about personality most of the time. Yet, there is another way to think about personality. One can think of David and Sarah's unique profile of conscientiousness across situations (within-person variation). For example, David might be more conscientious than Sarah when monitoring household savings, but Sarah might be more conscientious in managing property owned by the family. This article is about such within-person variation.

This article describes a variance partitioning approach to within-person variation based on Generalizability (G) Theory (Cronbach et al., 1972) and the Social Relations Model (SRM; Kenny et al., 2006; Kenny, unpublished computer program). G Theory and the SRM are closely related and can be treated as variations of the same approach for the purposes of this article. The approach defines within-person variation as differences among persons in their profiles of reactions to the same situations, beyond (1) the person's trait-like tendency to respond in the same way on average, to all situations, and (2) the situation's tendency to evoke the same response, on average, across people. The approach has revealed very large P × S effects for a wide range of constructs, including anxiety

(Endler and Hunt, 1966, 1969), five-factor traits (Van Heck et al., 1994; Hendriks, 1996), leadership (Livi et al., 2008; Kenny and Livi, 2009), social support (Lakey and Orehek, 2011) and task performance (Woods et al., in press).

Yet, the approach has not reached its full potential because of conceptual and analytic challenges, as investigators seem to have trouble moving beyond estimating the strength of P×S effects. One commonly sees a few studies showing strong P×S effects and no further progress. This stunted progress leaves many important questions unposed and unanswered. For example, what is the psychological meaning of P×S effects and how is this different from the effects of personality traits and situations? How does one conduct research to reveal this psychological meaning? Can P×S effects forecast important outcomes (e.g., leadership or job performance)? What research designs are appropriate for such forecasting? How can understanding P×S effects inform psychological theory? This article describes proposed solutions to many of these questions by drawing from recent P×S research on social support and identifies additional problems to be solved. This article will focus on conceptual issues rather than on statistical procedures. There are many excellent sources for estimating P×S effects and many are cited in this article.

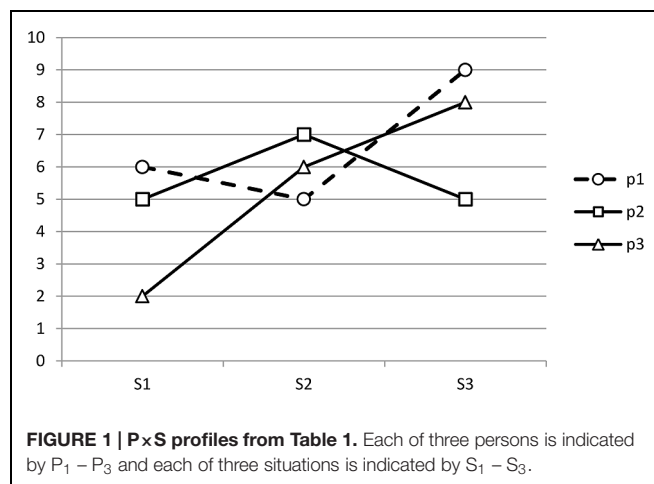
CONCEPTUAL BACKGROUND

Key Definitions

The variance partitioning approach defines P×S effects quantitatively, typically in repeated-measures experimental designs. Consider the design in which persons are exposed to the same situations and their anxiety in each is assessed (Table 1). There are three effects in this design: person, situation and Person × Situation interactions. Defining P×S effects requires that one first define person and situation effects.

Person effects indicate how much people differ from the grand mean in their levels of anxiety, averaged across situations. For example, Person 1 has higher anxiety than average, whereas Persons 2 and 3 have lower than average anxiety (Table 1). This effect reflects trait-like personality, as well as cross-situational consistency (Mischel, 1968) and is the traditional focus of personality psychology.

Situation effects indicate the extent to which situations differ from the grand mean in the extent to which they evoke anxiety, on average, across persons. For example, Situation 1 evokes lower anxiety in people than average, whereas Situations 2 and 3 evoke



higher anxiety than average (Table 1). Situation effects are the typical focus of social psychology, but when estimated in repeated measures designs, also reflect within-person variation. Situation effects reflect normative variation in how persons' anxiety, on average, ebbs and flow from one situation to the next. The effect is normative in that it captures people's typical responses.

P×S effects reflect how people differ in their profiles of anxiety across situations. For example, in Table 1 and Figure 1, Person 1 has a different profile of anxiety across the three situations than does Person 2. Person 1 is highly anxious at funerals (S₃), but not when giving speeches (S₁) or when on first dates (S₂). Persons 2 and 3 display a different pattern. P×S effects are defined quantitatively, and thus with clarity and precision: $P \times S = X_{ij} - P_i - S_j + M$ in which x_{ij} is person i 's score in response to situation j . The person's mean score across all situations (person effects) is P_i , S_j is the situation's mean score across all persons (situation effects) and M is the grand mean. That is, Person 1 responds with more anxiety to funerals (x_{ij}) than how she typically responds to situations on average (P_i), and with more anxiety than people typically experience at funerals (S_j). Phrased differently, funerals evoke unusually high anxiety in Person 1. Thus, like situation effects, P×S effects reflect within-person variation. However, P×S effects reflect within-person variation that is idiosyncratic to specific persons whereas situation effects reflect normative variation. Like person effects, P×S effects also capture individual differences. However, P×S effects reflect differences among persons in their profiles of responses to situations whereas person effects reflect differences among persons, on average, across situations.

The Development of the Variance Partitioning Approach

The variance partitioning approach emerged first from Cronbach et al.'s (1972) G theory of test reliability. G theory describes how to conceptualize and estimate various substantive effects and sources of measurement error. Substantive effects are what investigators want to measure and error is everything else. The designs for estimating P×S effects are essentially similar to, and were derived from, designs used to estimate

TABLE 1 | An example of a simple structure of a design to reveal Person × Situation effects.

	S ₁	S ₂	S ₃	Mean
P ₁	6	5	9	6.7
P ₂	5	7	5	5.7
P ₃	2	6	8	5.3
Mean	4.3	6.0	7.3	5.9

Each of three persons is indicated by P₁ – P₃ and each of three situations is indicated by S₁ – S₃.

test reliability. Consider again **Table 1**. If one substitutes test items for situations, we have the classic design for estimating measurement error and the internal consistency of a test. Thus, person effects reflect the extent to which people differ in anxiety, on average across items. This is typically what investigators want to measure. Person × Item interactions are essentially Person × Situation interactions: the extent to which people have different profiles of responses across items. Within the context of measurement theory, P×I interactions indicate the extent to which differences among people depend upon the item (i.e., measurement error). Internal consistency reliability is based on the relative strength of person effects and Person × Item interactions, as well as the number of items in a test. The key insight was that the same procedures for estimating Person × Item effects (i.e., measurement error) could be used to estimate P×S effects. Endler and Hunt (1966, 1969) were the first to apply this insight when Cronbach, Endler, and Hunt were at the psychology department at the University of Illinois (Urbana/Champaign) in the early 1960s. These analyses were sufficiently advanced in their day that they had to be calculated with the university's supercomputer.

The second major approach to studying P×S effects is the SRM (Warner et al., 1979; Kenny and La Voie, 1984; Malloy and Kenny, 1986; See Back and Kenny, 2010, for an accessible introduction). The SRM defines P×S effects in the same way as G theory, but applies to the special case in which other people are the situations and persons rate each other in a round-robin design. That is, instead of studying persons' reactions to funerals, speeches and first dates, one studies reactions to Jenny, Richard, and Stephen. Treating people as situations is an important conceptual advance and the SRM also reveals effects not encountered in G theory. Social psychology typically examines classes of situations at a high level of abstraction that averages out the specifics. The hope is that what is learned about situations transcends the particulars, including the specific people who populate the situations (Kenny, 2006). Yet, funerals are very different depending upon whom the funeral is for and who is present. A funeral for the parent of a co-worker is one thing; a funeral for your parent is something else entirely. A funeral for your parent when you like your family is different from a funeral when you dislike your family. In other words, the SRM assumes that important determinants of the effects of situations are the specific people who populate the situation.

EVIDENCE FOR STRONG P×S EFFECTS

There are very strong P×S effects for many constructs, including family negativity (Rasbash et al., 2011), attachment (Cook, 2000), person perception (Park et al., 1997; Branje et al., 2003), aggression (Coie et al., 1999), psychotherapy (Marcus and Kashy, 1995; Lakey et al., 2008), romantic attraction (Eastwick and Hunt, 2014), and many more. The next section provides a more detailed review of P×S effects on anxiety, five-factor personality traits, perceived social support, leadership, and performance. The strength and replicability of P×S effects are impressive.

Anxiety

Endler and Hunt (1966, 1969) applied the variance partitioning approach to P×S interactions in their seminal studies of anxiety. Endler and Hunt developed a questionnaire that assessed anxiety in specific situations. For example, "You are just starting off on a long automobile trip," "You are getting up to give a speech before a large group," and "You receive a summons from the police." The data were analyzed as a Person × Situation design, as described previously (**Table 1**). Across 22 separate samples, P×S effects accounted for 17% of the variance in anxiety. Person effects accounted for 8% and situations accounted for 7%. That is, there were large effects whereby people had different profiles of anxiety across situations. For example, Richard might have more anxiety in response to receiving a summons than in making a speech; whereas Stephen might have more anxiety in making a speech than in receiving a summons. There were also substantial person effects whereby some people reported more anxiety, on average, across situations than did others. For example, Richard might be more anxious on average than are others. In addition, there were substantial situation effects whereby some situations (e.g., receive a summons) evoked more anxiety in people than did other situations, on average (e.g., beginning a car trip).

Ingraham and Wright (1987) also found very large P×S effects in anxiety using the SRM. They used a round-robin design in which each person in the sample rated every other person (i.e., situations) on how much anxiety the other evoked. Study 1 was composed of graduate students participating in a group therapy training experience and Study 2 was composed of group therapy outpatients. There were large P×S effects in both studies, accounting for 37% of the variance. For example, Richard experienced less anxiety with Stephen than (1) Richard typically experienced across people, and (2) Stephen typically evoked in people. That is, anxiety largely reflected the unique relationship between two people. For comparison, person effects accounted for 15% of the variance and situation effects (other people) accounted for only 3%. Very strong P×S effects on anxiety were recently replicated in round-robin studies of Marines and college roommates (Lakey et al., in press).

Thus, there are very large P×S effects in anxiety that are at least as large as trait anxiety. These findings replicate well, are found for nominal situations (e.g., funerals) as well when situations are other people.

Five-Factor Traits

The five-factor model of personality has been widely influential as a standard framework for organizing personality characteristics, and the five traits are typically viewed as broadly generalizable across situations (Goldberg, 1990). Yet, people also have large idiosyncratic patterns in their levels of traits across situations. Van Heck et al. (1994) assessed neuroticism, extroversion, conscientiousness, agreeableness, and openness in a wide range of situations through self-report. Among Dutch and Italian college students, P×S, person, and situation effects were approximately equally strong, with each accounting for about 12% of the variance. Hendriks (1996) replicated these findings among Dutch college students and included peer reports as well. There were large P×S effects accounting for about 20% of

the variance for each of the five traits. Hendriks (1996) also found person ($\approx 20\%$) and situation effects ($\approx 12\%$). Thus, although people differ in their typical levels of the five factor traits (person effects), people also have idiosyncratic profiles in their responses to situations. For example, Person 1 might have high levels of agreeableness during a quarrel and low levels when playing a game. Person 2 might show the opposite pattern. In summary, five factors traits show strong P×S effects.

Perceived Support

Perceived support is the subjective judgment that friends and family would help during times of need and is a well-replicated marker of emotional well-being (Cohen and Wills, 1985; Barrera, 1986). Studying P×S effects for perceived support is essentially similar to studying anxiety or personality except that (1) the situations are people who provide support and (2) persons rate the supportiveness of providers rather than their own anxiety or personality. In a meta-analysis, P×S effects accounted for 62% of the variance in supportiveness (Lakey, 2010). Thus, the extent to which a person sees a provider as supportive is mostly idiosyncratic to the person. Phrased differently, the supportiveness of a provider reflects the unique relationship between the person and the provider. In addition to P×S effects, perceived support also reflects persons' trait-like tendencies to see other people as supportive (27%) and a relatively small portion (7%) reflects agreement among persons that some providers are more supportive than others (situation effects). These findings have been observed when Ph.D. students rated faculty members (Lakey et al., 1996), elite youth athletes rated coaches (Rees et al., 2012), and medical residents rated clinical mentors (Giblin and Lakey, 2010). They have also been found when sorority sisters (Lakey et al., 1996), marines, college roommates (Lakey et al., in press), and nuclear family members rated each other (Branje et al., 2002; Lanz et al., 2004).

Leadership

Leadership is a key concept in organizational behavior and theories vary widely in how leadership is conceptualized and studied. Yet, much research, theory and practice seems to reflect an implicit assumption that leadership is a trait-like characteristic of leaders (situations) that generalize across a range of followers (persons; Avolio et al., 2009). Variance partitioning studies of leadership provide a more nuanced approach. Most variance partitioning studies have used round-robin designs in which four- to five-person groups rate each other on leadership after completing a group task (Livi et al., 2008; Kenny and Livi, 2009). Tasks have included leaderless group discussions, thinking of essential items if stranded and thinking of ways to promote tourism. A recent meta-analysis found that 20% of leadership reflected P×S effects, 40% reflected leaders (situations) and 10% reflected followers (persons; Livi et al., 2008; Kenny and Livi, 2009). That is, the extent to which a given leader elicits a sense of leadership in followers partly reflected followers' personal tastes. One sees this in presidential elections. Although one candidate is ultimately preferred by a majority of voters, there is also

substantial disagreement among voters about which candidate is the best leader.

Performance

An important question in applied psychology is how to improve people's performance on tasks, such as typing, standardized tests, memory, vigilance, work performance, reading, and many others (Kanfer and Ackerman, 1989; Kluger and DeNisi, 1996). Research often focuses on how to train people (Kanfer and Ackerman, 1989; Kluger and DeNisi, 1996) and structure tasks (Gigerenzer and Goldstein, 1996) for optimal performance. Variance partitioning offers the unique focus on the extent to which performance is affected by the unique relationships among members of the work group. Consider three crewmembers operating a battle tank. The variance partitioning approach identifies three aspects of performance. Each crewmember has trait-like skill at the task (person effect) and each might elevate the performance of his other crew members (situation effects, as in leadership). In addition, the unique relationship between any two crewmembers might also elevate performance (P×S effects). If so, then in addition to selecting and training effective tank leaders (situations) and crewmembers (persons), tank teams might be selected so that the particular combination of soldiers (P×S effects) enhances performance beyond person and situation effects.

Recent research provides an example of identifying P×S effects on team performance (Woods et al., in press; Study 3). Groups of four strangers played a warfare video game that accommodated doubles play. Each person played the game with each of three teammates (situations) in a round-robin design and performance was assessed objectively as well as through self-reports. There were strong P×S effects in which a player's performance depended upon the teammate with whom he was paired, accounting for 74% (self-rated) and 35% (objective) of the variance. For example, Ken might display unusually good performance when paired with Matt, than when paired with Bill, beyond Ken's trait-like skill and Matt's ability to elevate performance in his teammates. There were also strong person effects in that some players had higher skill than did others, accounting for 23% (self-rated) and 63% (objective) of the variance in performance. There were no effects whereby some teammates elevated the performance of all other teammates (situations, cf. leadership).

Other investigators have documented P×S effects for memory performance following training (Gross et al., 2009, 2015). Persons heard presentations from different trainers (stimuli) and were tested on retention. There were significant P×S effects on memory following training, in that a person's memory for training depended, in part, on which trainer presented the material. For example, Person 1 might have unusually good memory for Trainer 1's presentation than for Trainer 2 or 3. Person 2 might show a different pattern.

Thus, there is emerging evidence for strong P×S effects on task performance. It would be straightforward to apply the variance partitioning approach to a wide range of human performance problems.

To conclude this section, very strong P×S effects have been observed for a wide range of constructs, including anxiety, five-factor personality, perceived support, leadership and task performance. Given the replicability, strength and broad generality of P×S effects, the variance partitioning approach should be widely used in many research areas. This does not seem to have happened. Why not?

DEVELOPING A PSYCHOLOGICAL UNDERSTANDING OF P×S EFFECTS

Although strong P×S effects are ubiquitous, it has been hard to make sustained progress in understanding them. Time and again, large P×S effects are observed for a construct and no further progress is made. After estimating the size of P×S effects, it has not been clear how to move forward.

How can investigators develop a psychological (versus purely statistical) understanding P×S effects? This is a special case of the general problem of how to develop a psychological understanding of anything. Cronbach and Meehl's (1955) seminal work on construct validity provides the key answer. The solution is merely to apply the general strategy of construct validation to the special case of P×S effects. This involves simply developing the nomological network for the P×S aspect of a construct, including (1) establishing the other constructs to which the P×S aspect is related (2) identifying mechanisms for the P×S aspect and (3) forecasting future outcomes from the P×S aspect.

According to Cronbach and Meehl (1955), construct validity is built by developing an understanding of a new construct's empirical properties (i.e., its nomological network). In personality research, this primarily involves understanding the new construct's correlations with other constructs. Over time, well-replicated links between the new construct and other constructs are established. Some of the links fit well with the rudimentary theory; others do not. The rudimentary theory is revised in light of these findings and new studies are devised to test the revised theory. Thus, one begins an iterative series of empirical studies and theory revision. In this way, one develops the validity of a new construct by pulling up by one's bootstraps.

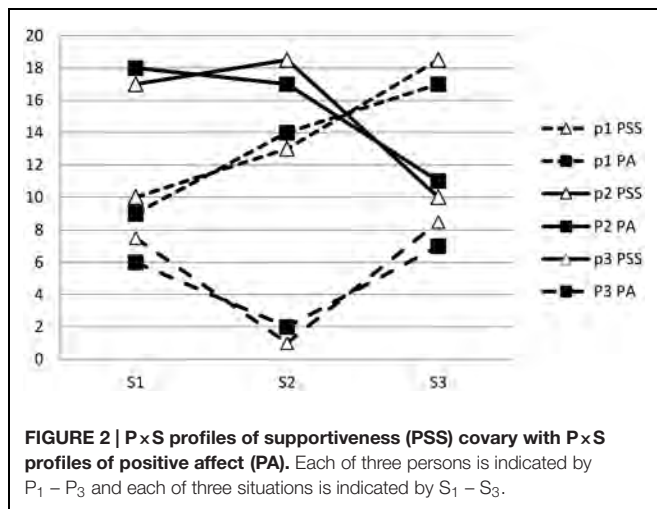
Here is an example of how this process has worked for perceived social support. Perceived support measures were developed to assess the extent to which friends and family helped with stressors (Barrera, 1986). The word "perceived" was used only to acknowledge that the measures relied upon self-report. Yet, perceived support was hypothesized to reflect the actual help that friends and family provided to promote coping and thereby protect persons from the harmful effects of stress. As expected, people with high perceived support had better emotional well-being than did people with low support (Cohen and Wills, 1985; Barrera, 1986). Yet, it was not long before other findings cast doubt on the original theory. For example, perceived support was not very closely related to support actually received from family and friends (Barrera, 1986), and support received was not consistently linked to

better emotional well-being (Barrera, 1986; Finch et al., 1999; Bolger et al., 2000). Instead, perceived support was much more closely linked to perceptions of providers as similar to recipients in attitudes and values (Lakey et al., 2002). In addition, most of perceived support's links to emotional well-being did not involve stress buffering, but occurred regardless of the presence of stress (Lakey and Orehek, 2011). Such findings were inconsistent with the original theory, led to additional empirical studies and the development new theories (e.g., Uchino, 2009; Lakey and Orehek, 2011). Some research findings will not fit the new theories, and this iterative process will continue. Thus, one develops a psychological understanding of perceived support.

How does one apply construct validity to P×S effects? This question seems to have been the sticking point in making progress, and the solution is both technical and conceptual. Building construct validity requires linking constructs to other constructs, but P×S effects are represented as profiles of scores across situations (Figure 1). How does one establish a nomological network for profiles of scores? Cronbach et al. (1972) provided the answer with multivariate generalizability analyses (see Strube, 2000, for an accessible introduction). The key insight is that since P×S aspects are represented as profiles, all other constructs must also be represented as profiles. In addition, the profiles must be commensurate. That is, if the P×S aspect of a construct is represented as a profile across five situations, the P×S aspect of another construct must also be represented across the same five situations.

Thus, it is not meaningful to correlate the P×S aspect with the trait aspect of a construct because they are represented incommensurately. As depicted in Table 1, each person has a profile of anxiety in the three situations. Each person also has an anxiety score averaged across the three situations (the person aspect). Estimating a correlation between trait anxiety and each person's profile requires mapping the three P×S profile scores onto the single person score. Of course, this cannot be done meaningfully, in part because each P×S score has already had the person aspect of anxiety removed. Moreover, there is more information in a three-score profile than can be contained in a single person score. Using a questionnaire measure of trait anxiety does not solve the problem, because we are still left with the issue of mapping three bits of information onto a single bit. Thus, one cannot explain the P×S aspect of anxiety in terms of the five factor traits, unless the traits are also expressed as profiles. It is straightforward to represent the five factors as profiles (Van Heck et al., 1994; Hendriks, 1996), but doing so changes their meaning. At minimum, the P×S aspects of the five factors are no longer traits.

Historically, a major obstacle in applying Cronbach et al.'s (1972) insight was the lack of computer programs for conducting the analyses. Kenny (unpublished computer program) developed a program for round-robin analyses and Brennan (2001) developed a program for more typical G designs. In addition, such analyses can be done with structural equations and multilevel modeling (Biesanz, 2010; Ackerman et al., 2015).



Developing Nomological Networks for P×S Effects: The Case of Perceived Support

Perceived support research provides an example of developing the nomological network for the P×S aspects of constructs. A core finding in perceived support research (Cohen and Wills, 1985; Barrera, 1986) is that perceived support is linked to emotional well-being. Thus, it is important to determine that this link occurs for the P×S aspects of support and well-being specifically.

Investigators have studied persons in the laboratory as they had conversations with the same support providers (situations), on multiple occasions (Neely et al., 2006; Veenstra et al., 2011). After each conversation, persons rated their positive and negative affect during the conversation, as well as the supportiveness of the provider. Independent observers also rated the conversations in Neely et al. (2006). Both studies found that the P×S aspect of perceived support was linked to the P×S aspects of high positive, and low negative affect. That is, when a provider evoked unusually high positive or low negative affect in a person, the person saw the provider as unusually supportive. That is, each person's profile of affect across providers covaried with her profile of supportiveness across the same providers (Figure 2).

Most social support research is field research and the variance partitioning approach can easily be applied to field contexts. For example, in one study, participants rated their perceived support and affect typically evoked by important support providers (Lahey et al., in press). In round robin designs, marines and college roommates rated each other. As found in laboratory studies, the P×S aspect of supportiveness was linked to the P×S aspect of affect. That is, when a provider evoked unusually high perceived support in a person, the provider also evoked unusually favorable affect.

These examples show that establishing the nomological network, and hence the construct validity of the P×S aspect of a construct is essentially the same as for any other construct. The key difference is that correlations must be estimated for the

P×S aspects of constructs specifically, and thus studies must be designed to isolate P×S aspects.

If one wants to understand the P×S aspect of a construct, one cannot use conventional research methods. Consider a conventional study in which persons rate the supportiveness of their social networks and their own emotional well-being. A typical finding is that perceived support is linked to emotional well-being. Unfortunately, the design cannot reveal the extent to which the link between perceived support and emotional well-being reflects, (1) the trait-like tendencies of persons to see everyone as supportive and to experience well-being (person effects), (2) persons' good fortune to be surrounded by providers who evoke a sense of support and well-being in nearly everyone (situation effects), or (3) the unique relationships between persons and providers in which the provider who elicits unusually high support in a person also elicits unusually good emotional well-being (P×S effects). The psychological meaning of these correlations differs dramatically depending upon which aspect of support the correlations reflect. The correlation between perceived support and emotional well-being, estimated with conventional methods, could reflect any one of the three effects, or some unknown combination of the three.

Identifying Mechanisms for P×S Effects

Part of developing a nomological network is identifying the mechanisms by which constructs are linked, but in the P×S research just described, no mechanisms were identified. We learned that when a person saw a provider as unusually supportive, the provider also evoked unusually favorable affect, but the studies did not indicate how this occurred. For example, how did Person 1 arrive at a judgment of Provider 1's supportiveness that was different from how Person 1 typically sees other providers, and different from how Provider 1 is typically seen?

Lutz and Lahey (2001) hypothesized that the P×S aspect of perceived support emerges, in part, because persons weigh information about providers (situations) differently when judging support. Persons use information about providers' personality (e.g., agreeableness and emotional stability) to judge providers' supportiveness (Lahey et al., 2002). Lutz and Lahey (2001) tested the hypothesis that persons weigh these traits differently. In two studies, persons were presented with descriptions of over 100 providers who differed in their five-factor personality profiles. For example, one provider was described as "self-conscious, not self-assured, somewhat reliable, very literary, not tender-hearted." The investigators could derive regression equations that described how each person used information about providers' personality to judge providers' supportiveness. As predicted, there were significant differences in how persons' weighed personality traits to judge supportiveness.

To see how these differences can explain P×S effects, consider the case depicted in Figure 3 in which Persons 1 and 2 rate Providers 1 and 2. Providers 1 and 2 have different five-factor profiles. For example, Provider 1 has high agreeableness and conscientiousness and Provider 2 has high neuroticism and openness. Person 1 and Person 2 weigh provider traits differently in rating supportiveness. Person 1 weighs provider

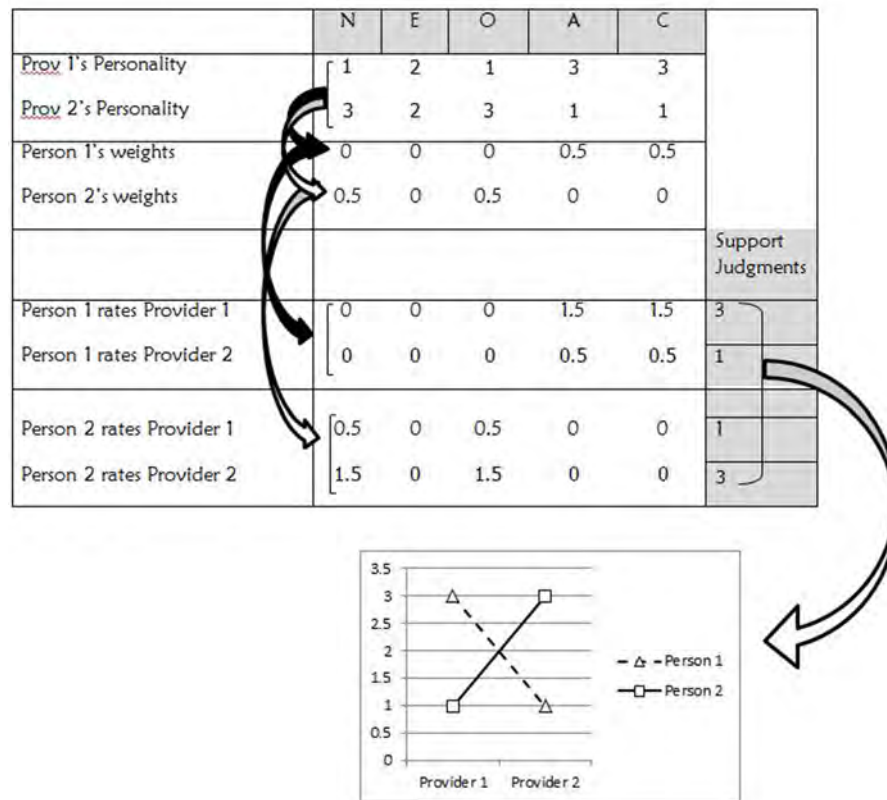


FIGURE 3 | P×S effects emerge when persons weigh providers' traits differently in forming support judgments. N = neuroticism; E = extroversion; O = openness; A = agreeableness; C = conscientiousness.

agreeableness and conscientiousness heavily and Person 2 weighs neuroticism and openness heavily. Each person's judgment of each provider is determined by (1) multiplying each provider's personality trait score by (2) the weight typically used by each person to judge support from the trait. For example, Provider 1's agreeableness score of 3 is weighed by 0.5 by Person 1, but weighed by 0 by Person 2, contributing to disagreement about Provider 1's supportiveness. Thus, when persons weigh provider traits differently in judging support, persons disagree about the supportiveness of the providers, resulting in P×S profiles. This mechanism is essentially similar to Mischel and Shoda's (1995) hypotheses that links among mediating units translate encoded information about situations to each person's unique profiles of responses to situations.

Forecasting Important Outcomes for the P×S Aspects of Constructs

An important part of the validity of a construct is that it can forecast future outcomes. For example, the construct validity of conscientiousness is supported by the fact that job applicants' conscientiousness scores forecast their subsequent job performance (Oh et al., 2011). Forecasting the P×S aspects of constructs is a simple extension of establishing a nomological network among P×S aspects: P×S profiles from Time 1 are used

to forecast P×S profiles at Time 2. What follows are two examples of forecasting the P×S aspects of constructs.

There are large P×S effects for students' (persons) evaluations of instructors' (situations) teaching (Gross et al., 2009, 2015). That is, Student A might find Instructor A to be more effective than Instructor B, but Student B might have the opposite opinion. Given the large size of P×S effects, it might be useful to forecast which students will find which instructor especially effective, so that specific instructors could be recommended to specific students to optimize instruction.

Gross et al. (2015) tested this concept by developing brief videos of instructors' teaching. The teaching trailers (cf. movie trailers) were shown to a group of students in three large college classes at the beginning of the semester. Students rated the effectiveness of each instructor's teaching in response to the trailer. Later in the semester, students heard hour-long lectures from each of the instructors and rated the effectiveness of each. Forecasting the P×S aspect of teaching effectiveness involved mapping each student's profile of responses to the trailers at Time 1 to his profile of responses to lectures at Time 2. In fact, Gross et al. (2015) could accurately forecast the instructors that specific students found unusually effective.

A second example of forecasting future outcomes for P×S profiles comes from social support research. Given the strong P×S effects on perceived support, one approach to intervention is

to assign specific support providers to specific persons, such that unusually supportive relationships emerge. Such an approach requires the technology to forecast which person will see which provider as uniquely supportive. Veenstra et al. (2011) forecasted the P×S aspect of supportiveness from brief conversations between persons and providers (situations). That is, a person's reaction to a stranger from a brief conversation forecasted the extent to which the person ultimately saw the former stranger as unusually supportive weeks and months later. Veenstra et al.'s (2011) analytic approach was the same as in Gross et al. (2015). From the first conversation (Time 1), each person had a profile of scores across the providers. Each person also had a profile of scores across the providers at Time 2. Forecasting P×S effects from Time 1 to Time 2 involved calculating the correlation between the Time 1 profiles and the Time 2 profiles.

The variance partitioning approach to P×S forecasting just described is essentially similar to that described by Shoda et al. (1994), except that the variance partitioning approach is simpler. Shoda et al. (1994) observed four types of children's behavior (e.g., prosocial, whining) across five types of situations (e.g., peer approaches, adult warns), over two time periods. For each child, Shoda et al. (1994) constructed profiles of responses for each behavior across the five situations. In calculating the profiles, each child's person score and each situation's score was removed. Thus, the profiles were identical to P×S profiles. Shoda et al. (1994) found that P×S profiles at Time 2 could be forecasted from P×S profiles at Time 1. However, this approach requires (1) calculating profiles for each person, (2) calculating correlations between profiles at Time 1 and Time 2 for each person and then (3) taking the average of the correlations across persons. In contrast, the variance partitioning approach achieves these steps in a single, ANOVA-like analysis.

To summarize, this section described how to establish the construct validity of the P×S aspects of constructs. In principle,

it is no different from establishing the validity of any construct. In tandem with theory development, one establishes a network of associations to other constructs. This process differs for P×S aspects only in that constructs are represented as profiles rather than as single scores. Yet, isolating the P×S aspects likely requires some re-conceptualization of the construct. For example, neuroticism is typically viewed as a trait that it is stable across situations and time. Yet, P×S neuroticism is not a trait, in that it is not stable across situations. By extension, mechanisms that are geared to explain the trait-like aspect of neuroticism (e.g., chronically accessible constructs or catecholamine dysfunction) might not translate well to P×S profiles. Thus, theories of the P×S aspect of neuroticism would need to focus on mechanisms that can take into account how different situations evoke different levels of neuroticism in different people.

P×S EFFECTS CAN CONTRIBUTE TO THEORY

The variance partitioning approach to P×S effects can make an important contribution to theory development. The approach can increase conceptual clarity by requiring the theory to be explicit about whether the core constructs are P×S, person or situation effects. If the theory can be made explicit, the variance partitioning approach provides guidance about research designs to test the theory with greater precision and recommends approaches to intervention. Examples from social support research will be used to illustrate these points.

Until recently, social support theory has been vague about whether perceived social support reflects P×S, person or situation effects. Most social support theory implies that perceived support reflects situation (provider) effects such that persons agree that some providers are more supportive than others and consensually supportive providers have beneficial effects on persons' emotional well-being (Thoits, 1986). Yet, there is a minority view that perceived support is a property of persons (Sarason et al., 1986; Lakey and Cassady, 1990; Uchino, 2009). That is, some persons are predisposed to see providers as supportive and to have good emotional well-being. Recent theory conceptualizes perceived support as a P×S interaction (Lakey and Orehek, 2011). Conventional research designs have been unable to discriminate among these interpretations. Greater conceptual clarity on the nature of perceived support is helpful.

One would design studies differently depending upon whether one conceptualized perceived support as an aspect of the person, the provider (situation), or a P×S interaction. As described previously, to capture the P×S aspect of perceived support, one must isolate each person's profile of supportiveness (and other constructs) across a number of providers, while removing person and situation effects. This typically requires a repeated-measure experimental design in which at least subsets of persons rate the same providers. To capture the person aspect, one should average perceived support (and other constructs) across many providers, situations, and time. To capture provider effects, one should have many providers rated by many persons; providers (instead of

TABLE 2 | P×S effects in a high-density design captured well (A) and poorly (B) by a simpler design.

Person class	Persons	Situation class			
		Interpersonal		Achievement	
		Situations			
		S ₁	S ₂	S ₃	S ₄
(A)					
Dependent	P ₁	4	4	2	2
Dependent	P ₂	4	4	2	2
Self-critical	P ₃	2	2	4	4
Self-critical	P ₄	2	2	4	4
(B)					
Dependent	P ₁	2	2	4	4
Dependent	P ₂	4	4	2	2
Self-critical	P ₃	2	4	4	2
Self-critical	P ₄	4	2	2	4

Each of four persons is indicated by P₁ – P₄ and each of three situations is indicated by S₁ – S₄.

persons) should be treated as subjects. Ironically, although most social support research at least implicitly conceptualizes support as an aspect of providers, almost no research has used designs that capture provider effects specifically.

The variance partitioning approach also provides useful guidance about how to help people change. One would approach intervention very differently depending upon whether one wanted to target the P×S, person or situation aspect. Social support interventions provide an example. Most interventions have been designed to work through provider effects. Thus, a set of providers are selected by project staff and made available to persons. This assumes that selected providers will be seen as supportive by nearly all persons and the providers will evoke better emotional well-being in nearly everyone (Heller et al., 1991). However, if one wanted to influence the person aspect of perceived support, interventions should attempt to change persons. For example, training persons in social skills and in resisting cognitive biases might alleviate tendencies to see everyone as unsupportive (Brand et al., 1995). Interventions to modify the P×S aspect of supportiveness would pair persons with providers such that unusually supportive relationships emerged (Lakey and Orehek, 2011).

To summarize this section, variance partitioning approaches can contribute to theory development by providing (1) greater conceptual precision in descriptions of core constructs, (2) guides to study design to test theories with greater precision, and (3) guides to intervention. Perceived support served as an example in this section, but the basic principles could be extended to a wide range of constructs. For example, to what extent is adult romantic attachment a feature of the person (he is insecure with everyone), a feature of the situation (she elicits insecurity in everyone) or an aspect of P×S effects (he is uniquely insecure with her)? To help him develop more secure attachment, should he seek psychotherapy to change his predispositions or get a different romantic partner? If he gets a different romantic partner, should he look for a partner who elicits security in everyone or a partner who elicits high security in him uniquely? As another example, is leadership a property of the leader (stimulus), the unique relationships (P×S) among specific leaders and followers, or the dispositions of followers (persons) to see everyone as good leaders? Training people to become better leaders assumes implicitly that leadership is a property of leaders and that people can learn leadership qualities that are broadly generalizable across followers and contexts. Alternatively, one might select leaders who are well-matched with the followers in a particular organization, or a leader might elect to lead an organization composed of dispositional followers.

CHALLENGES FACING VARIANCE PARTITIONING APPROACHES

There remain important challenges to understanding the P×S aspect of within-person variation. These include reducing the information density of P×S profiles, forecasting P×S profiles in response to novel stimuli and studying contexts in which persons do not encounter the same situations.

Reducing the Information Density of P×S Profiles

In variance components research, P×S profiles are represented so that each person is a level of a person factor and each situation is a level of a situation factor (Table 1), as described previously. This is an information-dense representation, as it requires large amounts of information about situations and persons. Even in a small study with 10 persons and 10 situations, 100 cells would be needed to represent each person's P×S profile. The information density of such designs can easily exceed software capacity and investigators' working memories. A simpler representation would be to classify persons and situations into categories. For example, in the 10 × 10 design just described persons and situations could each be classified into one of two categories, reducing the 100-cell design to four cells (2 × 2). A simpler representation would be preferable, as long as it could explain variance nearly as well as the more information-dense design. Yet, as described momentarily, there is no guarantee that P×S effects revealed in an information-dense design will be captured in a simpler design.

Most individual differences research uses only simple representations in the search for P×S effects. For example, research on depression and negative life events classified persons as high in dependency or self-criticism and classified life events as relevant to either interpersonal or achievement concerns (Hammen et al., 1985; Coyne and Whiffen, 1995). Dependent people were predicted to respond to interpersonal events (e.g., marital conflict) and self-critical people were predicted to respond to achievement events (e.g., failing a training program). Although initially promising, the work has not yielded very replicable findings (Coyne and Whiffen, 1995). One possibility is that there are, in fact, P×S effects in how people respond to events, but the research represented P×S profiles too simply to capture the effect.

Table 2 uses simulated data to illustrate how P×S effects in a high-density design might not be captured in a simpler design. Panels A and B include exactly the same data points and differ only in how they are arranged. Both panels include a high-density design as well as a simpler design. When analyzed as a high-density design, both panels yield very strong P×S effects with no person or situation effects. How well does the simpler design capture the P×S effect revealed in the high-density design? In Panel A, the simpler design accounts for all of the P×S effect. All dependent persons respond with increased depression to interpersonal events, but not to achievement events. All self-critical persons respond to achievement events, but not to interpersonal events. However, in panel B, the high-density P×S effect is not captured by the simpler design at all. Of course, if the simpler design captures the P×S effect well (Panel A), there would be no need to use the information-dense design. Yet, if the simpler design does not capture the P×S effect (Panel B), one would have to rely upon the high-density design. If one had only the simple design, one might incorrectly conclude that there were no P×S effects. Unfortunately, the simple design is what psychologists studying Person × Situation interactions typically have. If one happens to choose the right classification scheme, one will find a P×S effect. However, it might be better to start with the high-density design to see if a P×S effect is present. Then, one can

figure out how to represent the effect with a simpler classification scheme.

The variance partitioning approach is well-suited to analyze how well a simpler design can capture P×S effects revealed by a high-density design. Note that in **Table 2**, persons are nested within the dependent or self-critical class and situations are nested within the interpersonal or achievement class. If the simple design can capture a P×S effect present in the high-density design, we should see that the variance accounted for the P×S effect in the high-density design shifts to the Dependent/Self-critical × Interpersonal/Achievement interaction when the nesting factors are added.

It might be the case that many P×S profiles revealed in high-density designs cannot be adequately captured by simpler designs. If so, one will have to learn how to study P×S profiles in information-dense designs. Fortunately, the variance partitioning approach provides a way of conducting research with high-density designs. As described earlier in a different context, one can characterize the kinds of situations that elicit unusually strong reactions (P×S effects) in specific persons. For example, providers (situations) who evoke unusually high positive affect in persons are seen by persons as unusually similar to themselves, agreeable, supportive, eliciting good ordinary conversation as well as sharing activities (Lakey et al., 2004, *in press*). If an investigator does not want to rely on persons' subjective judgments to characterize situations, one could study more objective indicators. For example, the provider who evoked unusually high objective task performance in a person also evoked unusually few automatic negative thoughts and high self-rated performance (Woods et al., *in press*; Study 3).

Forecasting P×S Profiles for Novel Situations

How can we forecast a person's profile of responses to situations he has never faced? The approach to forecasting P×S profiles described by Veenstra et al. (2011) and Gross et al. (2015) do not apply to this question because their approach requires that persons have had brief exposures to the situations. Here, the prediction problem is when there is no prior exposure.

One approach would be to determine for each person how she weighs information about situations and then apply those weights to generate predictions about reactions to new situations. Thus, a regression model would be developed for each person. To forecast how a person would respond to novel situations, one would obtain descriptions of each novel situation on the same dimensions used to develop each person's regression model. For example, Lutz and Lakey (2001) developed individual regression models to describe how people used the five factor traits to judge provider supportiveness. To forecast judgments of novel providers, one would need descriptions of the providers' five-factor traits. Applying the persons' weights to the providers' features would generate predictions of how each person would react to each provider. This approach is commonly used in commercial recommender systems such as Pandora. In the Pandora system, raters evaluate songs on a number of dimensions. Users (persons) indicate the songs they

like. From user ratings, weights are presumably derived about how persons use the dimensions to judge songs. These weights are presumably used to predict reactions to new songs. Pandora is a proprietary system, and thus the details of the approach, as well as how well the approach predicts outcomes, are not explicit.

Although this approach should work in principle, there will be challenges in making such predictions with high precision. For example, how well will raters' descriptions of new situations generalize to each person's perceptions of the situations? We might know that a person weighs agreeableness heavily in judging providers. We might also know that observers have rated a novel provider as agreeable. In this case, we would forecast that the person would see the provider as supportive. However, the accuracy of the prediction will be limited by how well the observers' ratings generalize to the person's perception of the provider as agreeable, especially after the person has gotten to know the provider. If the person ultimately sees the provider as disagreeable, the original prediction based on observers' descriptions of the provider will be inaccurate. There is good reason to believe that generalizing observers' ratings to persons will introduce important imprecision, as inter-rater agreement about the personality traits of providers typically account for only about 30% of the variance (Kenny et al., 1994). Nonetheless, the variance partitioning approach provides the analytic tools for addressing these questions.

Sometimes Situations are Nested within Persons

Throughout this article, the assumption has been that persons are exposed to the same situations. Yet often, important situations are encountered by only a few people. That is, situations are nested within persons. For example, one has a small number of parents, and except for one's siblings, these parents are not shared with other people. One solution is to study only persons who encounter the same situations. Yet such designs exclude many people and situations. Another solution is the one-with-many design (Kenny et al., 2006). In one such design, situations (the many) are nested within persons (the one). For example, Lakey and Scoboria (2005) studied persons' reactions to their mothers, fathers and closest friends and no one in the sample shared the same parents and closest friends. In such a design, it is not possible to separate P×S effects from situation effects. This is because P×S effects cannot be defined without first defining situation effects and situation effects require that at least subsets of participants encounter the same situations. Thus, P×S effects are confounded with situation effects. In another example, Marcus et al. (2011) studied therapy patients (the many) who each rated his therapist (the one). This design can isolate therapist (situation) effects, but person and P×S effects are confounded because no patients rated the same therapists, and no patients rated multiple therapists.

Designs that confound P×S effects with other effects can be a serious problem if one wants to understand P×S effects. However, the problem might not be so serious under some circumstances. For example, situation effects are very small compared to P×S effects for perceived support (Lakey, 2010) as

well as for negative affect (Ingraham and Wright, 1987; Lakey et al., in press). Thus, for these constructs, the confounded (situation + P×S) effect in one-with-many designs primarily reflects P×S effects. Yet there is no guarantee that this will occur for other constructs. A given construct might primarily reflect situation effects (e.g., leadership), in which case one-with-many designs would be useless for understanding P×S effects. Thus, one must estimate the relative strength of situation and P×S effects in fully crossed designs before confidently interpreting the results of one-with-many designs. Still, for some constructs, the one-with-many design can be a useful tool for understanding P×S effects, especially since one-with-many designs are typically much easier to execute than round-robin studies.

Is It Always Necessary to Develop Separate Nomological Networks for P×S Effects?

As described previously, one develops the construct validity of the P×S component of a construct by developing its nomological network. One problem is that studies that isolate P×S components are typically more difficult to execute than are more conventional designs. Couldn't one use more conventional research designs to estimate the P×S nomological network? One could do this, and it might work under some circumstances. However, one runs the risk of mistakenly assuming that a correlation between constructs occurs for the P×S component when it does not. There are several examples in which aspects of the nomological networks for constructs differed depending upon the variance component that was studied. Examples include adult romantic attachment (Barry et al., 2007), enacted support

(Lakey et al., 2010), capitalization support (Shorey and Lakey, 2011) perceived support (Lakey et al., in press) and the link between positive and low negative affect (Lakey and Scoboria, 2005; Barry et al., 2007; Shorey and Lakey, 2011). Thus, one cannot know that a correlation between constructs occurs for a given component until one conducts studies that isolate the component.

SUMMARY AND CONCLUSION

If the reader is interested in Person × Situation interactions and is willing to take the variance partitioning approach, there is a very good chance that he will be rewarded with very large P×S effects for nearly any psychological construct he chooses to study. Moreover, with some modification, he can apply the same construct validation procedures used for personality more generally to develop a psychological understanding of the P×S aspects of constructs. The variance partitioning approach can add increased precision to theory by defining with greater clarity key aspects of constructs. Understanding whether the key constructs are features of the person, the situation, or P×S interactions will help him design studies to test theory with greater precision, and will provide a useful guide for training and intervention.

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Contextual Variability in Personality From Significant–Other Knowledge and Relational Selves

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We argue that the self is intrinsically embedded in an interpersonal context such that it varies in IF–THEN terms, as the *relational self*. We have demonstrated that representations of the significant other and the relationship with that other are automatically activated by situational cues and that this activation affects both experienced and expressed aspects of the self and personality. Here, we expand on developments of the IF–THEN cognitive-affective framework of personality system (Mischel and Shoda, 1995), by extending it to the domain of interpersonal relationships at the dyadic level (Andersen and Chen, 2002). Going beyond Mischel's early research (Mischel, 1968), our framework combines social cognition and learning theory with a learning-based psychodynamic approach, which provides the basis for extensive research on the social-cognitive process of transference and the relational self as it arises in everyday social interactions (Andersen and Cole, 1990), evidence from which contributes to a modern conceptualization of personality that emphasizes the centrality of the situation.

Keywords: significant others, relational self, close relationships, transference, cross-situational inconsistency

INTRODUCTION

The notion that people's responses and behavior will tend to vary by the situation they are in, as a function of internal states, mental representations, and interpretations that are brought to the fore by cues in the situation (Mischel, 1968, 1973, 1977; Wright and Mischel, 1987; Shoda et al., 1994), was iconoclastic when proposed, but is now supported by considerable evidence. While it may seem that people tend to possess global traits that do not vary appreciably by situation, this concept does not do justice to the complex nature of personality. *In situ* research has demonstrated substantial variability in behavior across situations (Mischel, 1968), while stability can be observed in the pattern of behavior individuals engage in across different situations over time (Mischel and Peake, 1982; Mischel and Shoda, 1995). What arises is a kind of *personality signature* or behavior profile across situations. Indeed, variability across situations that is stable over time is now rather widely accepted (e.g., Kenrick and Funder, 1988; Fleeson, 2001; Funder, 2008; Fleeson and Nofle, 2009).

In this article, we present a conceptual framework and a line of research in the interpersonal domain that characterizes individual behavior as the result of context-specific cues and makes use of long-term memory storage in a dynamic way—that is, emphasizing both what the individual brings to the table from personal experience and the situational cues that trigger such experience. We present the social-cognitive model of transference and the relational self, and the research that supports it (e.g., Chen and Andersen, 1999; Andersen and Chen, 2002), as an IF–THEN

person-situation interaction model and an interpersonal version of what is known as the cognitive-affective personality system or cognitive-affective processing system (CAPS) approach. Beyond this, we go further here than elsewhere in specifying the relation of our framework to the CAPS model, and further, address explicitly the voluminous literature on trait dispositions (particularly interpersonal traits) and their potential interface with this framework.

The CAPS framework relies on cognitive-affective units (CAUs), which represent individual experience and contribute to an individual's interpretations and behavior in particular contexts (Mischel and Shoda, 1995; see also Metcalfe and Mischel, 1999). Past experience alters the meaning and significance accorded to present situations, and importantly, the strength and likelihood of relevant behaviors being enacted in those situations. Of central importance in predicting human behavior, and if desired, in changing it, is accounting for the stimuli in situations that prompt particular behavioral patterns (Metcalfe and Mischel, 1999). The cognitive-affective systems model of personality is thus an IF-THEN theory in which the situation—or set of triggering cues—interacts with whatever disposition or set of associations the individual has with these cues, which in turn, places the individual in a distinct psychological situation. Indeed, the situational IF cue(s) evokes a contextual THEN, or the relevant experience and behavior.

In our research, we have examined how mental representations of significant others—that is, any important person, such as a close friend, current or past romantic partner, sibling, or parent whom the individual knows well and has had a considerable impact on the individual—arise as a function of contextual cues, and influence moment-to-moment interpersonal responses on the basis of their implicit activation. Because significant-other representations are often evoked and used, they tend to be chronically accessible (Andersen et al., 1995) and are even more likely to be evoked if triggering cues are present in the situation (Andersen et al., 1995; Chen et al., 1999; see Higgins, 1989, 1990). Hence, in the process known as *transference*, certain cues in a new person, such as his or her behavior or conveyed beliefs, attributes, or even facial features, can activate a relevant significant-other representation. The representation is then applied to understanding the new person. Of course, significant others are, by definition, people in whom the individual is invested emotionally and motivationally (Higgins, 1987, 1997; Hinkley and Andersen, 1996; Andersen et al., 1998). Hence, they allow for special relevance to be accorded to a new person, when triggered in transference, leading the new person to be seen, interpreted, and remembered in terms of significant-other knowledge, while also evoking a variety of relationship-specific and self-with-other experiences that are emotional and motivational in nature.

Accordingly, cues of any subtle resemblance to a significant other in a new person will evoke the significant-other representation, the relational self, and the transference process in IF-THEN terms. In many instances, this process can be interpersonally useful, easing social interactions, and prompting the individual to give new persons the benefit of the doubt, as positive feelings toward the significant other are felt anew toward (“transferred” to) these new persons (e.g., Andersen and Chen,

2002). In fact, under some circumstances, it can even diminish intergroup bias (Saribay and Andersen, 2007) and promote a sense of shared reality (Przybylinski and Andersen, 2012, 2015). However, it can have detrimental consequences as well (e.g., Berenson and Andersen, 2006; Reznik and Andersen, 2007; Berk and Andersen, 2008; Miranda et al., 2013) if the relationship with the activated significant other happens to be troubled in some way, even if this person is otherwise loved.

Given that the concept of transference derives from psychoanalytic thought (Freud, 1958, 1963) as modernized in neo-Freudian and interpersonal terms (Sullivan, 1953), it is perhaps less surprising that we conceptualize and examine it in social-cognitive terms (Andersen and Glassman, 1996; Chen and Andersen, 1999; Andersen and Chen, 2002). Drawing on a set of century-old assumptions about personality, psychological disturbance, and treatment, this work is clearly relevant to bridging the gap between contemporary social cognition, interpersonal approaches to the self, and psychodynamics. Moreover, it construes person-situation interactions as an interpersonal version of a cognitive-affective system approach.

A central contribution of this research is that it begins to populate the CAPS model with needed content and content specificity. Indeed, the CAPS model focuses primarily on process and to a degree, structure, while providing relatively little guidance as to the content of CAUs within the model. The current framework and research does this with a focus on the interpersonal domain, and outlines situations and processes more specifically. In particular, we emphasize how individual behavior varies across interpersonal situations, in a manner determined partly by the process of transference. In the process, elements of the interpersonal situation (i.e., of the person one is interacting with) resemble and, in turn, implicitly and automatically bring to mind a prior significant other, which influences the individual's inferences about and evaluation of the new person. Indirectly, this activation also brings to mind the relationship with this significant other, as well as the individual's view of the self in this relationship at the moment, his or her motivation, goals, and regulatory strategies, not to mention emotions and behaviors. Accordingly, in the CAPS model, the CAUs, such as expectancies, goals, affect, and self-regulatory plans, form a “system” of units that interact with each other in mediating behavior. In our approach, these units consist of the various aspects of an individual's significant-other relationships, and such units are organized in terms of individual representations of specific significant others and one's relationship with each, which are all stored in memory. Each one can be triggered from memory when the significant other is implicitly activated by subtly relevant cues in the environment (a person, a situation), leading to shifts in observed responses.

Further, our approach treats “dispositions” as reflected and embodied by the content of the longstanding significant-other representations and relationships in memory, which enable both stability in the individual's responses and the variability that arises in them across relevant interpersonal situations. Research on trait approaches to individual differences defines personality in terms of global dispositions that are shared and nomothetic (people differ in the degree to which

they hold a trait, rather than in its qualitative definition), and some trait dispositions are explicitly interpersonal (e.g., need for affiliation, extraversion, agreeableness, dominance). Our approach, by contrast, defines personality and individual differences particularly ideographically, based on prior learning and prior relationship experience. Although we do not argue that all variability across situations in individual responding (or stability over time) is reducible to interpersonal experience alone, nor that significant-other representations and relationships are the sole basis for the content of self and personality, we do simply argue that such knowledge in memory captures meaningful, longstanding, personally relevant knowledge, that anchors the individual in his or her own prior learning and experience, while still enabling variability in individual behavior to emerge as a function of variability in interpersonal contexts.

THE RELATIONAL SELF

Imagine that a new employee is hired at your workplace. He loves reading mystery novels, much as your adored older brother does, has a similar liking for Italian food, and even similar quirks (e.g., the same bombastic laugh). You immediately like him without knowing why and find yourself holding his opinion in especially high esteem. You even doubt yourself when you disagree with him, which you do not do with other coworkers. In this case, your self-doubt cannot be explained solely by a general personality trait (e.g., insecurity), or by the situation itself (being at work). Our model of transference, however, provides a framework for understanding why, when, and how this specific kind of response happens.

In transference, the representation of a significant other (e.g., one's brother) will be activated when a new person (e.g., the coworker) resembles that significant other in some subtle way (e.g., has a similar laugh). This resemblance can come in the form of the new person's personal characteristics, such as interests, behavioral tendencies, values, interpersonal style, specific expressions, or physical appearance. Once the significant-other representation is activated, it tends to be applied to the new person, influencing one's perception of the new person and one's responses to him or her (Andersen and Cole, 1990; Andersen and Baum, 1994). Thus, significant-other cues encountered in a situation combined with knowledge stored in memory (which is chronically accessible) about the significant other, affect both interpretations of the new person as well as one's responses to him or her. For instance, knowledge one has of the significant other is then assumed to be true of the new person who resembles this significant other, in addition to what one actually sees and learns about the new person. The individual then thinks that he or she "learned" this transferred information about the new person, when, in fact, the individual did not.

This effect on memory can be evoked based not only on cues to a new person's characteristics, but, as implied, also on his or her facial resemblance to a significant other (Kraus and Chen, 2010), and has been shown to persist for weeks (Glassman and Andersen, 1999b). Moreover, cues of either sort can provoke a relatively automatic positive evaluation of a new person when he or she implicitly resembles a significant other who is also

regarded positively—that is, liked or loved (e.g., Andersen and Cole, 1990; Andersen and Baum, 1994; Andersen et al., 1995; Chen et al., 1999; Günaydin et al., 2012). Finally, this transference process not only occurs implicitly (Andersen et al., 2005), but can also be triggered by cues presented entirely outside of awareness (Glassman and Andersen, 1999a). The latter is of importance both because the notion of the unconscious is so predominant in psychodynamic theory and in the transference concept, and because it suggests that the process of transference may not be readily detected or intentionally controlled.

Significant-other representations are linked in memory to representations of the self by the relationship with each significant other (Andersen and Chen, 2002). Thus, individuals have a specific relational self associated with each significant other represented in memory (Andersen et al., 1997; Chen and Andersen, 1999; Andersen and Chen, 2002; see also Baldwin, 1992; Chen et al., 2006), reflecting the version of the self generally experienced in that relationship. Accordingly, these versions of the self are also indirectly activated when a significant-other representation is activated as a function of situational triggering cues. Because any significant-other cue can activate the significant-other representation, these cues will also indirectly activate the self-with-significant-other representation and the significant-other relationship. Once these representations are activated, one "becomes" who one typically is with that significant other. Furthermore, motivations and goals relevant to the significant-other relationship are also activated in response to the new person—for instance, one might be particularly motivated to not be candid with him or her. In transference, information about the significant other's past acceptance or rejection stored in memory should also be activated when the significant-other representation is activated and thus should also be anticipated from the new person. In this way, the significant other need not be physically present to greatly influence the self and interpersonal interactions.

Said differently, significant others have been shown to be represented in memory in a manner that is rich in features and highly distinctive (Andersen and Cole, 1990; Andersen et al., 1998), both in terms of personality characteristics and physical features, as well as in interpersonal styles, habits, and interpersonal tendencies. Moreover, included in such significant-other knowledge are complex IF-THEN units that reflect the particular psychological (internal) states these others experience and how they behave based on them (as situational contexts, Idson and Mischel, 2001; Chen, 2003). Hence, such knowledge structures are complex.

RELEVANT CONCEPTIONS OF PERSONALITY

Traits as Dispositions

Although most trait theorists, historically, have acknowledged the relevance of situations to trait expression (e.g., Allport, 1937; Murray, 1938; Cattell, 1965), and the interaction between the person and the situation, this has not tended to be emphasized or commonly examined in empirical research. That is, the consensus was (and largely is) that trait dispositions are stable over time, as

are their correlates, and as such, are worthy of study in their own right, independent of context. This makes sense, and of course, Mischel's early work also prompted systematic research pitting the person against the situation (and *vice versa*) in numerous trait-situation studies at the debate's inception (e.g., Endler, 1975; Sarason et al., 1975; Endler and Magnusson, 1976; Magnusson and Endler, 1977), and onward, with results sometimes favoring the person and sometimes the situation, depending on the design of the research (Bem, 1972; see also Wachtel, 1973). Since then, the inclusion of potentiating environmental factors, whether life events like stressors or encounters with relevant situations, or experimental manipulations, for example, contextual "primes" that bring to mind trait-relevant content (e.g., Moskowitz, 1988; Schmit et al., 1995) has become less atypical, as researchers have examined both transient and more stable factors in observed personality responding (e.g., Chaplin et al., 1988; Murtha et al., 1996; Pervin, 2000). The stability of traits over time is of course well-argued and demonstrated (e.g., Block, 1971; Costa and McCrae, 1988; McCrae and Costa, 1990; Roberts and DelVecchio, 2000), and in conjunction with the person by situation debate, which addresses variability by context (even if just referring to contextual "primes"), the research on cross-situational variability is important and revealing about personality processes and content.

Considered differently, a question that arises is: What constitutes personality (and individual differences in personality) in the first place? It is presumably not restricted to trait dispositions. For example, more specific dispositional tendencies are presumably pertinent as well, such as the chronic individual difference of believing one is falling short of the ideal standards that a significant other holds for one, in longstanding goals with a significant other (e.g., for affection) that may have chronically gone unsatisfied, and more broadly, individual differences in chronic depression, or rejection sensitivity, or attachment style. We see these as deeply relevant to an interpersonal view of personality although such individual differences are not as broad as global trait dispositions *per se*, and the former have been examined in research on the relational self and transference (noted below). Trait dispositions, on the other hand, have not.

Beyond simply examining individual differences in personality, a central focus in conceptualizing personality as involving the relational self and stored knowledge about significant others is on illuminating what makes a person unique (Allport, 1937; Kelly, 1955; see also Higgins, 1990). Certainly, this is the thrust of George Kelly's approach to personality. We also aim to examine, not so much what is general and global in dispositions, but rather, what is idiographic about the individual in the domain of relationships. Indeed, the content of significant-other knowledge is idiographic—that is, the features that define significant-other knowledge are varied, including assumed qualities, habits, and the like, and these features are specific to each individual and to the particular relationship—and also, by definition, stable over time. The relationship with the significant other is also unique to the person and is comprised of content that is specific to the way the individual interacts with that other, which in turn indirectly evoked with new persons when the significant-other representation is implicitly cued. On the other hand, the

process itself that is triggered when contextual cues activate such prior knowledge—the overall process by which significant-other representations are activated and used with a new person—is common and nomothetic across people (Andersen and Chen, 2002). Our approach to the relational self (and transference), which is an idiographic-nomothetic approach that captures the unique in stored knowledge and the general in process, ultimately integrates both what is stable in the self and personality, and what is variable across triggering cues, providing a more nuanced and complete view.

Still, global traits and dispositions could, indeed, be readily examined in relation to this process. Based on existing research, we assume that the process of transference is likely to be triggered and to transpire quite readily regardless of individual differences in trait dispositions. However, the content of any individual's relational responses (those that depend on the relationship and the self in the relationship) may well vary considerably from another individual's, based on such dispositional differences, potentially predicting differentiated affective, and motivational responses. These are empirical questions that remain open.

On this note, one might ask the question of how this relational self (and transference) research links or specifically interacts with existing structural models of personality emphasizing interpersonal traits, such as affiliation, extraversion, agreeableness, or dominance. While the current research does not speak to the exact ways in which such dispositions may emerge in transference and the relational self, such interpersonal traits have been found to be of importance in interpersonal situations (see McClelland, 1985). For instance, the need for affiliation as well as for intimacy has been shown to underlie behavioral variability in interpersonal contexts (McAdams and Constantian, 1983; McAdams, 1999), for both men and women, and is assessed mostly using the thematic apperception test (TAT). As such, correlational work shows that those high in need for intimacy are more motivated to connect, share, and communicate with others, and are inclined to focus more on communal goals (McAdams and Powers, 1981; McAdams and Constantian, 1983), in addition to making more eye contact, and smiling and laughing more (McAdams et al., 1984). Likewise, extraversion, which is part of the Big Five (and also assessed by self-report), has been associated with one's ability to create positive social environments (Eaton and Funder, 2003). Indeed, extraverts tend to be more popular (Paunonen, 2003) and tend to have more satisfying romantic relationships (e.g., Watson et al., 2000). Relatedly, agreeableness (i.e., another Big Five trait assessed by self-report) is associated with better interpersonal adjustment among peers in adolescence (Graziano et al., 1997), more helping behavior (e.g., Graziano et al., 2007), and likeability (Nikitin and Freund, 2015). It has been linked as well to more distress in response to interpersonal conflict (Suls et al., 1998), and to preferences for tactics of de-escalation, such as negotiation rather than power assertion (Graziano et al., 1996). By contrast, trait dominance has been associated mainly with others' perceptions of the individual as competent (as reported by fellow group members and outside observers; Anderson and Kilduff, 2009), and relatedly, dominance-conveying behaviors (assessed by independent observers) have been shown to be more

commonly expressed with same-sex friends than with same- or opposite-sex strangers (Moskowitz, 1988).

With any such global trait disposition, such as these, one might predict that some of the processes revealed in the research on transference and the relational self may be more pronounced among people high in the particular interpersonal trait. Our guess is that this may not necessarily be the case, and rather, it is likely that each of these particular traits may further predict the content of the particular relational self and relationship patterns that arise, based on significant-other activation and use (e.g., in transference). This question may warrant future examination.

Cognitive Models

One way of thinking about the notion of transference is from the perspective of George Kelly's personal construct theory (Kelly, 1955). In this model of personality, people formulate personal constructs to represent the social environment, especially other people and themselves, by categorizing them into trait adjective terms. These personal constructs then guide individual interpretations, decisions, and actions. According to Kelly, significant others are fundamental to the constructs a person forms and stores in memory (each labeled by a trait adjective) because these constructs help the individual understand how various significant others are similar to and different from each other as well as from (and to) the self. These constructs are idiographic in nature—that is, unique to the individual. Mischel (1973) argued that such constructs are central to cognition, and are formed through basic social-learning mechanisms. By the latter extension, expectancies, learning strategies, and self-regulation are evoked by stimuli in specific situations based on what is stored in memory.

Of course, research on trait dispositions can be (and has been) conducted in cognitive terms, whether to identify the cognitive level of specificity and evaluative components of trait concepts (John et al., 1991) or to directly examine, for example, trait anxiety or neuroticism, and processes associated with each, in terms of how they are contextually cued and with what consequences (e.g., Eysenck, 2000), or to examine how trait categories influence social perception (e.g., Kenrick and Stringfield, 1980; Woike and Bender, 2009; see also Kihlstrom, 2013). Similarly, numerous researchers in clinical psychology have focused on individual differences in clinical syndromes such as phobia or major depression, and as such, they have long examined cognitive schemas of feared objects or of the self to illuminate the link between provoking stimulus cues or interpersonal situations and relevant existing knowledge (e.g., Hammen et al., 1985; Mathews and MacLeod, 1987). Still, idiographic measurement in the trait domain has remained rather atypical (although see, e.g., Lamiell, 1981; McAdams, 1996; and see also Larson and Csikszentmihalyi, 1983; Fournier et al., 2002; Conner et al., 2009).

Our model of the relational self and transference (Andersen and Chen, 2002) draws from both personal construct theory (Kelly, 1955) and Mischel's later notion of the cognitive-affective processing system (CAPS, Mischel and Shoda, 1995), to show that individuals bearing minimal resemblance to significant others implicitly activate significant-other representations and this leads to various perceptual, affective, and behavioral consequences. In

doing so, this model integrates the perspectives of psychoanalysis, behaviorism, and cognitive-behavioral approaches (Andersen and Saribay, 2006). Of course, at its core, it is a cognitive model, but conceptually it is also influenced by basic learning processes (learning theory, behaviorism) and by interpersonal psychodynamic approaches (Sullivan, 1953) that link the self to significant others and emphasize the central role of motivation and emotion. It nonetheless remains most compatible with other cognitive approaches (see, e.g., Kihlstrom, 2013).

Personality Prototypes as Mental Representations

In contrast to a fully idiographic approach, it is worth noting that personality prototype models (Cantor and Mischel, 1977, 1979) are based on knowledge about (conceptualizations of) personality, stored in memory, and grounded largely in general, nomothetic knowledge (beliefs) about people, such as trait assumptions or notions of personality types. Personality prototypes can be defined by a trait (i.e., adjective) label, designating a main feature of an individual's personality (and its synonyms) or by a noun label (see also Higgins and King, 1981), the latter of which is more elaborate, richer, and more distinctive in features, as in a "caricature" or stereotype of the whole of an individual's personality (Andersen and Klatzky, 1987). As such it is used particularly efficiently in making judgments (Andersen et al., 1990). Our work expands and moves beyond such notions of personality types, overall, to what may be the richest and most distinctive of such mental representations in memory (e.g., Andersen and Cole, 1990, Studies 1 and 2)—those that designate significant others in the individual's life (i.e., each of one's various significant others). This should and does make these representations compelling tools for encoding. The richer and more distinctive the representations, the more accessible and likely they are to be used, a notion (about significant-other representations) that is well supported by the data, as we show (e.g., Andersen and Cole, 1990, Study 3).

Indeed, a further innovation of early work on personality prototypes was to use cognitive measures (e.g., a recognition memory paradigm) to measure, experimentally, when and how personality prototypes are applied to a new person to "go beyond the information given" about this new person (Bruner, 1957; Cantor and Mischel, 1977). In this research, these traits were conceptualized as cognitive concepts, held in memory (see also Kenrick and Stringfield, 1980; Kihlstrom, 2013), that implicitly influence the kind of personality assumptions that the individual tends to make about others. Research on transference (e.g., Andersen and Cole, 1990) adapted that experimental paradigm (Cantor and Mischel, 1977) and, in so doing, offered the first evidence that transference occurs as a social-cognitive process in everyday perception. Further, the transference effect has been replicated repeatedly, including a variety of control conditions designed to rule out alternative explanations, and measuring a variety of consequences beyond the signature biased inference/memory and evaluation effects, all of which arise based on a new person's resemblance to a significant other (and the relationship and relational self evoked). Such consequences include relevant shifts in the motivation and goals that are pursued, behaviors that are enacted, and the sense of

self experienced, along with relevant shifts in emotions (e.g., Andersen et al., 1995, 1996; Baum and Andersen, 1999; Glassman and Andersen, 1999a; Berk and Andersen, 2000, 2008; Berenson and Andersen, 2006; Reznik and Andersen, 2007; Miranda et al., 2013; Przybylinski and Andersen, 2015). Of course, a significant-other representation is an *n*-of-one representation, and hence, not a personality prototype *per se*.

PSYCHOANALYTIC AND PSYCHODYNAMIC CONCEPT OF TRANSFERENCE

The Psychoanalytic

Historically, the concept of *transference* has been focal in psychoanalysis (Freud, 1958), and has referred to the assumption that patients re-experience unconscious psychosexual impulses (libidinous drive) and conflicts from childhood with their analyst (Freud, 1958, 1963; see also Andersen and Glassman, 1996). Libidinous drive fuels structures of mind (id, ego, and superego), he proposed, and although he did note that “imagoes” may be formed of one’s parents, these have no causal role in the theory. Indeed, in the drive-structure model (Greenberg and Mitchell, 1983), the structures of mind and the unconscious psychosexual drive that fuels it are universal; people vary mainly in intensity of their libidinal drive. Transference, in his view, is thus fueled by libidinal impulses and processes. Freud acknowledged too that transference can transpire outside of the patient-therapist relationship, but this was far from his emphasis (Freud, 1958; see Luborsky and Crits-Christoph, 1990). Our emphasis is on social-cognitive processes in which “transference” occurs in everyday perception and interpersonal interaction, arising as an ordinary, non-defensive process, based on significant-other knowledge stored in memory that is triggered situationally by interpersonal cues. Hence, ours is a distinctively non-Freudian characterization, although we retain the term and the overall assumption that something about one’s past experience emerges in the present.

The Psychodynamic

More specifically, our approach draws directly from that of the neo-Freudian, Harry Stack Sullivan, an interpersonal psychodynamic theorist who contradicted most of Freud’s assumptions (he dropped the entire drive-structure model, the notion of infantile psychosexual drive, and unconscious libidinal wish), focusing instead on actual interpersonal learning. Sullivan proposed the notion of *parataxic distortion*, a version of transference in which “personifications” of significant others and of the self (linked through “dynamisms” or relational dynamics) both emerge with new people (Sullivan, 1953). Personifications and dynamisms are somewhat analogous to mental representations of significant others and the relationship, respectively, and are developed through actual learning and interpersonal interactions with significant others (rather than drive). Given that Sullivan rejected assumptions about psychosexual drive made by Freud, he proposed instead basic needs for satisfaction and safety (security). Expressing one’s own perceptions, feelings, and beliefs in words with others,

and also developing one’s own talents and capabilities, in each case while managing to remain connected (“integrated”) with significant others, together fulfill the former need. Security is compromised if a balance across these components of satisfaction cannot be reached. As such, the content of personifications and dynamisms includes these motivations and how they were (or were not) met with the significant other, and these are reflected in parataxic distortion with others (i.e., transference) as well. Sullivan’s assumptions about motivation are quite consistent with ours, although we have proposed other human needs as well—that is, for connection, autonomy, competency and control, comprehension/meaning, and security (Andersen et al., 1997; Andersen and Chen, 2002). Like Freud, Sullivan emphasized transference in the therapeutic context. On the other hand, he also discussed its occurrence in everyday life and did so more than Freud did. We, of course, emphasize significant-other representations and their association in memory with the self, as well as the processes by which they are brought to mind in new interpersonal encounters, affecting perception and behavior. Our approach is thus vastly closer to Sullivan’s than to Freud’s, even though we adopt Freud’s term—transference—simply because it is less cumbersome and, generally, more recognizable.

It is also worth noting that aspects of Sullivan’s interpersonal model are similar to object relations theory, as described by Melanie Klein and others, with the exception that the former emphasizes interpersonal learning and behavior as well as actual interpersonal experiences, while the latter focuses more on fantasy and libidinal drive (Klein, 1946, 1952; Greenberg and Mitchell, 1983; Grotstein, 1985). Still, like Sullivan, object relations theorists assume a notion similar to mental representations of significant others—individuals develop internalized relations with objects (significant persons) in the environment, and engage in projective identification in which these internalizations can be projected onto others. They also largely focused on transference in the therapeutic context, while not rejecting that it may arise in everyday life.

Attachment Theory

Attachment theory is yet another framework in which interactions with significant others are thought to contribute to the development of internal working models of the self and others that are then used in subsequent relationships, influencing beliefs, memories, emotions, expectations, and behaviors about others as well as the self (Bowlby, 1973). These working models are developed from early interactions with attachment figures, reflecting expectations about the availability and responsiveness of the caregiver in times of stress, and whether or not the self is competent and worthy of love (Bowlby, 1969). A core assumption is that these working models serve as the basis for later relationships. Much research has focused on infant-caregiver interactions in the Strange Situation paradigm as well as toddler/child-caregiver interactions (e.g., Thompson, 1998, 1999), and of course, on adult attachment in romantic relationships that involve categories of secure or insecure attachment, assessed by self-report (e.g., Hazan and Shaver, 1987; Bartholomew, 1990; Griffin and Bartholomew, 1994; Pietromonaco and Barrett, 2000; Mikulincer and Shaver, 2007). While the latter function as a broad

individual differences (e.g., avoidant attachment), people also have relationship-specific working models (e.g., Baldwin et al., 1996; Overall et al., 2003; Klohnen et al., 2005). Working models in the attachment framework are similar to mental representations (of self, other, and the relationship) in that they guide responding in new situations, when relevant. Hence, although our model does not originate from attachment theory, or share its precise focus, it is clearly compatible as a framework.

In Sum

Since its inception, the concept of transference has been examined largely theoretically, rather than empirically, and thus rarely subjected to the scrutiny of science (with some exceptions, e.g., Horowitz, 1989, 1991; Luborsky and Crits-Christoph, 1990). How transference has been defined has also differed depending on the theorists involved (e.g., Greenson, 1965; Ehrenreich, 1989), with the common components tending to reflect “the experiencing of feelings, drives, attitudes, fantasies, and defenses toward a person in the present which are inappropriate to the person and are a repetition, a displacement of reaction originating in regard to significant persons of early childhood” (Greenson, 1965, p. 156). Although the conception of transference and the data we have are compatible with this definition in broad strokes, our framework and data focus on a wide variety of significant others (not only from early childhood) and highlight the precise cognitive processes that evidence suggests underlie transference. Specifically, our framework and data emphasize what is likely to trigger transference and how—that is, under what circumstances and with what consequences—leading to precise predictions that are subjected to experimental test. Such evidence emphasizes the specific nature of each particular significant other in one’s life and the relationship one has with him or her, as well as the self as experienced with that significant other, while also examining the basic cognitive processes that underlie the transference effect. We examine the cues in an interpersonal situation that trigger transference, the specific processes that prompt it, and its precise consequences that arise via what knowledge is stored in memory.

EVIDENCE SUPPORTING TRANSFERENCE AND RELATIONAL SELF

A Word on Methods

Research on transference typically uses a two-session paradigm. In the first session, participants name and describe at least one significant other by listing an equal number of positive and negative sentences (two to six words each)—about the significant other’s interests, likes, attitudes, beliefs, tendencies, or specific behaviors or styles (e.g., likes to think about politics, plays the flute, is even-tempered)—and then rank-ordering the sentences based on their descriptiveness of this significant other. Weeks later, participants return for a supposedly unrelated experiment, and are for example, randomly assigned to a condition in which they learn about a new person who is described using some of the features the participant listed in the first session about their significant other intermixed with filler items that are indicated as being irrelevant to the significant other, or a

new person who does not resemble a significant other at all (e.g., Andersen and Baum, 1994; Andersen et al., 1996; Berk and Andersen, 2000; Berenson and Andersen, 2006). Hence, in one condition the new person bears a subtle resemblance to the significant other. In a yoked control condition, significant-other descriptions are instead drawn from those that another participant listed about his or her significant other. This one-to-one yoking of a participant in the control condition with one in the transference condition ensures that those in the resemblance and control conditions are presented with exactly the same descriptions. This allows us to control for content of the features used and thus rule out the possibility that descriptions of any significant other can trigger the transference process. After being presented with descriptions about the new person, participants complete various dependent measures.

It is worth noting as well that we have also made use of a fully within-subjects design in which the participant learns about various new persons, one of whom resembles their own significant other, while the other new persons do not, allowing for the examination of shifts in the same participant’s responses as a function of triggering cues (e.g., Andersen and Cole, 1990; Andersen et al., 1995; Glassman and Andersen, 1999b). In addition, we often cross such within-participant manipulations with between-subject factors in a mixed model design (e.g., Chen et al., 1999; Przybylinski and Andersen, 2013, 2015).

Signature Cognitive and Evaluative Effects Inference and Memory

Early work on transference has assessed activation of a significant-other representation and its use via a recognition-memory paradigm assessing what one remembers about a new person and the tendency to “fill in the blanks” about him or her using the significant-other information stored in memory (adapted from Cantor and Mischel, 1977). Research has demonstrated that after learning about a new person who exhibits some subtle similarity to a significant other, individuals will tend to assume that the new person possesses other features of their significant other. That is, they report higher confidence in having learned specific features about the new person that they in fact did not—features relevant to significant-other knowledge (e.g., Andersen and Cole, 1990; Andersen and Baum, 1994; Andersen et al., 1995; Baum and Andersen, 1999; Berenson and Andersen, 2006; Saribay and Andersen, 2007; Przybylinski and Andersen, 2013, 2015). The individual remembers the new person in a manner colored by the stored significant-other knowledge, based on subtle resemblance to the significant other (versus to a yoked participant’s significant other). For instance, if an individual finds out that a new person likes to knit and it so happens that the individual’s own sister likes to knit and is also very self-confident, the individual is more likely to incorrectly remember having learned that the new person is actually very self-confident.

In this research, resemblance to a significant other is usually constructed as a small number of significant-other based features embedded among distractor cues (irrelevant features), which makes the triggering/cueing process relatively implicit in all of our experiments. Accordingly, the effect has been found

even when significant-other features are presented subliminally (Glassman and Andersen, 1999a), and thus outside of conscious awareness. The transference effect occurs effortlessly, and cannot be controlled easily—that is, it is automatic (see Andersen et al., 2007)—and also persists over time (Glassman and Andersen, 1999b). Moreover, the effect arises even when the significant-other representation is activated based on subtle facial resemblance to a new person. That is, individuals made inferences about the new person consistent with knowledge of their significant other after being presented with a photograph, allegedly of the new person, which they had previously rated (in a prior session) as resembling their significant other (Kraus and Chen, 2010).

To rule out alternative explanations of such effects, potential experimental confounds have been carefully examined. For instance, these effects could possibly be accounted for by the fact that participants themselves generated their own significant-other features used to describe the new person in a previous session (Greenwald and Banaji, 1989), but did not generate such features for the yoked-control condition. Since memory tends to be better for self-generated materials, a control condition is used to include descriptions that the participant also self-generated, but instead to describe a social category the person tends to use (Andersen and Cole, 1990), or a non-significant other in the person's life (e.g., Andersen et al., 1995; Glassman and Andersen, 1999b), or in some cases, no one person at all (the no representation condition, e.g., Przybylinski and Andersen, 2013, 2015). Such control conditions address self-generation effects. The inference and memory effect, in sum, is stronger for representations of a significant other than for other self-generated information and for social categories the individual tends to use. Hence, the effect cannot be reduced to simple social categorization effects (e.g., stereotyping) or to self-generation.

Much research shows that transference is quite pervasive and occurs even averaging across individual differences in relationships. Indeed, the transference effect, as indexed by this signature cognitive measure, occurs regardless of whether the individual views the significant other positively or negatively (e.g., Andersen and Baum, 1994; Andersen et al., 1996; Hinkley and Andersen, 1996). It also emerges independent of the self-discrepancy the individual may have from a parent's standpoint (when the parent is the significant other), for example, if the individual has fallen short of the parent's standards (Reznik and Andersen, 2007), and regardless of psychological and physical abuse by a parent (as the significant other) while growing up (Berenson and Andersen, 2006), chronically dissatisfied affection goals with the significant other (Berk and Andersen, 2008), and of depressive symptomatology (Andersen and Miranda, 2006; Miranda et al., 2013). Unsurprisingly, other affective and motivational consequences also arise in this process (noted below), usually as a function of the relationship that is indirectly activated when the significant-other representation is cued.

Finally, as further evidence that the transference process does in fact emerge quite automatically, evidence shows that the transference process is moderated by variables that are known to moderate other automatic processes. Research in other labs has shown that transference is more likely to occur if the individual is

experiencing a circadian rhythm mismatch (it is the wrong time of day for him/her, Kruglanski and Pierro, 2008), or is high in need for closure (Pierro and Kruglanski, 2008), or is not inclined to engage in careful assessment (Pierro et al., 2009).

Evaluation

Individuals evaluate people and objects quickly and relatively automatically (e.g., Bargh et al., 1996). Such snap judgments can be influenced by significant-other representations. That is, when a significant-other representation is activated and applied to a new person in transference, the way one evaluates the significant other is also implicitly evoked and applied to the new person, and the person is evaluated as the significant other is—that is, positively or negatively. This significant-other based evaluation is grounded in the notion of schema-triggered affect (Fiske and Pavelchak, 1986), as it arises based on the triggering of a significant-other representation, and this effect is considered another signature effect of transference. Indeed, a new person will be evaluated more positively in self-reported Likert ratings if he or she minimally resembles an individual's own positive significant other versus a yoked participant's positive significant other (Baum and Andersen, 1999) or versus an individual's own negative significant other (Andersen and Baum, 1994; Andersen et al., 1996; Berk and Andersen, 2000). As noted, this effect also occurs across a wide variety of relationships, for example, when the significant other is a parent and the individual believes he or she falls short of the parent's standards (Reznik and Andersen, 2007; see Higgins, 1987), or if the individual was abused by the parent (shown in facial expressions, Berenson and Andersen, 2006).

Indeed, snap judgments can also be triggered by minimal facial resemblance in a new person, as shown by research from two other labs—for instance, when the new person is depicted using a photograph that was previously rated by the participant as similar (versus not) to a loved significant other (Kraus and Chen, 2010), he/she is rated more positively. Along these lines, when the new person is depicted using a photograph that was created by morphing the face of a loved significant-other with another person's face (Günaydin et al., 2012), the individuals tended to indicate (by saying “yes” versus “no”) that the new person possessed certain positive traits, such as trustworthiness or intelligence. Moreover, automatic positive evaluation of a new person, based on his or her significant-other resemblance, is enhanced when one's own mortality is made salient (Cox et al., 2008, Study 5). That is, research in yet another lab has shown that a parent-resembling new person is evaluated more positively, especially if one has just thought about one's own death (versus about extreme pain; Cox et al., 2008), suggesting that transference involving a loved significant other is more likely in the face of death threat and may thus serve terror management functions and serve existential needs (see Przybylinski and Andersen, 2015).

Indeed, when the significant other is regarded positively, an immediate positive emotional response should be elicited, and there is evidence on the individual's own facial expression of affect to support this. When the new person is similar to a positive rather than a negative significant other, more positive facial affect is expressed (as unobtrusively recorded), and this occurs quite

quickly—that is, as one reads the relevant features presented about the new person (Andersen et al., 1996). The quick emergence of this emotional response suggests automatic evaluation of the new person (Bargh et al., 1996), arising in the transference process, based on evaluation of the significant other. As noted, this effect is even evident when the significant other is an abusive parent from one's childhood (Berenson and Andersen, 2006). People often denote that they love their parents independent of having negative or dangerous experiences with them, and these positive feelings are elicited relatively immediately in transference in the form of positive facial affect (Berenson and Andersen, 2006).

Relationship Effects Expectancies

Intermixed with the information one has about significant others, is information regarding how each significant other relates to and behaves toward the individual, and this knowledge should be applied to new people resembling these significant others in transference. Indeed, research shows that the acceptance or rejection one expects from a significant other is activated and applied to the new person in transference. When a new person resembling a positive versus negative significant other is encountered, the new person is expected to be more accepting and less rejecting, an effect that does not hold in the control condition (Andersen et al., 1996; Berk and Andersen, 2000). Thus, the individual anticipates being liked or disliked by the person based on expectations he or she has of the significant other, and this occurs across individual differences, such as one's self-discrepancy from the parent's perspective (Reznik and Andersen, 2007), whether or not the significant other has typically shown the level of affection one has desired (Berk and Andersen, 2008), whether or not one has been rejected by a loved significant other (Miranda et al., 2013), and whether or not a parent was abusive in the past (Berenson and Andersen, 2006).

Beyond the transference context, relationships (as stored in memory) are known to be linked with overall expectations of rejection or acceptance (e.g., Baldwin and Sinclair, 1996). Knowledge of how accepting or rejecting a significant other is, is stored in memory, and such expectancies are readily activated, whether in relationships or based on priming of the relationship (e.g., Baldwin et al., 1990; Miranda et al., 2013); this is especially so if the individual tends to be rejection-sensitive (Downey and Feldman, 1996).

Interpersonal Behavior

Another important component of significant-other relationships is behavior. The typical behaviors engaged in with the significant other should also be activated in transference and enacted with the new person, evoking behavioral confirmation—or a self-fulfilling prophecy. The new person should then enact behaviors the individual expects of him or her. Indeed, individuals having a phone conversation with a naïve stranger who was made to resemble a positive (or negative) significant other—or not—evoked expected behaviors from the new person (Berk and Andersen, 2000). The new person's part of the conversation, as assessed by the ratings of independent judges who were blind to condition, connoted the expected positive

or negative affect, based on how positively or negatively the significant other was regarded, and this effect was not evident when the new person did not resemble a significant other. Some research suggests that this effect occurs without specific intention and thus individuals do not consciously attempt to elicit the expected behavior (e.g., Chen and Bargh, 1997). We assume this is what happens in transference. In a familiar example, an individual may unknowingly respond to a new person as though he is a past romantic partner without realizing that he or she is doing this, and in turn the new person may start to behave as the romantic partner would.

Furthermore, individuals in transference will also, under some circumstances, engage in behaviors designed to solicit liking and positive responding from the new person despite a troubled relationship with the significant other. That is, when a new person resembled a well-regarded significant other who commonly failed to satisfy one's goals for affection, individuals not only became more hostile as a result, but this hostility was linked to persisting longer on a behavioral task said to increase positive response from others (Berk and Andersen, 2008). Thus, behaviors done to achieve a particular goal one has with the significant other are evoked and enacted in transference.

Motivation and Goals

The motives and goals held with significant others are stored with significant-other knowledge in memory, and evidence shows that they are, indeed, brought to mind and applied when significant-other knowledge is evoked. In transference, goals to be close to positive significant others are frequently activated and pursued with a new person in the context of transference. That is, individuals are motivated to approach and to be disclosing toward a new person who bears minimal resemblance to a positive significant other and to avoid closeness when the new person is similar to a negative significant other (Andersen et al., 1996; Berk and Andersen, 2000). As further evidence of this, behavioral approach motivation has also been shown to emerge in a positive transference. That is, individuals moved their chairs closer to where they were told the new person would sit for an upcoming interaction if this new person resembled the positive significant other versus not (Kraus et al., 2010).

However, this behavior is also relationship-specific. For example, when a loved significant other has not met one's goals for love and affection—the goal is unsatisfied—this knowledge emerges in transference (Berk and Andersen, 2008). When such a significant other is evoked by resemblance to him or her in a new person, the usual positive affect evoked by transference is disrupted and the individual shows a decreased motivation to be close and disclosing to the new person, even showing increased hostility. Interestingly, when the significant other in this study was a relative (suggesting that the relationship is not likely to be ended), the hostility expressed by the individual was positively related to increased enactment of explicit behaviors that would help attain acceptance and liking from the new person (Berk and Andersen, 2008). The goal that had not been fulfilled with the significant other was pursued in transference,

even as the individual became more hostile and even if these mixed messages—expressing hostility yet also seeking affection—may prove particularly confusing and frustrating to the new person.

Beyond this, transference not only prompts goal activation and goal pursuit—when mental representations of significant others are activated—but also specifies both the *how* and *why* of goal pursuit based on the activated relationship. That is, activation of significant-other knowledge shapes both the overall goal to be sought, as the *why* of goal pursuit (its higher-order goal), and the subgoal to be selected, as the *how* of goal pursuit, or the means of pursuing that goal (Ahn and Andersen, 2016). Such evidence attests to the richness of the transference concept in its implications for motivation and goals.

Even achievement goals can be brought to the fore in transference. When a significant other holds such a goal for the individual and knowledge of that significant other is implicitly activated in transference, the individual will actively pursue the achievement goal in behavioral terms at that moment (Xu and Andersen, 2014). Moreover, such goals from a prior significant-other relationship can be triggered and enacted even with a current romantic partner (versus only with new persons). Thus in transference, achievement goals from a prior relationship may be suddenly pursued with a current romantic partner, even if this goal is potentially disruptive to the current relationship (Xu and Andersen, 2014).

Finally, research outside the domain of transference has shown other goals can also be evoked when a significant-other representation is activated. For instance, priming a significant-other representation increases the pursuit of goals that one has with the significant other—such as competition, achievement, and helping goals (Fitzsimons and Bargh, 2003; Shah, 2003a,b) as well as attachment-style congruent goals when a significant other with whom one is securely or insecurely attached is primed (Gillath et al., 2006).

Moreover, research from other labs has again shown that while significant others do affect the kinds of goals that are activated and pursued, goals that are activated at the moment also can, in turn, have implications for social perception and social categorization. When a goal has been primed, individuals spontaneously bring to mind the individuals in their life that are instrumental to the goal—useful for pursuit of the goal—or not. For instance, after a goal is primed, individuals make more memory errors between individuals within categories of “instrumental” and “non-instrumental,” respectively, suggesting that social categorization also depends on the kinds of goals that are active (Fitzsimons and Shah, 2009). On the other hand, activating a significant other does not always foster active behavioral goal pursuit of the most relevant goals in that relationship and may even undermine motivation, since people often tend to “outsource” goal pursuit plans to significant others who are supportive of those goals (Fitzsimons and Finkel, 2011). Moreover, being subliminally exposed to the name of a significant other who is controlling can elicit reactance and oppositional behavior (Chartrand et al., 2007), depending on the nature of the relationship.

Some Effects of the Self in Relation to the Other

Likewise, individuals tend to form a version of the self in the context of a particular relationship, as the self is typically experienced with each specific significant other, and this relational self should be evoked in transference. Indeed, in transference, an individual's sense of self should parallel the version of the self that is experienced with the relevant significant other. For example, one may be especially gentle and supportive toward one's wife, and yet one may be assertive and seek power amongst co-workers. These various ways of perceiving the self and behaving—for example, being both gentle and assertive—can each constitute the self; however, in line with Mischel's IF-THEN theory (Mischel and Shoda, 1995), they differ based on the interpersonal context in which they are activated. When the significant other representation is activated, the corresponding self is activated and enacted, as well (Andersen and Chen, 2002).

Indeed, there is evidence to support this. Adjusting for one's self-definition at pretest, the “relational self” with the specific significant other is experienced with the new person, independent of whether the significant other is regarded positively or negatively (Hinkley and Andersen, 1996). The knowledge one has of the self with the significant other, as well as its valence, enters the working self-concept when the significant-other representation is evoked. This effect can also be provoked by facial resemblance to a significant other in a new person. When presented with a photo of a new person whom individuals had previously rated as resembling a significant other in an earlier session, individuals described themselves more as the person they are when with the significant other (Kraus and Chen, 2010).

Activation of the relational self has also been shown to indirectly activate automatic self-verification processes in transference. Research from another lab showed that upon learning about a significant-other resembling person (versus not), individuals end up rating themselves in a manner that better reflects their desired self (how they would like to be viewed) on self-attributes most important to the relational self (Kraus and Chen, 2009). In the absence of significant-other resemblance, by contrast, individuals are more likely to self-enhance using a wide variety of attributes. In fact, when a significant-other representation is activated, individuals will also describe themselves (e.g., how athletic or artistic they are) to a new person resembling the significant other in such a way as to receive self-verification for important aspects of the activated relational self (Kraus and Chen, 2014).

Along the same lines, one's sense of self-worth is also dependent in part on the relational self that is active at the moment. Contingencies of self-worth that are experienced with a significant other (e.g., Crocker and Wolfe, 2001; Horberg and Chen, 2010) are activated when that significant-other representation is implicitly activated in transference. Research from another lab showed that when a significant other with whom individuals wanted to be close to was implicitly activated, individuals were more likely to stake their self-esteem on performance in those domains in which the significant other wanted them to do well (Horberg and Chen, 2010). That is, individuals' sense of self-worth and the degree to which they had

thoughts about failure were affected by perceived success or lack thereof on performance in that particular domain.

Relational selves can also help affirm one's overall sense of self when aspects of relational selves are deemed important. For example, research on self-affirmation and relational selves from another lab suggests that individuals who see relational self-aspects as particularly important to their identity, can readily maintain a positive sense of self in the face of threat (e.g., negative feedback on an aptitude test) by focusing on these particular aspects of the self (Chen and Boucher, 2008), and in so doing, protect their self-esteem. That is, individuals threatened by bogus negative feedback showed a heightened tendency to characterize themselves in relational terms in a self-description task (Study 1) and to evaluate positively the letters in their own names (versus other letters, Study 2), suggesting positive implicit self-esteem (Chen and Boucher, 2008).

Cultural differences also sway how the self is contextually experienced and perceived in relation to different significant others. For instance, research has shown that Asian Americans show more cross-situational inconsistency across different relationships than do European Americans, and yet they do maintain consistency in self-descriptions—within each relationship—over time (an across-time consistency often found in dispositional research, writ large, English and Chen, 2007). Further, among European Americans, but not Asian Americans, inconsistency in individuals' self-perceived traits across different relationships has been shown to be associated with reduced feelings of authenticity and relationship quality. Both groups, however, experience lower levels of authenticity and relationship satisfaction based on perceived inconsistency in the same relationship over time (English and Chen, 2011). In short, this research suggests that Asian Americans may be even more likely to experience the self on an if-then basis, even though we know European Americans also show such cross-situational consistency, as noted.

In addition, evidence stemming from other labs does show that the attachment system is triggered in transference (e.g., Cox et al., 2008, Study 5) and that attachment style and working models clearly emerge in transference (e.g., Brumbaugh and Fraley, 2006, 2007). In the classic transference paradigm, manipulated resemblance to a prior romantic partner led individuals to apply their attachment style with a past romantic partner (the prior significant other) to a potential dating partner, as reflected in self-reported anxiety and avoidance (Brumbaugh and Fraley, 2006). Likewise, such manipulated resemblance led the overall attachment style to arise in relation to potential new friends (again in anxiety and depression, Brumbaugh and Fraley, 2007). Beyond this, other research indicates that manipulated mortality salience (thoughts of death) makes transference more pronounced in relation to a new person (based on manipulated resemblance to a parent), in terms of self-reported liking and also behaviors such as arranging for less physical distance (more physical closeness) with the new person (Cox et al., 2008, Study 5), increasing the relevance of the parent as a secure base, and hence, the new person as a safe haven.

Hence, the relational self that is active at any particular time is clearly dependent on important situational cues—that is, whether

or not a new person bears a resemblance to the significant other. IF significant-other resembling cues are present in the situation, THEN the significant-other representation will be evoked, and the self-with-that-significant-other will become the functioning self-concept at that time.

Self-Regulation

In addition to shifts in the working self-concept as a function of the implicit activation of a significant-other representation, contextual self-regulation is also evoked in transference. One example of this is when negative self-with-significant-other features enter the operative self-concept in transference, and thus pose a threat to the self, a self-defensive response should be elicited—as is common in response to other threats (see Greenberg and Pyszczynski, 1985; Steele, 1988). Indeed, when a significant other who is associated with a disliked version of the self is evoked (Hinkley and Andersen, 1996; Reznik and Andersen, 2007), the negative self-with-other features that have been evoked should lead to the positive features that are not a part of the relational self to enter into the working self-concept, shielding one's image of the self from threat, and this is in fact the case (Hinkley and Andersen, 1996; Reznik and Andersen, 2007).

Similarly, the individual may, under some conditions, come to protect the significant other in transference. This kind of regulation may occur because it is favorable for people to believe that their significant others are generally loving and good, despite their faults. Thus, significant-other faults are often transformed into charming quirks and even virtues (e.g., Murray and Holmes, 1993). In transference, this process may occur relatively automatically if it tends to occur consistently in the relationship over time. Indeed, as previously noted, immediate facial affect expressed in transference connotes the general feelings related to the significant other. Furthermore, when negative features of a positive significant other are encountered, participants express even more positive immediate facial expressions than when they encounter positive features, an effect not evident in the control condition (Andersen et al., 1996). Thus, it appears that facial affect transforms the valence of the feature from negative to positive, so as to parallel the general positive affect related to the significant other. This implies that self-regulation of this kind is evoked because encountering a negative feature of a liked or loved significant other in a new person may threaten the positive regard one has for the significant other.

Such self-regulation could in principle extend to a significant other's negative emotions or behaviors when they are expressed by a new person, as well. In particular, for example, if a significant other has psychologically and physically maltreated an individual in the past, a cue that may suggest rising tension from this significant other should be especially negative; however, it should still elicit self-regulation from the individual. Hence, cues like anger from the significant other are likely to signal impending abuse and may prompt self-regulation in the individual to shield him or her from its consequences. Research has tested whether or not new people in transference can trigger similar self-regulation processes. For example, research tested how individuals abused as children by a parent (or not) respond in transference when the new person displays the pattern typical prior to abuse, such as

becoming more irritable when awaiting the interaction (Berenson and Andersen, 2006).

Although abused individuals displayed immediate positive facial affect in transference, they expressed negative evaluations of the new person compared to a control condition—they expected rejection from him or her, were indifferent to whether or not the new person liked them, and experienced significantly more negative mood. When they were told that the new person was becoming irritable and angry, however, those in transference relative to the yoked control condition exhibited more positive facial affect regardless of abuse history, presumably to maintain general positive regard for the significant other. Previously abused participants showed comparable levels of positive facial affect as non-abused participants after encountering this cue. Such a regulatory response aimed at protecting the other may not be wise if the new person who is similar to the abusive significant other is also abusive; that is, abuse could be perpetuated in a new relationship. Interestingly, abused participants exhibited much less negative affect when the new person resembled their parent and was also acting angry and irritable compared to participants in all other conditions, a kind of apathy that is referred to as “emotional numbing” in the abuse literature.

In addition, individuals who possess certain emotional vulnerabilities may be particularly likely to experience negative affect when a loved, but rejecting significant other is activated in transference. For example, dysphoric and non-dysphoric college students who expected to meet a new person resembling a loved, but sometimes rejecting, significant other were asked to describe themselves by completing sentences to assess their working self-concept (as in Hinkley and Andersen, 1996). Dysphoric individuals described themselves in terms that were rated by judges as more rejecting (Miranda et al., 2013). They also experienced an increase in negative affect. However, when the new person resembled a yoked significant other, or even a disliked significant other, this effect did not occur. In fact, dysphoric individuals showed a decrease in depressive mood when a disliked significant other was brought to mind compared to a yoked participant's significant other. Non-dysphoric individuals did not experience such shifts in mood following the activation of any of the significant-other representations.

Another way of thinking about self-regulation and transference is to consider how an individual may experience having a self-discrepancy (Higgins, 1987) from the perspective of a parent, when falling short of the standards held by that parent, and the emotional vulnerability this entails. Indeed, implicit activation of a parental representation in transference should indirectly activate one's sense of self, as well as the parent's standards for the self, which may not be the same (Reznik and Andersen, 2007). Hence, activating a parental representation may evoke a self-discrepancy (e.g., Higgins, 1987) in transference, if such a discrepancy exists in the relationship with the parent. A discrepancy between one's actual self and one's ideal self (who one could ideally be) or one's ought self (who one should be) prompts feelings of dejection (as the actual-ideal discrepancy is activated) or feelings of agitation (as the actual-ought discrepancy is activated). These precise feelings thus arise in transference, when relevant to the relationship.

However, when significant-other cues are encountered in the new person that directly bring to mind the standard a parent holds for oneself (i.e., when the new person emphasizes hopes for or obligations for new friends), the regulatory functions of the standards activated (i.e., according to self-regulatory focus theory; Higgins, 1997) should be prompted based on transference. That is, ideal standards (or hopes) are relevant to a promotion focus—a focus on seeking out potential gains, while ought standards (or obligations) are relevant to a prevention focus—a focus on threat to avoid losses. Feelings of agitation should be exacerbated when in a state of prevention focus, whereas a promotion focus should decrease feelings of dejection, and this is what evidence has shown. Individuals in transference with an actual-ideal discrepancy from their parent's standpoint who were presented with a cue bringing to mind the parent's ideals showed evidence of promotion focus that reduced feelings of dejection while a similar cue presented to individuals with an actual-ought discrepancy did not facilitate a reduction of agitation-related feelings in transference (Reznik and Andersen, 2007).

Other problematic inconsistencies that exist in a significant-other relationship are also activated in transference. For instance, a discrepancy in goals one has with a significant other, such as an unsatisfied goal for love and affection, as noted, is activated when the significant other is (Berk and Andersen, 2008). This leads individuals to experience feelings of hostility toward the new person, while still attempting to satisfy the activated goal. That is, when the representation of the significant other with whom they have such a goal discrepancy is activated in transference, individuals persist on a task designed to elicit liking from the new person. Similarly, dysphoric individuals who have sometimes been rejected by loved significant others, and thus have experienced a discrepancy in their relationship regarding love and affection, report increased depressed mood when such a significant other is activated (Miranda et al., 2013). They also describe themselves in a manner conveying rejection in this context.

Indeed, a different way of viewing the matter of self-regulation with respect to transference and the relational self is to ask whether or not this relatively automatic process can ever be intentionally short-circuited. When the transference process perpetuates suffering by triggering interpersonal problems, individuals may have good reason to want to prevent it. On the other hand, its automaticity—that is, the notion that it arises without effort, intention, or awareness (see Andersen et al., 2005, 2007)—should make it difficult or impossible to control (Przybylinski and Andersen, 2013). Evidence suggests that this is so. However, it can be controlled when people make use of an intentional strategy that can itself be automatized, which can in fact be effective in eliminating unwanted inferential and memory biases (Przybylinski and Andersen, 2013).

In Sum

Taken together, this research convincingly demonstrates how the self, as experienced from moment-to-moment, can vary as a function of situational triggering cues that activate and bring to mind stored knowledge of significant others. When such knowledge is activated, it indirectly activates the specific relational

self, as well as the relationship with a particular significant other. This results in shifts in judgments, memory, evaluations, goals and motivations, as well as emotional state, and perceptions of the self, based on this activated stored knowledge. In turn, how one responds to a new person at the moment will also depend on the nature of the significant other that is activated in the moment. The effects tend to be of moderate effect size and are well replicated (e.g., Miranda et al., 2013; Przybylinski and Andersen, 2013, 2015). In this sense, the evidence demonstrates the cross-situational variability of the person in the domain of interpersonal relationships as a function of triggers in the current situation.

While we do not assume that everything about personality is interpersonal, the fact that significant-other representations have been shown to be activated quite automatically, based on incidental contextual cues, implies that even when the individual is consciously focused on other things or enacting a common routine exchange with another person, the process is still likely to unfold, at least in subtle ways. Of course, if the individual is anticipating further interaction with the person or for other reasons is more engaged, self-relevant expectations, emotions, and motivations should be more likely. In this respect, there are likely to be boundary conditions on the more emotionally laden phenomena we have observed. In addition, as previously noted, there may be circumstances under which the transference process is particularly likely to occur such as when one is experiencing a circadian rhythm mismatch (Kruglanski and Pierro, 2008), is high in need for closure (Pierro and Kruglanski, 2008), or low in assessment orientation (Pierro et al., 2009), or when one's mortality has been threatened in some manner (Cox et al., 2008).

Finally, although we do not focus exclusively on within-person designs that directly examine variability in responses within the individual across contexts—nor focus on stability in the transference effect over time (longitudinally)—we have shown that the transference effect, as provoked (or not) by initial situational (person) cues and that this persists at least over a 2- to 3-week period concerning that new person (Glassman and Andersen, 1999b). Moreover, even when we use a between-subjects design, this still does involve long-standing (and relatively stable) stored significant-other knowledge. The experimental designs are also carefully controlled, by manipulating whether or not the individual's own significant other is cued (i.e., exposure to differing interpersonal situations), in order to assess how responses then vary.

FUTURE DIRECTIONS

The complex, situation-dependent ways of responding we have empirically shown to occur in transference provide support for a relational IF-THEN conceptualization of personality, and call for future research that could clarify the conditions of behavior and personality, based on situational cues. First, significant others are often not thought of as merely “positive” or “negative,” but rather possess varying degrees of ambivalence that have specific significance for one's experience when these significant-other representations are activated. Such ambivalence, as it may be triggered situationally by transference, is in need of further testing

beyond the activation of standards that the significant other holds and past abuse by that significant other.

Considerably more research on these topics is necessary, particularly that which focuses on emotion and emotion regulation in transference. For instance, it is now well-known that, although significant others may be loved, they may still be associated with painful emotions and this suffering can be perpetuated in transference. Conceptually, it is of central importance to ascertain whether or not or precisely how people may prevent the processes of transference (beyond just memory and inferences, as in Przybylinski and Andersen, 2013) from transpiring when triggering cues are present in a situation. The ability for one to regulate a relatively automatic way of responding evoked implicitly and without intention so as to not be affected by it is worth further consideration.

In addition, examining the conditions in which positive interpersonal results may come about in transference, as opposed to just negative ones, would be important to understanding the way positive interpersonal responses are related to representations of significant others. For instance, in some circumstances individuals should not only make certain mistakes in interpreting the new person, but also may pay special attention to him or her and be especially motivated to understand him or her, such as through empathy. These consequences of transference have not been adequately explored.

CONCLUSION

To conclude, our model, known as the relational self, integrates the self and personality. We draw in part on Mischel's (1968) notion of cross-situational variability in behavior, and also show consistency within individuals based in the cognitive-affective processing system and their personality signature (Mischel and Shoda, 1995; Metcalfe and Mischel, 1999). Our model shows an intrinsic link between the situation and an individual's responses in the situation—including emotion, expectancy, and the experience of the self—that is grounded in relationships with significant others. We argue that significant-other representations can be individually activated at any time as a function of situational cues, leading to the indirect activation of the self when with the significant other, as well as the relationship with the significant other. These activated representations affect interpersonal behavior and other responses in predictable ways.

We argue that the precise responses in transference are specific to the person and to the relationship with the significant other that is evoked, even though they are stable over time—that is, when similar cues are present in the environment, similar responses should be evoked. In this way, the self and personality are, at any given moment, dependent on cues in the situation as well as on the chronic accessibility of significant-other representations. Thus, significant-other knowledge stored in memory that may be activated is stable over time, as is the version of the self one is with that other. Thus, transference occurs on an IF-THEN basis—IF one encounters someone who is similar to a significant other, THEN one becomes the version of the self when with that significant other. Indeed, this process transpires in individualistic cultures like the U.S.—where the research was conducted—as

well as across genders, and among individuals not specifically preselected as allocating special attention to relationships.

Overall, the contributions of Mischel and his colleagues—both conceptual and empirical—facilitate an important shift in the field of personality. Researchers are increasingly embracing the notion that behavioral variability is fundamental to personality, and are embracing ways to test the complexity of that variability, versus regarding it as merely error variance. This can enrich our understanding of individuals greatly. As a relational IF–THEN framework, our model reflects this perspective in personality theory, and can be considered one of various IF–THEN models of personality to emerge in the last decade or so, such as those reconceptualizing CAUs (Mischel and Shoda, 1995) as “schemas” or organized

knowledge structures similarly brought to the fore in relevant situations, thus allowing for situation-specific interpretive tendencies (Cervone, 2004; Cervone and Batooszek, 2013).

Our work shows the important role significant others play in understanding personality, especially affect, expectations, behavior, and how the self is experienced from one situation to the next. It also integrates ideas from psychodynamic theory, as well as those from social cognition and learning theory. Drawing on Mischel's insights, the model combines diverse areas of psychology to map the complexity of personality, by integrating an individual's interpersonal history with the present situation, and highlighting why an individual's variability by context reflects essential aspects of the person.

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Examining the Dynamic Structure of Daily Internalizing and Externalizing Behavior at Multiple Levels of Analysis

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Psychiatric diagnostic covariation suggests that the underlying structure of psychopathology is not one of circumscribed disorders. Quantitative modeling of individual differences in diagnostic patterns has uncovered several broad domains of mental disorder liability, of which the Internalizing and Externalizing spectra have garnered the greatest support. These dimensions have generally been estimated from lifetime or past-year comorbidity patterns, which are distal from the covariation of symptoms and maladaptive behavior that ebb and flow in daily life. In this study, structural models are applied to daily diary data (*Median* = 94 days) of maladaptive behaviors collected from a sample ($N = 101$) of individuals diagnosed with personality disorders (PDs). Using multilevel and unified structural equation modeling, between-person, within-person, and person-specific structures were estimated from 16 behaviors that are encompassed by the Internalizing and Externalizing spectra. At the between-person level (i.e., individual differences in average endorsement across days) we found support for a two-factor Internalizing–Externalizing model, which exhibits significant associations with corresponding diagnostic spectra. At the within-person level (i.e., dynamic covariation among daily behavior pooled across individuals) we found support for a more differentiated, four-factor, Negative Affect-Detachment-Hostility-Disinhibition structure. Finally, we demonstrate that the person-specific structures of associations between these four domains are highly idiosyncratic.

Keywords: internalizing, externalizing, personality structure, personality dynamics, psychopathology, multilevel SEM, idiographic modeling, unified SEM

INTRODUCTION

Occasioned by patterns of extensive diagnostic co-occurrence, there has been substantial interest in mapping the fundamental nature of psychopathology using quantitative modeling techniques (e.g., Krueger, 1999; Krueger and Markon, 2006; Cramer et al., 2010; Borsboom et al., 2011; Kotov et al., 2011; Wigman et al., 2015). Prime examples of these efforts include the empirically identified *Internalizing* (e.g., unipolar mood disorders, anxiety disorders) and *Externalizing* (e.g., substance use, antisocial behavior) spectra (e.g., Achenbach, 1966; Krueger, 1999; Wright et al., 2013). As has

been the case in the basic personality trait literature, research on the structure of mental disorders has prioritized the *between-person* level of analysis (i.e., individual differences). However, there has been increasing interest in studying contextualized dynamic processes associated with psychopathology (e.g., Myin-Germeys et al., 2009; Wichers, 2014). These approaches use a variety of *within-person* data collection and analytic techniques that seek to illuminate the granular and nuanced dynamics of mental disorders. On the surface these two perspectives to understanding psychopathology may seem at odds: one seeking to cast clinical phenomena in terms of generalities, the other pursuing a high degree of specificity. Here we explore bridging these two approaches by examining the structures that emerge from daily diary reports of maladaptive behaviors at the between-person, within-person, and person-specific levels of analysis. In so doing we draw links to efforts in basic personality science that seek to integrate structural and dynamic models by treating traits as ensembles of contextualized processes (e.g., Wright, 2014; DeYoung, 2015; Fleeson and Jayawickreme, 2015; Revelle and Condon, 2015).

The Structure of Individual Differences in Psychopathology

Psychiatric comorbidity is extensive in the general population (Kessler et al., 1994, 2005), and in clinical samples poly-diagnosis is the rule rather than the exception (Zimmerman and Mattia, 1999). This complicates clinical communication, treatment selection, and frustrates efforts to uncover the pathophysiology, etiology, and maintenance mechanisms of mental illness (Hyman, 2010). As a result, prominent clinical scientists, including the current and past heads of the U.S. National Institute of Mental Health, have called for a complete overhaul of the framework for classifying mental disorders (Hyman, 2010; Insel et al., 2010). Rather than enumerating increasingly detailed categories of disorder, it has been suggested that dimensions of functioning that cut across traditional diagnoses better approximate the structure of psychopathology (e.g., Brown et al., 1998; Widiger and Trull, 2007; Cuthbert and Insel, 2013; Harkness et al., 2014). One promising approach for addressing these issues involves statistically modeling patterns of covariation in diagnosed disorders and symptoms to clarify the natural between-person structure (BP-Structure) of mental disorders (Krueger and Markon, 2006; Wright and Zimmermann, 2015). This approach has been profitably applied to both child (Achenbach, 1966; Lahey et al., 2008) and adult (Krueger, 1999; Krueger and Markon, 2006; Kotov et al., 2011) disorders. In adult psychopathology, as noted above, a well-replicated BP-Structure has emerged based on individual differences in the clustering of disorders and their symptoms into Internalizing and Externalizing spectra (Wolf et al., 1988; Kotov et al., 2010a; Markon, 2010; Wright et al., 2013). This structure has demonstrated strong empirical and statistical evidence for its validity, including invariance across cultures (e.g., Slade and Watson, 2006), gender (Eaton et al., 2012), age groups (Eaton et al., 2011), and time-points within samples (Krueger et al., 1998; Vollebergh et al., 2001).

However, these domains are necessarily broad and decontextualized. In other words, they describe psychopathology in terms of individual differences, not in terms of the within-person or person-specific dynamic processes that often define mental disorders. Indeed, BP-Structural analyses of mental disorder covariation have largely relied on lifetime diagnoses (Krueger, 1999; Kotov et al., 2010a, 2011; Roysamb et al., 2011; Forbush and Watson, 2013; Wright et al., 2013) or some admixture of lifetime and current diagnoses (e.g., Markon, 2010; Blanco et al., 2013; Wright and Simms, 2015). What can be concluded from these studies is that the identified spectra of psychopathology (e.g., Internalizing, Externalizing) reflect latent dimensions of liability for the recognized mental disorders (Krueger and Markon, 2006; Caspi et al., 2014). That is to say, they reflect population-level risk for developing more specific instantiations of psychopathology during the lifespan. These spectra provide invaluable information about patterns of disorder covariation (i.e., co-morbidity), heritability (Kendler et al., 2011), and even the lack of specificity in responses to treatment (Barlow et al., 2010). Yet by themselves these dimensions lack the ability to provide information about proximal etiologies of clinically significant impairment, processes contributing to symptom exacerbation, or possible maintenance mechanisms.

Psychopathology as Maladaptive Dynamic Processes

Major theories of psychopathology posit processes of disorder development, exacerbation, and maintenance that play out over diverse time scales and frequently involve an interaction between individuals and the context in which they live their lives (e.g., Beck et al., 1979; Teasdale, 1988; Nolen-Hoeksema, 1991; Linehan, 1993; Benjamin, 2005). Indeed, many of the symptoms that define psychiatric disorders are cue- or context-dependent. For instance, social phobia is characterized by intense anxiety and behavioral avoidance when confronted with social or evaluative situations. The hallmark interpersonal impairments of borderline PD are responses to perceptions of significant others' behavior. The binge-purge cycles of the patient diagnosed with bulimia nervosa reflect a maladaptive and extreme regulatory cycle (e.g., binges and purges both occur in response to heightened negative affect in a specific sequence). Even the blunted hedonic response in depression can be understood as a lack of the normative shift in affect in response to pleasurable events. This has led many researchers to begin studying the dynamic processes of psychopathology as they unfold in the naturalistic settings of daily life (e.g., Shiffman et al., 2002; Wegner et al., 2002; Silk et al., 2003; Ebner-Priemer et al., 2007; Trull et al., 2008; Sadikaj et al., 2013; Pe et al., 2015; see also Myin-Germeys et al., 2009 for a review).

This approach has provided much needed systematic empirical confirmation of the clinical description of psychiatric phenomena (e.g., affective instability in borderline PD; Russell et al., 2007; Trull et al., 2008) and has offered new insights into maladaptive behavioral sequences (e.g., individuals diagnosed with borderline PD are more likely to respond to perceived

quarrelsomeness with negative affect, but no more likely to respond to negative affect with quarrelsomeness than controls; Sadikaj et al., 2013). Interestingly, as debates about psychiatric nosology have been pushing the field away from disorder-specific symptoms and toward dimensions that cut across traditional diagnoses, the study of dynamic processes in psychopathology has instead been emphasizing highly specific micro-processes (e.g., Wichers, 2014; Fried, 2015). It is notable that the majority, but not all, of the research studying dynamic processes in naturalistic settings have used a diagnostic group based design (e.g., comparing patients vs. community controls). Although there are plenty of good reasons for selecting circumscribed diagnostic groups for study (e.g., ensuring sufficient levels of pathology; maximizing statistical power in very expensive and difficult to collect data), this approach is at odds with efforts to collapse across categories to study dimensions of shared impairments (Krueger and Markon, 2006; Insel et al., 2010).

Thus, there is a tension between different areas of clinical science, which presumably share the same goal of clarifying the nature of psychopathology. The tension created is one between emphases on BP-Structure and within-person processes, which is certainly not a novel challenge (cf. Titchener, 1898). Taking as a given that both empirical thrusts have important information to contribute, the question becomes how best to integrate advances in the between-person structure of individual differences with the within-person study of dynamic processes (Wright, 2011; Hopwood et al., 2015).

Conceptually Integrating Between-Person Structure and Within-Person Dynamic Processes

A model for resolving the tension between investigations that focus on BP-Structure and within-person dynamic processes can be found in contemporary personality theory. Akin to the quantitative modeling of covariation in mental disorders, personality researchers invested heavily in the modeling of dispositional attributes that ultimately resulted in the Big-Five/Five-Factor Model of personality (for reviews see Digman, 1990, 1996; Goldberg, 1993; Wright, *in press*). Paralleling these investigations, researchers interested in personality processes have sought to study the within-person temporal dynamics of specific thoughts, feelings, and behavior, which are the behavioral building blocks of personality traits (e.g., Carver and Scheier, 1982; Larsen, 1987; Mischel and Shoda, 1995; Eid and Diener, 1999; Fleeson, 2001; Moskowitz and Zuroff, 2004; Cervone, 2005). Until recently and with few exceptions (e.g., Borkenau and Ostendorf, 1998), studies of the BP-Structure and dynamic processes of personality have largely proceeded separately (Read et al., 2010). There is now increasing interest in meaningful synthesis of models of individual differences in structure and the putative underlying dynamic processes that give rise to this structure (e.g., Fleeson, 2007; Fleeson and Gallagher, 2009; Fournier et al., 2009; DeYoung, 2015; Fleeson and Jayawickreme, 2015; Revelle and Condon, 2015). At the risk of oversimplifying, these integrative approaches take the domains outlined by BP-Structural models of individual differences (e.g., the Big-5), and

use them as the orienting dimensions to organize hypotheses and investigations into the patterning of within-person dynamic processes (e.g., McCabe and Fleeson, 2012; Wright et al., 2015).

This integrative approach may be viable in psychopathology research given that the structures of personality and psychopathology are meaningfully overlapping (Wright and Simms, 2015). Long hypothesized, going back to antiquity and the writings of Hippocrates and Galen, evidence for the link between personality/temperament and mental disorders has is now quite robust. For one, several meta-analyses show that personality trait ratings and mental disorder diagnoses are strongly associated (e.g., Saulsman and Page, 2004; Ruiz et al., 2008; Samuel and Widiger, 2008; Kotov et al., 2010b). The meta-analytic results show that disorders falling within the Internalizing spectrum demonstrate strong associations with Neuroticism and Detachment (i.e., Introversion), whereas disorders falling within the Externalizing spectrum are most strongly associated with Disinhibition (i.e., low Conscientiousness and Impulsivity) and Antagonism (i.e., low Agreeableness).

Moreover, the hierarchical organization of personality traits and mental disorders bear unmistakable resemblance. A consistent finding is that at the level of two higher-order domains, dimensions of maladaptive personality bear close resemblance to the Internalizing and Externalizing spectra (Markon et al., 2005; Kushner et al., 2011; Wright et al., 2012; Wright and Simms, 2014). In these models, the Internalizing domain subsumes lower-order domains of Negative Affectivity and Detachment, and the Externalizing domain subsumes Disinhibition and Antagonism. Further, there is now accumulating evidence from models that incorporate broader sampling of psychopathology for additional spectra labeled Antagonism and Detachment/Anhedonic or Pathological Introversion (Markon, 2010; Kotov et al., 2011; Røysamb et al., 2011; Wright and Simms, 2015). Although direct evidence from hierarchical structural models of DSM diagnoses is lacking, the conceptual convergence with hierarchical models of personality suggests that a disorder based Antagonism domain can be joined with traditional indicators of disinhibitory pathology to form a broader Externalizing factor (e.g., Krueger et al., 2007), whereas Pathological Introversion would join affective disorders to define a higher order domain of Internalizing. Thus it is expected that with further targeted research the hierarchy of mental psychopathology and personality will largely converge.

Taken together, this suggests that much like contemporary personality science, investigations into within-person temporal processes of mental disorders could benefit from using the same empirically derived domains (e.g., Internalizing, Externalizing) that organize between-person differences in psychopathology in traditional cross-sectional research. As such, demonstrating similarities in structure at both levels would be the minimum requirement to ensure success of this approach. However, it is unknown whether the within-person structure (WP-Structure) that emerges from the temporal patterning of specific behaviors over time mirrors the BP-Structure of individual differences in the expression of those same maladaptive behaviors either

at the higher-order level of Internalizing and Externalizing or possibly with lower-order differentiation of sub-factors within each domain.

Methodological Integration of Structure and Dynamic Processes

Joining models of between-person individual differences with the study of within-person dynamic processes immediately raises the issue of how to appropriately model and test whether such a marriage will succeed. Specifically, it involves modeling data that has a multilevel structure, with many time-points or occasions of measurement nested within individuals. There are two sources of variance in this type of data: variability associated with between-person differences in mean item endorsement, and variability associated with within-person, time-point specific deflections around those means. As Molenaar (2004) has shown, the structure of within-person covariation of behaviors is mathematically distinguishable from the covariation patterns of between-person differences in the mean levels of these behaviors (see also Nesselroade and Molenaar, 1999; Borsboom et al., 2003; von Eye and Bergman, 2003; Grice, 2004). That is to say, there is no guarantee that the same structure holds at both levels. Furthermore, the same WP-Structure may not apply to all individuals (Molenaar, 2004; Molenaar and Campbell, 2009). Indeed, for many applications, it is the person-specific (i.e., idiographic) structure (PS-Structure) that is of greatest interest. For instance, when it comes to tailoring and applying a behavioral intervention, substantial individual heterogeneity compels the development of a “model of the individual.”

A note on terminology is warranted. Here we draw a distinction between three tiers of structural analysis that are available when modeling intensive longitudinal data. BP-Structure refers to traditional conceptions of cross-sectional individual differences, and is derived from the covariation of behaviors averaged across time-points. Thus, it is time-invariant, or *static* in nature. We additionally consider two levels of *dynamic* structure. For the first dynamic approach, we use the term “WP-Structure” for the structure of temporal covariation in behaviors, pooled in whole or in part across individuals as is common in multilevel analysis. In other words, it is the within-person, dynamic patterning of behaviors, controlling for average levels, but shared, at least in part, across all individuals in the sample. For the second approach we use the term “PS-Structure” for person-specific models of temporal covariation that are based solely on a single subject’s multivariate time-series.

Several approaches have been developed for the appropriate structural analysis of intensive longitudinal data in groups of individuals. Multilevel structural equation modeling (MSEM; Muthén, 1991, 1994) generally offers a top-down approach, decomposing the total variance of the observed variables into the latent between- and within-person portions, and then fitting a model to each. It can be considered a top-down method because in MSEM a WP-Structure is specified that is then fitted to all individuals simultaneously (see also Shumway and Stoffer (2006) section 6.11 for a time-series perspective on this approach).

Other methods adopt a bottom-up approach, starting with the structure of individuals and finding communalities in the individual data structures [e.g., the Integrated Trait-State Model (Hamaker et al., 2007) or Multilevel Simultaneous Component Analysis (Timmerman, 2006)], or iteratively fitting group- and individual-specific SEMs [e.g., Group Iterative Multiple Model Estimation (Gates and Molenaar, 2012)]. These approaches arrive at partially shared structure or parameters.

Methods for deriving PS-Structures involve the idiographic analysis of a single individual’s multivariate time-series. Certain methods are mathematically and conceptually parallel to the analysis of multivariate structure across individuals [e.g., P-technique Factor Analysis (Baldwin, 1946; Cattell, 1966)] or augment the analysis with temporal information by including a block-Toeplitz matrix [Dynamic Factor Analysis (Molenaar, 1985)] or using a multiple indicator vector autoregression moving average model (Hamaker et al., 2005). Recent developments include unified SEM (uSEM), which combines vector autoregression with SEM (Kim et al., 2007). Although similar, these methods differ in their emphasis on latent variables and inclusion of temporal lags [i.e., modeling associations from one time point ($t-1$) to the next (t)].

All of these methods share the ability to appropriately handle multilevel data structures, and each offers distinct advantages and disadvantages that need to be weighed with the specific modeling demands of the research question. To highlight a key distinction, the models of dynamic structure (i.e., WP-Structure or PS-Structure) differ in their level of complexity and flexibility in allowing for differences in structure across individuals. The least complex is the shared WP-Structure derived from MSEM with the most being the PS-Structure derived from idiographic analyses. Arguably, PS-Structure offers the most precise match to any given individual’s actual patterning of behavior. At the same time, when investigating large samples of individuals there may be value in using a more constrained approach like MSEM to appropriately reduce highly dimensional data into coherent but manageable factors. Practically speaking, investigators need to balance traditional assessment considerations (e.g., reliability of estimates, measurement error, bandwidth fidelity tradeoffs, etc.) with modeling complex nuanced dynamic processes.

The Current Study

The overarching goal of the current study was to provide a bridge between research paradigms that adopt divergent approaches to clarifying the fundamental nature of psychopathology. More precisely, we sought to provide a much needed conceptual link between work that has established transdiagnostic domains or crosscutting dimensions of psychopathology in cross-sectional data, and more recent efforts to understand the complex dynamic processes that characterize mental disorders as they play out in daily life. Toward this aim, we posed the following specific questions. First, *does the BP-Structure of individual differences in daily endorsement of maladaptive behaviors conform to the latent structure of psychiatric diagnoses* (i.e., Internalizing and Externalizing)? Second, *can the same structure be applied to the WP-Structure of dynamic daily fluctuations in maladaptive behaviors*? Third, *is there PS-Structure heterogeneity in the daily*

and cross-day (i.e., lagged) links among the dimensions identified by WP-Structural analyses?

To answer the first two questions we estimated multilevel confirmatory factor analyses (i.e., MSEM) in a sample of individuals diagnosed with PDs who completed daily diaries of maladaptive behaviors over 100 consecutive days. We tested two *a priori* models for both the BP- and WP-Structures. We based our tested models on research on the overlap in BP-Structures of personality and psychopathology discussed above. Thus, we tested two-factor Internalizing and Externalizing models, as well as a nested four-factor model that partitioned Internalizing into its lower order domains of Negative Affectivity and Detachment, and partitioned Externalizing into lower order domains of Disinhibition and Hostility (representative of the broader Antagonism domain). Finally, we then addressed the third question by using uSEM to examine the person-specific interplay among components of this dynamic structure for a subset of participants, mapping networks in which Internalizing and Externalizing sub-factors influence each other at multiple temporal lags.

MATERIALS AND METHODS

Participants

The sample used in this study was collected as part of a project designed to investigate general daily processes of behavior in individuals with PD. As such, recruitment targeted individuals diagnosed with *any* PD. Participants were recruited from a clinical sample ($N = 628$) enrolled in an ongoing study to improve efficient measurement of PD (Simms et al., 2011, under review). Participants were recruited into the broader clinical sample by distributing flyers at mental health clinics across Western New York, and were eligible for participation in the parent study if they reported psychiatric treatment within the past 2 years. Participants received structured clinical interviews by trained assessors for clinical syndromes and PDs using the sixth edition of the Mini International Neuropsychiatric Inventory (MINI; Sheehan and Lecrubier, 2010) and a version of the Structured Clinical Interview for DSM-IV-TR PDs (SCID-II; First et al., 1997), respectively. Only specific PD diagnoses were evaluated; PD-NOS was not evaluated or diagnosed. Disorder-level Kappas from independent ratings of a subset of participants ($n = 120$) were strong ($Mdn K = 0.96$; $range = 0.66–1.00$). Those who met the threshold for *any* PD diagnosis on the clinical interview were contacted for possible participation in the current daily diary study. The sole additional requirement for participation was daily Internet access via computer or mobile device.

One hundred and sixteen participants attended the baseline assessment for the daily diary study. Due to the focus on variability in behavior in this study, only participants providing at least 30 days worth of data were included to ensure reliable estimates of variability. Only 15 individuals were excluded for providing less than 30 diaries, resulting in an effective sample size of 101. Of these participants, 66 (65.3%) were female, and the majority reported being either White (82.2%) or

African American (14.9%). On average, time between diagnostic interview and the initial assessment in this study was 1.4 years ($Range = 1.2–1.7$ years; $SD = 0.16$ years). The rates of PD diagnoses were as follows: 35.6% paranoid, 13.9% schizoid, 16.8% schizotypal, 7.9% antisocial, 36.6% borderline, 2.0% histrionic, 19.8% narcissistic, 53.5% avoidant, 5.9% dependent, 50.5% obsessive-compulsive. The average number of PD diagnoses per participant was 2.4. Additionally, 62.4% were diagnosed with mood disorders, 69.3% with anxiety disorders, 8.9% with psychotic disorders, and 23% with substance/alcohol use disorders. Demographics for the retained sample are presented in **Table 1**. Relative to the pool of 628 participants the current sample was drawn from, no differences were found on Age, Sex, or Employment Status. We found differences on Race ($\varphi = 0.19$), Marital Status ($\varphi = 0.13$), Educational Attainment ($\varphi = 0.16$), and Income ($\varphi = 0.17$), all of which were of small effect. Participants in the retained sample were less likely to be Black, and were more likely to be in higher Income or Educational Attainment categories. The retained sample was more likely to be married and less likely to be divorced or separated. Seventy-two percent of participants reported current mental health care treatment, 14% within the last year, and the remainder longer than 1 year prior to the daily diary protocol.

Procedure

A complete description of the study was provided, and written informed consent was obtained prior to participation in accordance with the Declaration of Helsinki. The University at Buffalo institutional review board approved all study procedures. Participants attended an initial in-person training and assessment session during which study procedures were explained, and a battery of self-report measures was completed via computer. Starting the evening of the in-person assessment, participants were asked to complete daily diaries assessing daily interpersonal behavior, affect, symptoms, stress, and functioning via secure website every evening for 100 consecutive days. Surveys were to be completed at roughly the same time each day, between 8 pm and 12 am. However, participants were allowed to deviate from this schedule if necessary (e.g., working nightshift) so long as (a) they completed diaries at the end of their day, and (b) the diaries were completed at roughly the same time each day. Participants received daily email reminders and also were provided several paper diaries they could use in the event of technological difficulties. Compliance rates were very high, with a total of 9,041 diaries completed by participants in this study after data cleaning ($Mdn = 94$ days, $M = 89.5$ days, $range = 33–101$ days, 90% > 60 days), a small fraction of which were done by paper (~2% of completed diaries).¹ Compensation was

¹We examined basic demographics of gender and age, severity of personality disorder based on clinical interview, and average reported daily diary domains that we examined in the study. We found modest correlations of rate of participation with age ($r = 0.20$, $p = 0.04$) but not gender ($r = 0.17$, $p = 0.10$), no association with any of the personality disorders (all p 's > 0.10), and modest associations with average daily hostility ($r = -0.24$, $p = 0.02$) and disinhibition ($r = -0.23$, $p = 0.02$) but not the remaining two daily domains (p 's > 0.07). Thus, individuals who were younger and reported higher levels of daily Externalizing behavior participated less. However, we believe this had little influence on the results given that (a) these associations are in the context of very high rates of participation ($Mdn = 94$ days;

TABLE 1 | Sample demographics.

	<i>N/M</i>	<i>%/SD</i>
Age	44.9	13.3
Gender		
Male	35	34.7
Female	66	65.3
Race/Ethnicity		
White	83	82.2
Black	15	14.9
Native American	3	3.0
Hispanic	5	5.0
Education		
No high school diploma	6	6.0
High school diploma	16	15.8
Some college	34	33.7
College degree	28	27.7
Graduate/Professional	17	16.8
Employment		
Employed	35	34.7
Unemployed	13	12.9
Disabled	33	32.7
Retired	9	8.9
Student	5	5.0
Homemaker	3	3.0
Income		
Less than \$15,000	26	25.7
\$15,000–\$29,999	23	22.8
\$30,000–\$44,999	20	19.8
\$45,000–\$59,999	13	12.9
More than \$60,000	19	18.9
Marital Status		
Married	27	26.7
Widowed	5	5.0
Divorced	18	17.8
Separated	3	3.0
Never Married	48	47.5

N = 101.

provided for daily participation at the rate of \$100 for $\geq 80\%$ participation, and prorated at \$1/day for $< 80\%$. Participation also was incentivized through recurring raffles (\$10 drawing every 5 days for those providing at least four diaries) and drawings for additional money and tablet computers at the end of the study, with the odds of winning proportionally tied to participation.

Measures

Daily behaviors were measured using 16 items created for the purpose of this project. The specific questions used in this study are listed in the boxes denoting observed variables in **Figure 1**. These 16 items were selected for their relevance to the current study from a larger set of behaviors designed to provide broad coverage of the daily manifestations of personality pathology. Items were intended to reflect concrete behavioral manifestations of broad domains of personality pathology as they

M = 89.5 days) and (b) multilevel SEM weights participants contribution to the covariance matrices based on the number of observations.

might occur in daily life. Items were written so that they were not so extreme as to have problematically low endorsement on a daily basis, and participants were given an 8-point response scale for each item anchored with *Not at All* (0) and *Very Much So* (7). Prior work in this sample has examined the basic descriptive features of these and the additional excluded items, including rates of endorsement, levels of (in)stability, and associations with the DSM-5 personality trait domains (Wright and Simms, under review). Of the 16 items used in this study, four were hypothesized primarily to reflect Negative Affectivity (multilevel coefficient alphas using Geldhof et al., 2014 approach were $\alpha_{\text{Between}} = 0.88$, $\alpha_{\text{Within}} = 0.76$), three primarily to reflect Detachment ($\alpha_{\text{Between}} = 0.84$, $\alpha_{\text{Within}} = 0.64$), four primarily to reflect Hostility ($\alpha_{\text{Between}} = 0.93$, $\alpha_{\text{Within}} = 0.87$), and the remaining five to primarily reflect Disinhibition ($\alpha_{\text{Between}} = 0.92$, $\alpha_{\text{Within}} = 0.82$).

Additionally, symptom counts from diagnostic interviews for major depressive disorder, dysthymia, generalized anxiety disorder, social phobia, post-traumatic stress disorder, alcohol use disorder, substance use disorder, child conduct, antisocial, avoidant, dependent, borderline, narcissistic, histrionic, and paranoid PDs were used to develop a interview based structural model described below. Reliabilities (*K*'s) are reported above.

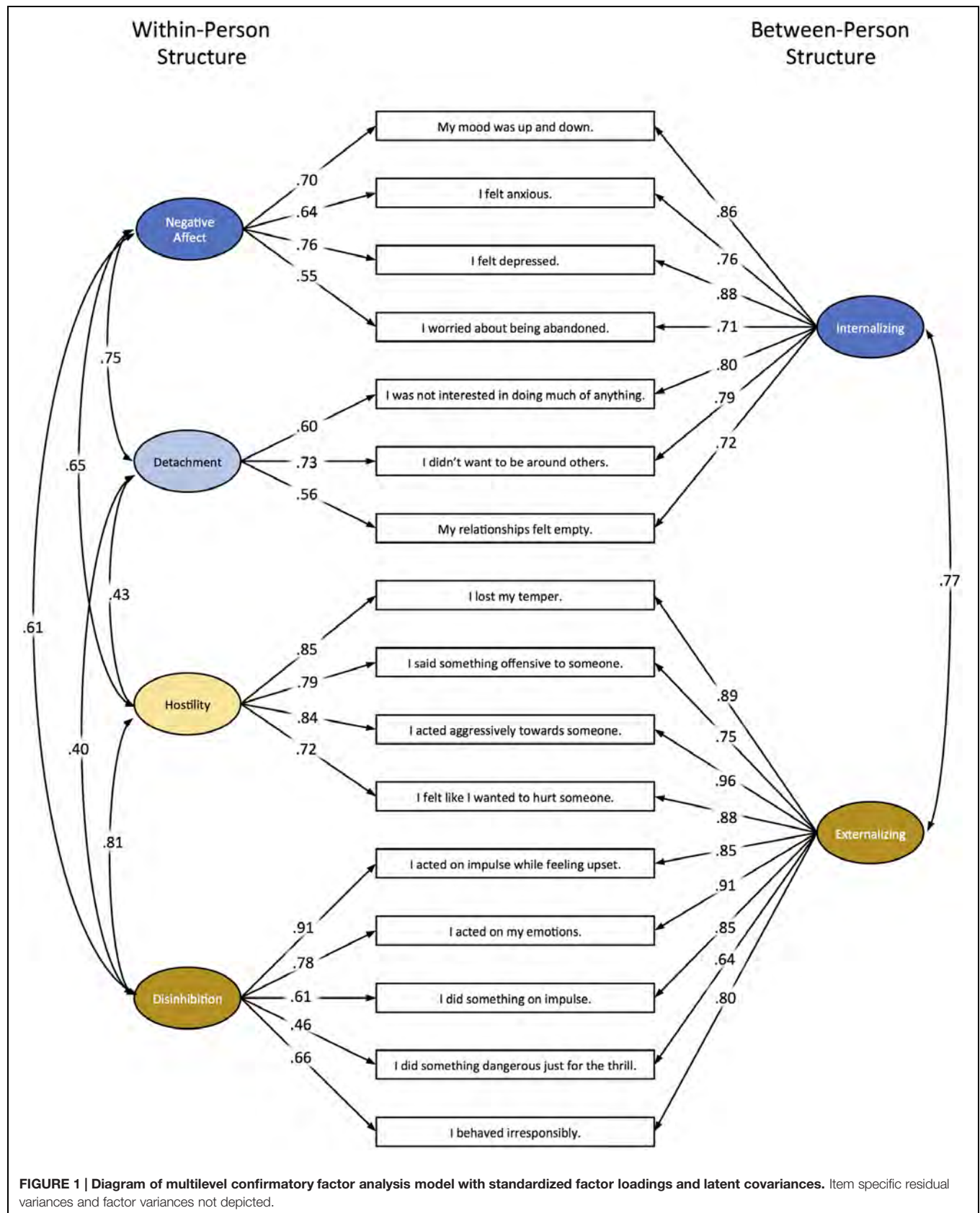
Data Analysis

As described in the introduction, our analyses incorporate both MSEM and uSEM, and we describe each in turn.

Testing BP- and WP-Structure of Maladaptive Daily Behaviors

The first two questions we sought to answer concerned whether the structure derived from individual differences in psychiatric diagnoses could be adequately fit to the daily diary data at the between- and within-person levels. We additionally sought to use the WP-Structure to reduce the dimensionality and complexity of the data for subsequent idiographic analysis. Therefore we selected MSEM as an analytic framework. MSEM extends traditional multilevel regression (i.e., hierarchical linear modeling; random coefficient regression) to multilevel covariance and mean structural modeling (Muthén, 1991, 1994). It does so by partitioning the total variance in the observed variables into the latent between-person variance (commonly referred between-cluster or between-group variance), and the observed within-person (also within-cluster or within-group) variance (Muthén, 1991). The partitioned variance can then be used to calculate both between- and within-person covariance matrices. Although the within-person covariance matrix is straightforwardly calculated and understood, calculation of the between-person covariance matrix is more complex (e.g., it is weighted for differences in cluster size) and is conceptually akin to the covariance among random intercepts (see Muthén, 1994 and Heck, 1999 for technical details, and Reise et al., 2005 and Preacher et al., 2010 for accessible summaries).

With the variance thus partitioned, MSEM offers the opportunity to separately estimate and compare between- and within-person structures by fitting standard latent variable



models, like confirmatory factor analysis (CFA). A multilevel CFA was employed here and allows for potentially different factor structures to emerge at each level of the data. In the current context, the between-person structure reflects the pattern of covariation in average item endorsements over the course of the study, or, conceptually, the trait structure of these behaviors. In contrast, the within-person structure reflects the tendency for individual behaviors to covary at the daily level, or, conceptually, the dynamic structure of these behaviors. Here we estimate a series of between- and within-person factor models to determine the optimal structure of daily maladaptive behaviors sampled in this study.

For our first aim, we primarily were interested in testing whether a two-factor (Internalizing, Externalizing) model would acceptably fit the data, and if so, whether a four-factor model (Negative Affect, Detachment, Hostility, Disinhibition) improved upon this fit at the BP and WP levels. In addition to the 2- and 4-factor models of interest, we estimated one-factor models as a point of comparison. To test this, we estimated a series of MSEM models in Mplus version 7.31 (Muthén and Muthén, 1998–2012). Due to significant skew and kurtosis in the Externalizing behavior items, we treated all items as ordinal, and estimated multilevel CFAs using a robust (mean adjusted) weighted least squares approach (WLSM) on the polychoric correlation matrix. Model fit testing in MSEM can be challenging because the χ^2 test and alternative fit indices are derived from the comparison of the observed and implied covariance for both the between- and within-person matrices simultaneously. Therefore it is difficult to disentangle sources of ill model fit across levels. To address this complication, we adopted Ryu and West's (2009) approach, which eliminates any source of ill fit from a given level by fitting a saturated model (i.e., zero *df*), while models of interest are tested in the other level. For example, first a saturated model was fit on the within-person level, and hypothesized models were fit to the between level, and then this process was reversed, fitting a fully saturated model at the between level, and estimating models of interest at the within-person level. Saturated models fit the data perfectly, and therefore they do not contribute to lack of fit, so any source of ill fit comes from the models at other levels. Ryu and West (2009) provide additional details about appropriate calculation of alternative fit indices for independence models at each level. Although evaluation of global model fit in MSEM remains an understudied topic, we considered the χ^2 test, as well as several alternative fit indices, using their single-level SEM recommended cutoffs (Hu and Bentler, 1999). These include the root mean square error of approximation (RMSEA) with values <0.05 for good model fit, comparative fit index (CFI) with values near or >0.95 indicative of good model fit, and the SRMR, with values <0.08 indicative of good model fit. Because we used the WLSM estimator, nested models were compared using the strictly positive Satorra–Bentler scaled χ^2 difference test (Satorra and Bentler, 2010).

In order to test the validity of our retained model, in a final MSEM we estimated interview-based Internalizing and Externalizing spectra using data from the structured clinical interview that were administered on initial assessment, and

used these as predictors of the between-person factors from the daily behaviors. We used Kotov et al. (2011) structure, which includes PD diagnoses in the model, as a template to select relevant variables for our interview based model. We combined the diagnoses from Kotov et al.'s (2011) Externalizing and Antagonism domains in order to arrive at a broader Externalizing domain that would better match out daily behaviors. Thus, our interview-based Internalizing model was indicated by symptom counts for major depression, dysthymia, social phobia, post-traumatic stress, generalized anxiety, avoidant, dependent, and borderline PDs. The interview-based Externalizing factor was indicated by symptom counts for alcohol use, drug use, childhood conduct, adult antisocial, narcissistic, histrionic, paranoid, and borderline PDs (Please see Appendix A in Supplementary Material for example MSEM syntax).

Exploring Person-Specific Structures of Maladaptive Daily Behavior

Our second aim was to demonstrate how the optimal WP-Structure derived from the MSEM could be leveraged to inform person-oriented personality processes, providing a picture of the data at a third conceptual level of analysis. To accomplish this, we implemented individual-level unified structural equation modeling (uSEM; Kim et al., 2007; Gates et al., 2010). This approach combines SEM and vector autoregression of a single participant's daily diary data in order to map the interplay among personality factors, that is, how variability in each factor is influenced by the contemporaneous (occurring on the same day, *t*) and lagged (occurring on previous days, *t*–1) variability in other factors. The model with a mean fixed zero is defined as:

$$\eta(t) = A\eta(t) + \Phi_1\eta(t-1) + \Phi_2\eta(t-2) + \dots + \Phi_j\eta(t-j) + \zeta(t),$$

where $\eta(t)$ is the *p*-variate time series to be explained at day *t* = 1, 2, ..., *T*, with *p* the number of MSEM-derived within-person factors and *T* the number of daily diary entries, *A* the (*p*,*p*)-dimensional matrix of contemporaneous regression coefficients explaining how each factor is influenced by other factors on the same day, Φ_q is the (*p*,*p*)-dimensional matrices of regression coefficients at lag *q* = 1, 2, ..., *j* explaining how each factor is influenced by itself or other factors from previous days, and ζ is the *p*-variate error process, lacking sequential dependencies and having a zero mean and a diagonal contemporaneous covariance matrix. Simulation studies have found that incorporating contemporaneous and lagged effects simultaneously greatly improves reliability of results when compared to models that solely include one type of effect (Gates et al., 2010) and has been successfully applied to neuroimaging and observational data (Hillary et al., 2011; Beltz et al., 2013), with the present study being the first application to daily diary data.

We fit uSEMs to the daily diary data of four exemplar participants in a data-driven fashion (cf. Gates et al., 2010) that accounted for the presence of multiple solutions (a characteristic of SEMs; MacCallum et al., 1993), and that satisfied the assumption of independent errors. We used LISREL for the analyses (Jöreskog and Sörbom, 1992). Model fitting was

TABLE 2 | Multilevel confirmatory factor analysis model fit and model fit comparisons.

Model	Model fit							Model comparisons			
	<i>df</i>	χ^2	$\chi^2 p$	RMSEA	CFI	SRMR _W	SRMR _B	Models	$\Delta\chi^2 df$	$\Delta\chi^2_{SB}$	$\Delta\chi^2_{SB} p$
Between											
(1) SW/1B	104	52.07	1.00	0.000	1.00	–	0.090	–	–	–	–
(2) SW/2B	103	21.16	1.00	0.000	1.00	–	0.060	1 vs. 2	1	30.58	<0.001
(3) SW/4B	98	16.63	1.00	0.000	1.00	–	0.055	2 vs. 3	5	4.78	0.443
Within											
(4) 1W/SB	104	2860.36	<0.001	0.054	0.95	0.111	–	–	–	–	–
(5) 2W/SB	103	1284.23	<0.001	0.036	0.98	0.062	–	4 vs. 5	1	1581.46	<0.001
(6) 4W/SB	98	478.76	<0.001	0.021	0.99	0.057	–	5 vs. 6	5	794.87	<0.001

Selected model at each level bolded. Models were estimated treating all observed variables as categorical using mean adjusted weighted least squares (WLSM in MPlus) as the estimator. In the Model column the numerals reflect number of factors estimated, and W, within; B, between; S, Saturated. RMSEA, root mean square error of approximation; CFI, Comparative fit index; SRMR, standardized root mean square residual; $\Delta\chi^2_{SB}$, Satorra-Bentler chi-square difference test.

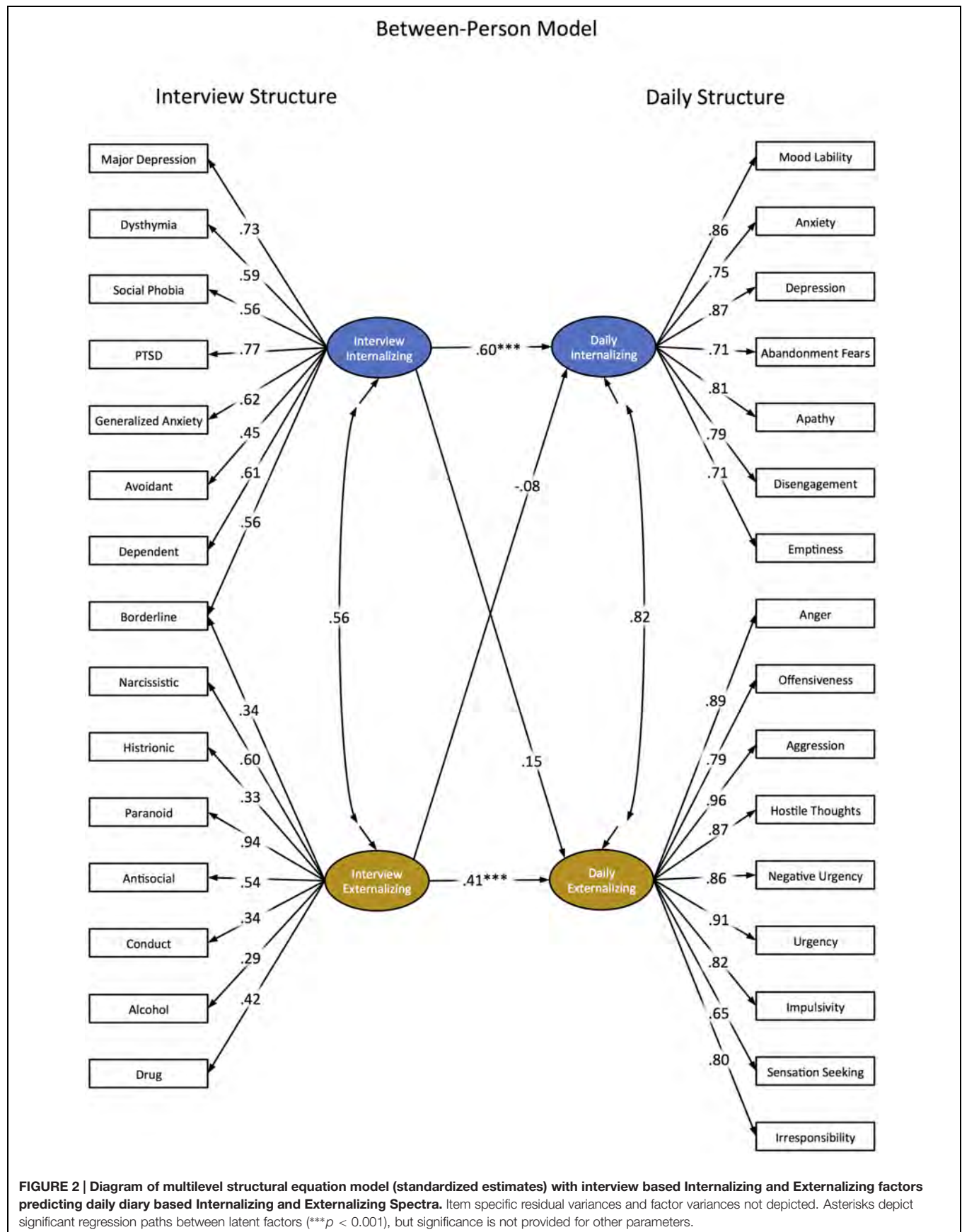
conducted in several steps. First, the items contributing to each MSEM within-person factor were averaged to create a factor composite score, as is commonly done in individual differences research. Second, a null uSEM model (i.e., no contemporaneous or lagged effects estimated) of the first order was fit to the data using the block Toeplitz method (cf. Molenaar, 1985). Third, Lagrange Multiplier tests (i.e., modification indices; Sörbom, 1989) were used to free and estimate the parameter in the A or Φ_1 matrix that would most improve model fit; this process iterated until no parameter would significantly (at $p \leq 0.05$) improve model fit if it were freed. Multiple solutions could occur during this iterative process if modification indices showed that two parameters would equally improve model fit (i.e., their Lagrange Multiplier tests were equivalent). In these cases, each parameter was freed and estimated in a separate solution, and the iterative estimation process continued independently for each (with the possibility of further separations), generating a set of possible solutions (cf. Beltz and Molenaar, in revision). Fourth, non-significant parameters were trimmed from the models. Fifth, model fit was evaluated for the solutions using alternative fit indices, with two of the following four required to indicate excellent fit (Brown, 2006): $RMSEA \leq 0.05$, $SRMR \leq 0.05$, $CFI \geq 0.95$, $NNFI \geq 0.95$. Sixth, if multiple solutions occurred during the model fitting process, then the optimal solution was selected by choosing the model with the lowest AIC, a selection criterion employed in previous work (Akaike, 1974; MacCallum et al., 1993; Beltz and Molenaar, in revision). Seventh, the solution was examined for independent residuals using a posteriori model validation (Box and Jenkins, 1970). Specifically, one-step-ahead prediction errors were generated from the model and tested for white noise (cf. Beltz and Molenaar, 2015). If white noise was found, then a first order uSEM was appropriate for the data, and the solution was accepted. If white noise was not found, then a first order solution was insufficient for capturing all sequential dependencies in the data, and steps two through seven were repeated for a second order uSEM (i.e., a model with A, Φ_1 , and Φ_2 matrices; Please see Appendix B in Supplementary Material for example uSEM synt).

RESULTS

Global model fit and model fit comparisons for the MSEM analyses can be found in **Table 2**. Starting with the between-person level, all estimated models were considered a good fit to the data using the chi-square tests, which were uniformly non-significant. This was expected due to the low-powered test with a between-person sample size of 101. The RMSEAs and CFIs also were excellent, although the SRMR was only acceptable in models with 2 and 4 factors. The likelihood ratio test indicated that model fit improved going from 1 to 2 factors, but a four-factor model did not significantly improve the fit. As such, we selected a two-factor structure as the optimal BP model in these data. For the WP level, the chi-square tests were uniformly significant. This was expected due to the high-powered test with 9,041 within-person observations. The RMSEA and CFI suggested all models were good fitting, although each improved appreciably going from 1 to 4 factors. The SRMR was only acceptable in models with 2 and 4 factors. Finally, the chi-square difference test strongly favored a four-factor solution. Thus, our final retained model differed in structure across levels of analysis, with two factors at the between-person level, and 4 factors at the within-person level of analysis.² The model with standardized parameter estimates can be found in **Figure 1**.

To test the validity of this model, we estimated Internalizing and Externalizing factors from the original clinical interviews and regressed the daily diary based Internalizing and Externalizing factors on each of these. This resulted in an excellently fitting model [$\chi^2_{(525)} = 568.54$, $p = 0.09$; $RMSEA = 0.003$; $CFI = 1.00$; $NNFI = 1.00$; $SRMR_{Within} = 0.05$, $SRMR_{Between} = 0.09$]. Relevant model parameter estimates can be found in **Figure 2**. We found

²To be comprehensive, we estimated three-factor models at each level, which had a negligible impact on fit at the between-person level, but resulted in significantly poorer fit relative to the four-factor model at the within-person level. We additionally note that changing the estimator to robust maximum likelihood (MLR) resulted in identical conclusions, as did mean and variance adjusted weighted least squares (WLSMV) estimation. In fact, all parameter estimates were identical using the WLSMV estimator, and model fit was substantially improved, but direct comparison of fit cannot be accommodated in a MSEM framework in MPlus. Thus, our results and conclusions are robust to estimation approach.



that the interview-based Internalizing factor was a significant predictor of daily Internalizing ($\beta = 0.60$; 95% confidence interval = 0.38 to 0.81; $p < 0.001$), but not of daily Externalizing ($\beta = 0.15$; 95% confidence interval = -0.09 to 0.38; $p < 0.22$). In contrast, we found that the interview-based Externalizing factor was a significant predictor of daily Externalizing ($\beta = .41$; 95% confidence interval = 0.18 to 0.63; $p < 0.001$), but not of daily Internalizing ($\beta = -0.08$; 95% confidence interval = -0.32 to 0.16; $p < 0.55$). Thus, our between-person factors estimated from daily diaries evidence significant associations with corresponding traditional interview based factors, and these associations were specific.

Next, we examined person-oriented personality processes by mapping with uSEM the interplay among the four within-person factors for four exemplar participants; four, three, five, and four items as indicated from the MSEM analysis were averaged to create the Negative Affect, Detachment, Disinhibition, and Hostility composite scores, respectively; see **Figure 1**. Time series plots and descriptive statistics for each participant's scores are shown in **Figure 3**. Notice how some characteristics of participants' daily responses shown in the time series plots were independent of the descriptive statistics (i.e., means and standard deviations shown in the bar graphs). For example, participants A, B, and C had similar Disinhibition means and standard deviations despite markedly different patterns of responses across days, such as participant B having large peaks and valleys that appear to co-occur with Negative Affect, a pattern not seen in the others. Also, participant D had means close to zero for all composite scores even though Detachment scores were close to 5 on a couple of days. Finally, participant C had long periods of constant Detachment scores, but this information is lost in the descriptives. These are precisely the characteristics – those typically lost in cross-sectional research or when time series data are analyzed in aggregate – that uSEM captures and reflects in individual-level dynamic personality network maps, revealing the person-oriented processes underlying personality.

Model fit can be found in **Table 3**, and the final uSEM maps for each participant are shown in **Figure 4**. The final map for exemplar participant A (**Figure 4A**) fit the data well; multiple solutions were not present, and first order relations were sufficient for capturing all sequential dependencies in the data. The final map for exemplar participant B (**Figure 4B**) fit the data well; four solutions were generated, with the retained solution selected based on lowest AIC and first order relations were sufficient. The final map for exemplar participant C (**Figure 4C**) fit the data well; seven solutions were generated, AIC was again used to select the final solution, and first order relations were sufficient. The final map for exemplar participant D (**Figure 4D**) fit the data well; three solutions were generated, and second order relations were required to capture all sequential dependencies in the data.

The maps can be understood as visual depictions of a series of regression equations (consistent with the beta-weights that accompany the relations), with one equation for each personality factor. A simple example concerns the Detachment of participant B: on any given day, it was positively predicted by Negative Affect occurring on the same day, meaning that increases (decreases)

in Negative Affect statistically predicted increases (decreases) in Detachment. This is consistent with the synchronous rise and fall of Negative Affect and Detachment scores visible in the time series plot. A more complex example concerns the Negative Affect of participant A: on any given day, it was explained by Negative Affect (i.e., itself) levels from the previous day, and inversely by Detachment levels from the previous day. Participant A's Negative Affect was also explained by Hostility and Detachment levels on the same day, and it predicted Detachment levels on the same day as well as Hostility levels on the next day. The set of relations between Negative Affect and Detachment (with reciprocal same day relations, and an inverse prediction of Negative Affect by Detachment) and the pair of relations between Negative Affect and Hostility (with Negative Affect predicting Hostility on the next day, but Hostility predicting Negative Affect on the same day) suggest the presence of feed-forward and feedback mechanisms.

The maps reveal several interesting findings. Visual inspection shows different personality dynamics for each of the participants. For example, the map for participant B was the sparsest (i.e., had the fewest relations with 6), and the maps for the other three participants were equally dense (i.e., had 10 relations). This is an especially interesting finding for participant D, who had composite scores close to zero and second order map relations, suggesting the presence of complex personality processes despite low mean levels of endorsed symptomatology. Graph theoretical metrics, such as total degree (i.e., the number of incoming and outgoing relations for a factor), reveal that Negative Affect was the most important factor for participants A and B, Detachment and Hostility were most important for participant C, and Disinhibition was most important for participant D. This is intuitive in some cases (e.g., Negative Affect also had the highest mean for participant A), but not in others (e.g., Detachment had long periods of constant scores and Hostility had the lowest mean for participant C).

DISCUSSION

The overarching aim of our study was to provide a conceptual and analytic integration of individual differences research on the structure of psychopathology liability and the complex dynamic processes that comprise mental disorders. First, using data from a sample of individuals diagnosed with PDs who completed several months of (*Mdn* observation $N = 94$) daily diary studies, we tested the BP- and WP-Structures of 16 behaviors chosen to index the broader Internalizing and Externalizing spectra with MSEM (see **Figure 1**). Results indicated that for the BP-Structure, a two-factor model (Internalizing and Externalizing) was sufficient for explaining individual differences in the endorsement of the 16 behaviors, whereas for the WP-Structure a more differentiated four-factor model was supported (Negative Affect, Detachment, Disinhibition, and Hostility). We then demonstrated that the BP-Structure of this model showed specific associations with similar factors derived from traditional psychiatric interviews. Second, using the results of the MSEM, which served to greatly reduce the multivariate modeling space from the individual items to these

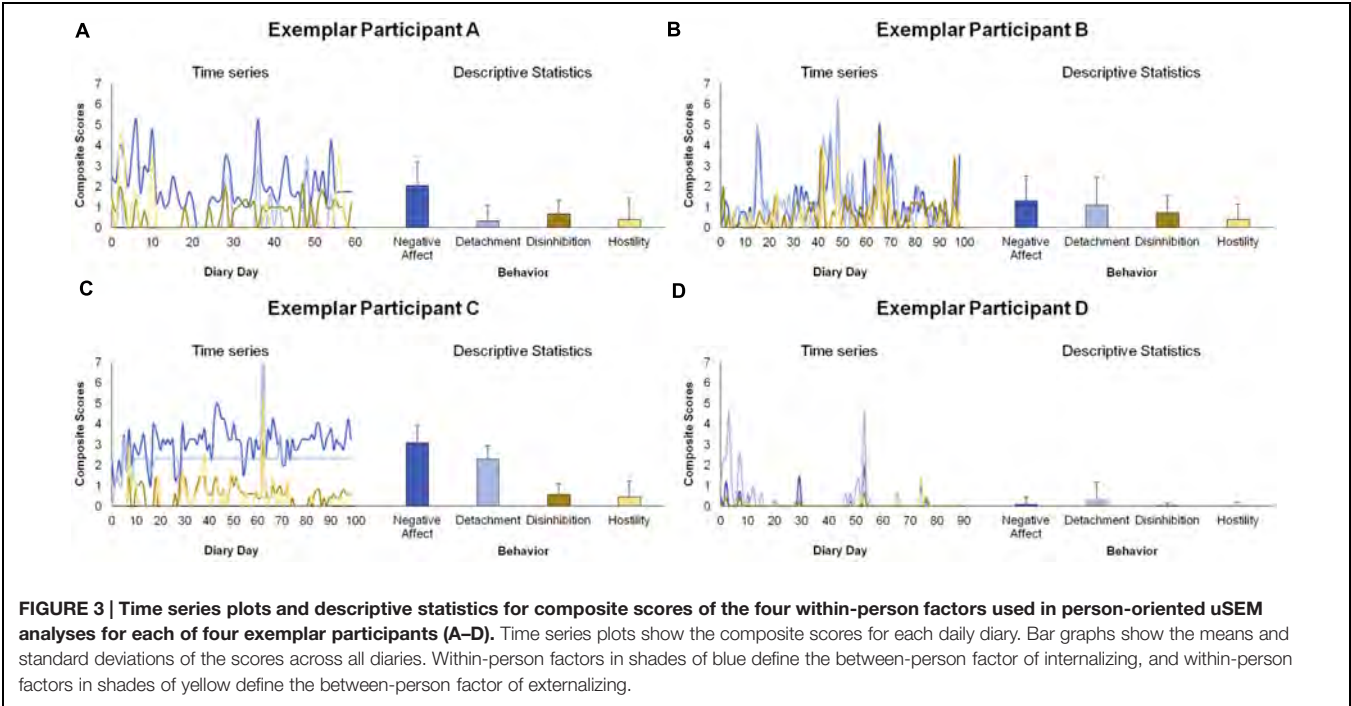


TABLE 3 | Unified SEM (uSEM) model fit results for four exemplar participants.

Participant	Model fit							AIC for multiple solutions	
	df	χ^2	$\chi^2 p$	RMSEA	SRMR	CFI	NNFI	Selected model	Closest alternative
A	12	13.57	0.33	0.025	0.043	0.99	0.98	60.65	N/A
B	16	13.68	0.62	0.000	0.044	1.00	1.00	52.68	53.10
C	12	11.58	0.48	0.000	0.044	1.00	1.00	59.41	60.36
D	28	18.00	0.93	0.000	0.037	1.00	1.00	116.90	129.40

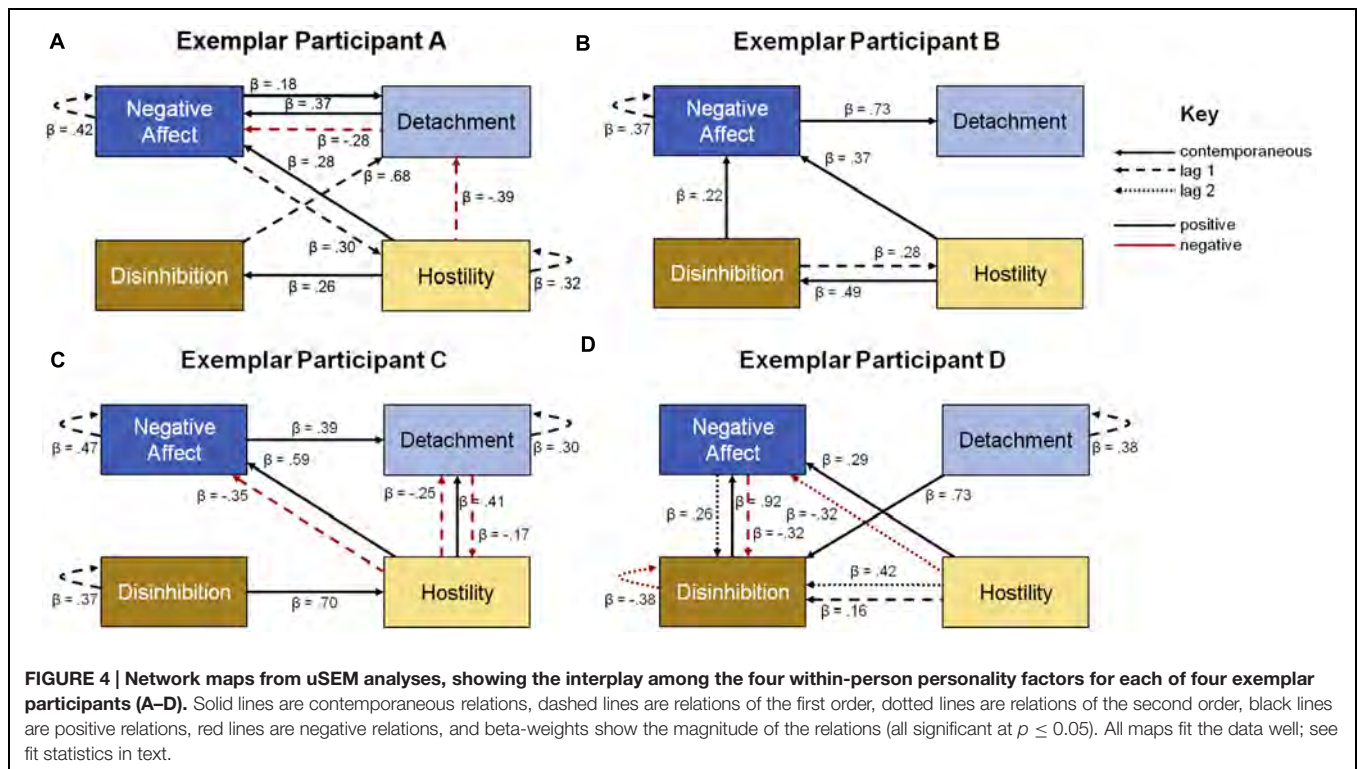
Models were estimated in LISREL at the lowest temporal order to produce white noise residuals, and multiple solutions were identified during data-driven model fitting. RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual; CFI, Comparative fit index; NNFI, non-normed fit index; AIC, Akaike information criterion.

four factors, we fit a set of idiographic uSEM models to a subset of the participants ($n = 4$) in order to showcase the heterogeneity in dynamic associations among the four daily constructs (i.e., PS-Structures). Thus, our approach represents a hybrid of using MSEM for data reduction and theoretical model testing, followed by the data driven exploration of fine-grained person-specific dynamic processes. We consider each analytic approach and set of results in turn.

Integrating Structure and Process: Daily Internalizing and Externalizing Behaviors

This study was motivated, in large part, by a tension that has developed in the science of psychopathology; namely, how can models that seek to establish crosscutting dimensions of functioning be reconciled with data collection and analytic approaches that seek to study nuanced contextualized processes? As noted in the introduction, this is a basic tension that has long existed in the personality literature (e.g., Read et al., 2010), which only lately has been given serious theoretical

attention (e.g., Fleenor and Jayawickreme, 2015). Adopting some of the conceptual strategies from basic personality science, we tested whether the structure of daily fluctuations in maladaptive behavior conformed to a similar structure derived from individual differences in lifetime psychiatric diagnosis; specifically, the Internalizing and Externalizing spectra. We found that a variant of the hypothesized structure provided a good fit to the data. At the between-person level the items mapped onto a clear two-Factor Internalizing-Externalizing structure. However, the correlation among these two factors was high ($r = 0.77$), indicating that those individuals who report higher average levels of daily Internalizing behavior also report higher average levels of daily Externalizing behavior. Prior research has, in fact, found correlations among lifetime variants of these two factors ranging from modest to strong (range of $r_s = 0.17$ – 0.56) (e.g., Krueger, 1999; Markon, 2010; Røysamb et al., 2011; Forbush and Watson, 2013; Kotov et al., 2011; Wright et al., 2013). Although our final model would suggest these two domains are significantly discriminable, their



covariation argues for the importance of considering general severity in daily psychopathology (cf. Kessler et al., 2005; Caspi et al., 2014). Due to the novelty of these analyses, direct comparisons with additional samples are not possible. As such it remains unclear why the covariation between these two factors here is higher than in traditional individual differences work. It may be due to truly higher overlap among daily behaviors, the manner in which MSEM partials between-person variance, the estimator (i.e., robust WLS), the severe nature of the sample, or other factors. Future research will be needed to clarify the degree of overlap among individual differences in these domains derived at the daily level.

More central to our aim, we found that the WP-Structure of daily maladaptive behaviors was more differentiated than the BP-Structure. The identical two-factor Internalizing-Externalizing structure as the between-person model provided good fit to the data by most indices, even as the four-factor structure provided significantly improved fit. The fanning out of content at the four-factor model is consistent with structural models of psychopathology (Markon, 2010; Roysamb et al., 2011; Wright and Simms, 2015) and maladaptive personality traits (Markon et al., 2005; Kushner et al., 2011; Wright et al., 2012; Wright and Simms, 2014) and can be understood as more circumscribed variants of the “pathological Big-4” (Livesley et al., 1998; Widiger and Simonsen, 2005; Calabrese et al., 2012). As such, the resultant 2- and 4-factor structures reflect the hierarchical organization of personality and psychopathology.

It is difficult to overstate the importance of understanding these dimensions as hierarchically organized. In the con-

temporary era of studying contextualized processes, as researchers seek to study putatively highly specific dynamic phenomena, there will be a pressing need to organize the results of individual studies, highlighting near-neighbor processes for investigation and mapping out “dynamic nomological nets” (cf. Cronbach and Meehl, 1955). As specific dynamic processes are proposed and tested, it will behoove researchers to test for convergent and discriminant validity in near neighbor constructs. For instance, hypotheses that specify processes associated with negative affect should demonstrate discriminability between specific affects and/or detachment related processes. This is a basic approach adopted in individual differences research, and will serve to further clarify specificity and generality in dynamic processes in psychopathological research.

Estimating and Interpreting Individual uSEM Models and Treatment Implications

Armed with the reduced dimensionality of the four-factor WP-Structure, we then sought to demonstrate that it provides a strong platform for studying dynamic PS-Structures as they play out across days. We approached this by estimating uSEM models at the individual level for four exemplar participants; we mapped the lagged and contemporaneous interplay among Negative Affect, Detachment, Disinhibition, and Hostility for each person. The heterogeneity among these participants is evident in their time series plots (Figure 3) and in their network maps (Figure 4). The time series

showed that each individual tracked different Negative Affect, Detachment, Disinhibition, and Hostility trajectories. For example, participants A and D had Detachment ratings that were mostly low and punctuated by relatively few extreme spikes, whereas participants B and C had Detachment ratings that were constantly changing. The maps showed a highly distinct network of associations among the domains of pathology for each individual. For example, the relations between Negative Affect and Detachment differed among the participants, with Negative Affect positively predicting Detachment for participants B and C, reciprocal positive contemporaneous relations between Detachment and Negative Affect on the same day and Detachment inversely predicting Negative Affect on the next day (perhaps evidencing feed forward and feedback loops) for participant A, and no association between the behaviors for participant D.

In the context of a research study, each of these network maps catalyzes the imagination, leading to questions about how these processes play out in participants' daily lives. However, in different contexts, specifically clinical settings, one could envision collecting similar data, and using these models to develop hypotheses about a patient's particular sequence of maladaptive behavior and points of intervention. Take, for example, the uSEM model for participant A. The model suggests that Negative Affect is the lynchpin in this individual's pathology. Negative Affect, although central to the person's structure, is more often than not an outcome. Thus, an initial point of intervention may be to address predictors of this individual's Negative Affect, such as Detachment and Hostility. Hostility, for example, appears to drive same day Negative Affect and Disinhibition, which leads to decreases in next day Detachment, perhaps suggesting pursuing rapprochement with embattled others. This may signal a relative interpersonal strength or healthy functioning that might be leveraged in a treatment. Many additional distinct hypotheses flow from examining the remaining paths across the four maps.

Clinically, the goal would be to disrupt these processes in order to effect change. Yet it would not require distal armchair speculation, as the clinician and patient would have proximal experience with which to augment these quantitative findings. A practitioner could use similar diagrams to those presented here as a tool to engage the patient in a collaborative discussion of how he or she understood his or her own processes, and together develop a target and plan for intervention. This approach of developing hypotheses based on coefficients derived from intensively sampled data and integrating the patient's own phenomenology is likely viable, as similar methods have been furthered and tested based on traditional dispositional measures (e.g., Finn, 2007). Thus, these results have the potential for direct clinical applicability, at least as a novel tool that can be taken from bench to bedside. In fact, several of the modeling challenges (e.g., multiple well fitting solutions; see Beltz and Molenaar, in revision) may be seen as a boon because they can be presented as alternative hypotheses for the patient to choose from, thereby engaging him or her in his or her treatment. The major rate-limiting step is the development and dissemination of powerful but user-friendly data collection

tools, analysis software, and research on the use in clinical practice.

Selecting an Appropriate Modeling Framework and Alternative Approaches

Refocusing our lens on the methods, we note that there are always a number of decision points to navigate when doing any statistical modeling. With highly multivariate, intensive, longitudinal data across many individuals, the number of possibilities for different analytic approaches is, to say the least, quite large. There were several major considerations that we grappled with, of which we mention two here: (1) adopting a confirmatory vs. exploratory framework, and (2) deciding whether to estimate structures with parameters that varied or were shared across individuals.

First, both confirmatory and exploratory models can be estimated in a MSEM framework. Our primary goal here was to test the degree to which an established model could be fit to a distinct data type. However, different modeling scenarios may compel an exploratory framework. Much needed is basic psychometric and scale development work for item banks to be used in intensive longitudinal data. The same degree of care that has been put into cross-sectional measures has generally not been incorporated in the measures used in dynamic processes (for an exception see Tomko et al., 2014).

Second, one of the exciting possibilities afforded by intensive longitudinal data of the type we modeled here, is that it allows for the estimation of not only the structure of individual differences, but individual differences in structure (i.e., idiographic structures). A challenge for covariance-based idiographic modeling approaches such as uSEM is that they require a minimum of variance in each observed variable in order to be included in the estimation (cf. Nesselroade et al., 2007). In prior studies, which have used many fewer participants, large portions of items have had to be discarded due to lack of endorsement (Nesselroade et al., 2007). This becomes particularly problematic given the use of maladaptive items, which tend to have lower endorsement, even among clinical samples. Even considering the 16 items used here, for many of the individuals specific items would have to be discarded. Therefore, by using MSEM (which estimates the WP-Structure pooled across individuals) or by creating behavioral composites for idiographic analyses, all participants and items can be included in the model.

A related consideration is the optimal degree of complexity for the estimated networks of dynamic processes. For some applications, very specific behaviors may be desired (e.g., in the study of suicidal attempts), but as granularity increases, so too does the potential network complexity. To make this concrete, consider assessing 20 specific negative affect items at each assessment, and analyzing a network of associations among the individual items. This would result in up to 380 possible contemporaneous associations, not considering lagged associations. This would strain direct interpretability, and place limits on the amount of other domains (e.g., social behavior, cognition, motivation) that could be modeled congruently. Naturally, graph theory indices

(e.g., node centrality) can be used to winnow down such a highly parameterized model. Alternatively, selecting fewer but broader domains offers desirable qualities like enhanced reliability of assessment, greater bandwidth of measurement, and easier interpretability. The point is that researchers need to be mindful of the optimal level of granularity for their questions of interest.

Limitations and Future Directions

Several limitations with the current study bear mention. For one, our model derives from the specific set of daily behaviors we chose to measure, and it does not include items related to daily substance use. This is a potential limitation seeing as substance abuse forms a major component of the traditional dispositionally estimated Externalizing domain. Nevertheless, substance abuse is thought to reflect specific instantiations of broader constructs such as Disinhibition or impulsivity, which were well covered in our daily diary data. This is evident in the significant regression path between our interview and daily diary based Externalizing factors. Additionally, the results must be interpreted in the context of this specific sample, which was not a random section of the population, but rather selected to possess elevated psychopathology. Specifically, the current sample was selected for a diagnosis of any PD. Although this ensured breadth of psychiatric diagnoses due to well-established comorbidity patterns, and participants additionally met the criteria for several other clinical syndromes (e.g., anxiety disorders, mood disorders, substance use disorders), future work would benefit from a broader range of severity.

Furthermore, we only estimated and presented uSEM models for four participants. As noted above, this was primarily to demonstrate that, despite strong covariation among factors in the WP-Structural model, individuals exhibit rich and interesting heterogeneity in the dynamic processes constituting that model; the factors within the WP-Structure have contemporaneous and lagged associations with each other that are directional and unique to each participant. Future work should examine the full sample, ideally with a method that can establish shared and unique pathways across individuals (e.g., GIMME; Gates and Molenaar, 2012).

A related issue is that these models were estimated as context independent, and future work is needed that incorporates external variables (e.g., daily stress; cf. Gates et al., 2011). In the current sample we additionally measured a variety of daily stressors, perceived stress in response, several indicators of daily functioning (e.g., sleep, job attendance), and a number of basic behaviors (e.g., affect, social behavior) in the daily diary. In subsequent investigations we plan to examine daily stressors as a contextual input to the system predicting daily fluctuation in psychopathology domains. Similarly, we hope to examine the effect of fluctuations in daily psychopathology on daily functioning. Finally, we hope to test whether a variety of baseline dispositional assessments serve amplify or dampen these within-person linkages in context (stress), psychopathology, and functioning.

An Agenda for Integrating Empirical Structure and Dynamic Processes in Psychopathology

As this study is the first to attempt to bridge the contemporary empirical thrusts of structural and dynamic investigations into psychopathology, we have merely scratched the surface of what is possible. Here we outline several necessary steps toward more fully realizing the potential of an integrative science of psychopathology.

First, as mentioned briefly above, we must stress the need for measurement development and normative data collection. The items used here were developed ad hoc for this current project as no inventory for intensive repeated measurement of psychopathology (e.g., momentary, daily, etc.) was available. That these items performed extremely well as intended is very encouraging, but that should not preclude more extensive measurement development and refinement. Structural models of individual differences, which have arguably established broad domains of relevant phenotypic functioning (Harkness et al., 2014), provide a firm base from which to launch these measure development excursions. Moreover, there are many other variables that could imbue this work with more psychological texture and nuance. For instance, incorporating motivations and goals in addition to behavior and affect would likely prove fruitful. Going hand in hand with this effort should be the collection of normative data. If intensive repeated measurement is to be used clinically, then established norms, in both the population and treatment samples will be necessary. This will involve more than just importing and applying traditional psychometrics (e.g., means), but the thoughtful application of existing and development of novel “dynamic psychometrics.” At the most basic level this might include relevant measures of variability and instability of behavior over time (e.g., Jahng et al., 2008; Houben et al., 2015), but should conceivably be expanded to include normative associations between daily behaviors, behaviors and environmental antecedents (e.g., What is the average strength of association between daily stress and hostility? Or, between social anhedonia and withdrawal?). Integration of graph theory metrics into the normative data description may also prove fruitful, especially as variable sets increase in number and complexity.

Second, we have focused here on the individual as a closed system, considering neither environmental inputs nor impact on external variables (e.g., other people). However, it is well understood that humans are not closed systems, and indeed as reviewed briefly above contemporary theories of psychopathology are largely based on models of the individual acting in context. Thus, further research in this vein should incorporate traditional inputs and outputs to the system in the form of putative environmental antecedents, stressors, protective factors, and functional concomitants of maladaptive functioning. At the same time we underscore that although traditional perspectives might draw distinctions between environmental and individual located variables (e.g., Cohen et al., 1995) in practice these distinctions are difficult to make, and the current

diagnostic nomenclature blends contextual, behavioral, and functional variables. In this regard, the focus on and use of more fine-grained data sampling and analytic approaches may help disentangle the problematically heterogeneous disorder based models of psychopathology.

From this follows our third suggestion, that further work in this area should move forward unencumbered by traditional diagnostic categories. Current models of psychopathology reflect top-down organizational schemes, and are largely studied as such. In the current study we have similarly adopted a top-down perspective in part, in that we used results from quantitative structural models of psychopathology as the starting point for establishing structural models of daily behavior. We believe this provides useful if not necessary scaffolding for the subsequent person-specific analyses. Yet whether one starts with a refined (as we suggest) or an unconstrained set of variables, starting from the bottom-up and seeking out individual differences in dynamic patterns of behavior is an avenue ripe for exploration; especially if combined with techniques that can establish relatively homogenous groupings of individuals based on shared parameters. Building on this, there is a need for more research that takes intensive repeated measurement as a starting point, and seeks to establish functional outcomes that are strongly if not uniquely predicted by resulting parameters (e.g., Stepp et al., 2011; Forbes et al., 2012).

Finally, we believe that this line of research is ideally suited to refining the way in which clinicians assess, diagnose, and monitor treatment effects. For one, the approach is rooted in a dimensional architecture that recognizes that psychopathology varies along gradients of severity, and does not adhere to convenient but arbitrary boundaries. But key is that it incorporates that psychopathology is a process, and therefore should be assessed as such. Thus beyond goals of reducing overall symptom levels, many of the processes hypothesized to drive change in psychotherapy involve not only the decrease in the level of one variable, but also the dynamic change in the association among multiple variables. Indeed, as we have been arguing, psychological symptoms rarely occur in isolation, and instead are coupled with specific contingencies, linked with problematic behaviors, and connected with maladaptive processes. As a result, clinicians often seek not just to decrease a problematic behavior, but also to change the connection between two or more behaviors in order to disrupt the maladaptive processes that maintain psychopathology. Examples include increasing emotional differentiation (i.e., unlink distinct negative emotions), diminishing the link between negative emotions and maladaptive self-regulation (e.g., cutting, substance use, withdrawal), increase positive coping behaviors when distressed, increase tolerance of anxiety in feared situations, and attenuating the link between triggering stimuli and phobic responses. Quantitatively, each of these would be represented by a *dynamic*

relationship among variables—or, stated otherwise, an *association that changes over time*. Accordingly, the targeted variables should be assessed in a manner that allows for establishing the strength of these links, and then repeatedly assessed in a way that allows for the continued probing of the strength of that link via appropriate quantitative methods (Wright et al., 2014).

The avenues for future work in this area are wide open, and we have outlined but a few potential directions for a program of research that seeks to integrate structural and dynamic processes. Importantly, much of the fundamental work has yet to be done, starting with measurement, establishing structural similarities, refining the psychometrics, and then moving from a well-established beachhead into more complex and nuanced investigations.

CONCLUSION

In sum, we believe the findings presented here are an initial step down one possible path toward merging two contemporary paradigms in psychopathology research, the psychometric approach to establishing crosscutting domains, and the investigation of contextualized dynamic processes. It is our hope that the clearly interpretable factor solutions estimated at the between- and within-person levels demonstrate that domains derived from the study of individual differences in psychopathology can be fruitfully applied and used to organize investigation into person-specific dynamic processes. This approach is already being implemented in basic and applied personality science to establish contingencies and mechanisms driving behavior (e.g., Beckmann et al., 2010; McCabe and Fleeson, 2012), and similar approaches should be viable in psychopathology research.

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SUPPLEMENTARY MATERIAL

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Bayesian Analysis of Individual Level Personality Dynamics

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A Bayesian technique with analyses of within-person processes at the level of the individual is presented. The approach is used to examine whether the patterns of within-person responses on a 12-trial simulation task are consistent with the predictions of ITA theory (Dweck, 1999). ITA theory states that the performance of an individual with an entity theory of ability is more likely to spiral down following a failure experience than the performance of an individual with an incremental theory of ability. This is because entity theorists interpret failure experiences as evidence of a lack of ability which they believe is largely innate and therefore relatively fixed; whilst incremental theorists believe in the malleability of abilities and interpret failure experiences as evidence of more controllable factors such as poor strategy or lack of effort. The results of our analyses support ITA theory at both the within- and between-person levels of analyses and demonstrate the benefits of Bayesian techniques for the analysis of within-person processes. These include more formal specification of the theory and the ability to draw inferences about each individual, which allows for more nuanced interpretations of individuals within a personality category, such as differences in the individual probabilities of spiraling. While Bayesian techniques have many potential advantages for the analyses of processes at the level of the individual, ease of use is not one of them for psychologists trained in traditional frequentist statistical techniques.

Keywords: bayesian statistics, implicit theories, mindsets, within-person, personality processes, performance spiraling, simulations

1. INTRODUCTION

Psychological reports based on the study of between-person effects often characterize the results as relating to individual level within-person processes. For example, Blackwell et al. (2007) describe how, relative to those with an entity or fixed view, individuals with an incremental or developmental view of intelligence “display mastery-oriented strategies (effort escalation or strategy change) vs. helplessness strategies (effort withdrawal or strategy perseveration) in the face of setbacks” (Blackwell et al., 2007, p. 247). The implication for most readers is that an individual with an incremental view of intelligence will respond to an incident of failure or setback with a mastery oriented strategy, and that an individual with an entity view of intelligence will respond to an incident of failure or setback with a helplessness strategy. The argument that the views, mindsets or beliefs held by individuals shape their reactions to situations, such as failure and setbacks, has been

tested for a range of latent variables, including, for example, the ideal vs. ought self (Higgins et al., 1994), learning vs. performance goal orientations (Elliott and Dweck, 1988), external vs. internal locus of control (Paulhus, 1983) and cultural group processes (Na et al., 2010). In each of these cases, the argument is made that the prior view of each individual influences his or her pattern of responses, but the effects are tested at the group level using aggregate statistics such as means, variances and correlations. Thus, statistical inferences regarding between-person differences are used to imply the existence of dynamic within-person processes.

While it is possible that the average pattern of responses observed at the group level will also be observed at the individual level, this cannot be assumed without testing at the individual level (Eysenck and Eysenck, 1985; Borsboom et al., 2003; Grice, 2015). As noted by Grice (2015, p. 1) many relationships observed at the group level do not replicate at the level of the individual, such as the structure of the Big 5 (Grice et al., 2006; Beckmann et al., 2010) and the Power Law of Learning (Heathcote et al., 2000). While this fact is widely recognized and frequently discussed (e.g., Nezlek, 2001; Schmitz, 2006), a barrier to testing models of psychological processes at the individual level has been an over reliance on the aggregate frequentist statistics of means, variances and correlations that require sample sizes greater than one (Danziger, 1990; Grice, 2015). As a result, the study of individual level processes using, for example, case studies or individual time series to capture the dynamics of within-person processes, such as those described by Blackwell et al. (2007) for entity theorists and incremental theorists, has received relatively little attention until recently.

In more recent times, the collection of individual level time series data with repeated observations of the psychological states and behaviors at multiple time points has been facilitated through the development and application of simulations (Wood et al., 2009; Beckmann et al., 2012) and experience sampling methods (e.g., Minbashian et al., 2010; Fisher and To, 2012). The analyses of these individual time series has been associated with an increased use of growth curve modeling techniques, including latent curve modeling (LCM; e.g., Goodman et al., 2011) and growth mixture models (GMM; e.g., Grimm et al., 2010), which combine LCM and finite mixture models to estimate individual trajectories. These methods provide a significant advance in the modeling of dynamic psychological processes in that, in addition to means, variances and correlations they provide estimates of the different trajectories and other features of the pattern of responses over time. However, these are frequentist methods and inference relies on the assumption of asymptotic normality of the sample estimates¹. While this assumption is generally correct for group level estimates, it is unlikely to be true at the individual level without a large number of observations per individual. As a result, inferences at the individual level from frequentist growth curve modeling techniques are limited to point estimates and do not allow for inferences regarding dynamic within-person processes.

¹The finite sample properties of the estimates in LCM and GMM have not been established.

In the current study, we present a Bayesian approach to the modeling of individual level processes using a multiple trial task. Bayesian approaches provide greater flexibility in the modeling of the pattern of within-person processes at the individual level because they are not limited by the assumption of asymptotic normality of the distribution of sample estimates. Given a model to predict the likely observed pattern of individual level outcomes and prior assumptions regarding the parameters that describe the model, Bayesian analyses enable inferences to be made regarding each individual in a sample.

Bayesian analysis offers some advantages for psychologists interested in moving beyond group level tests of between-person differences to study if and how their theories of individual level processes impact on the observed pattern of within-person responses. First is the fact that a Bayesian approach allows for the modeling of individual processes and interpretation of the pattern of observations for each individual in a sample to see if they fit the pattern predicted by the theory. Second, the flexibility of a Bayesian approach requires a priori specification of the processes that generate observations according to the specific theory used to generate the hypotheses, including the predicted pattern of specific values for those observations. The researcher must be able to describe the dynamic model of the processes in mathematical terms, thus requiring greater precision than the prediction of a significant correlation, covariance or mean difference. Third, in the absence of significance tests, Bayesian methods require more detailed examination and explanation of the pattern of results. For example, analyses at the individual level may reveal that most but not all incremental theorists adopt a mastery strategy following failure and that most but not all entity theorists adopt a helplessness strategy. With individual level Bayesian analyses, we are able to determine how many and which individuals in each category respond in a manner that is consistent with the theoretical model and the probability that each individual responds in a manner consistent with their categorization.

In the following we will demonstrate how the Bayesian approach can be used to model within-person processes at the level of the individual. We use data from 28 professionals who worked on a complex, dynamic decision-making task and for whom we also collected data about their implicit beliefs about ability.

2. AN EXAMPLE STUDY: IMPLICIT THEORIES OF ABILITY

Two views on intelligence were first described by Carol Dweck as implicit theories of ability (ITA) and later as mindsets (Dweck, 1999), which Dweck labeled as entity and incremental theories. Individuals with an entity theory of ability believe that intelligence is inherent or natural and therefore fixed and not readily subject to change. To the degree that experience and developmental activities make a difference, entity theorists believe it to be the result of pre-existing natural abilities. Individuals with an incremental theory of ability believe that abilities like intelligence are malleable because they are primarily

the product of experience, effort and developmental activities. For an incremental theorist, natural abilities are potential to be developed and realized through developmental strategies and effort.

As noted by Blackwell et al. (2007) these two different views of intelligence have been shown to significantly influence how people react to failure and setbacks when learning new tasks (Wood and Bandura, 1989; Dweck, 1999; Tabernero and Wood, 2010). In her formulation of the ITA model, Dweck (1999) argued that entity theorists who experience failure or setbacks during learning interpret the feedback as evidence of a lack of ability and begin to doubt their capacity to learn the task. If the task is complex enough and requires full use of cognitive resources, this self-doubt interferes with subsequent performance and will lead to a downward spiral. Also, when performing at an acceptable level, entity theorists will stick with the strategy they know and not experiment with new strategies that might expose them to the risk of failure. Thus, in the early stages of learning, entity theorists will often lock into a strategy that proves suboptimal as the task unfolds. In contrast, according to Dweck (1999) those classified as incremental theorists are more likely to interpret failure feedback as evidence of a poor strategy or lack of effort. As a result of these attributions to controllable factors, incremental theorists experience less self-doubt and focus on opportunities for improvement by changing their strategy or working harder on subsequent trials, which is more likely to lead to recovery over time.

Thus, the ITA model leads to the prediction that, at an individual level, when performance drops, entity theorists are more likely to spiral further down while incremental theorists are more likely to recover. As a corollary, entity theorists are predicted to learn a task more slowly and have lower performance than incremental theorists, as has been shown at the group level (Wood and Bandura, 1989; Tabernero and Wood, 2010). As noted above, these aggregated group level results do not directly test the arguments for the differential patterns of individuals' responses to failure by entity and incremental theorists, nor do they demonstrate that the observed group level effects are the product of the predicted dynamics at the individual level. The only conclusion that can be made with confidence in comparisons of the group level learning curves of entity and incremental theorists is that entity theorists, on average, learn at a slower rate than incremental theorists. As well as allowing us to examine group or between-person differences in the average rate of performance increase (Question 1), a fuller and more direct analysis of the ITA model at the individual level using Bayesian methods also allows us to examine within-person effects (Questions 2 and 3). Our analyses address the following research questions:

1. Do individuals classified as entity theorists increase performance at a slower rate on average than individuals classified as incremental theorists?
2. Following failure what is the likelihood that an individual exhibits spiraling, that is further decreases in performance?
3. Is the probability of spiraling higher for individuals classified as entity theorists than for those classified as incremental theorists?

In addressing these questions we demonstrate features of the Bayesian approach for the analyses of individual level processes and the advantages and disadvantages of that approach. One important advantage of the Bayesian approach for the testing of psychological theories, noted above, is the requirement of specifying how the explanatory mechanisms described in the model will influence the patterns of responses for individuals, plus any assumptions built into the model. Consider research Question 2: To answer this question we need to precisely define spiraling behavior in formal mathematical terms and then develop a statistical model to test for its existence. We define spiraling behavior to be a sustained decrease in performance so that individual performance trajectories must be monotonically increasing before the commencement of any spiral and monotonically decreasing afterwards. If individuals' trajectories are assumed to be linear² this means that the slopes of these trajectories are positive before and negative after the commencement of a spiral. We will show how we incorporate this structure into our model via the prior distribution of the regression coefficients.

The assumption of a prior distribution is sometimes pointed to as a subjective Achilles' heel of Bayesian methods but, in addition to the explicit statement and formal mathematical modeling of the explanatory mechanism and assumptions made, the necessity of specifying a prior distribution allows one to examine the sensitivity of any conclusions to these prior assumptions. For example, in addressing Question 3, we ask: How much prior information needs to be imposed in order to conclude that entity theorists are more likely to exhibit spiraling behavior than incremental theorists? We can make inferences about observed differences between entity and incremental theorists using prior beliefs that a difference will occur with a probability ranging from 0 to 100%. Researchers using frequentist statistics are less likely to test the sensitivity of inferences to the assumptions of their models, because the assumptions of asymptotic normality are implicit in the methods so that psychological researchers are often unaware of their existence³.

Another important feature of Bayesian statistics for analyzing individual level processes is that any event or quantity of interest can be treated as a random variable. In many theories of latent psychological variables that influence individual level processes of learning and performance, the situational event of interest is the experience of failure or a setback. Failures and setbacks are the result of many exogenous forces and can occur at different times for different individuals. This can be modeled as a random variable using Bayesian methods. By way of contrast, psychological experiments based on frequentist methods of inference typically seek to constrain the experience of failure to a single fixed event, a manipulation, and then use the aggregate or average group level response to infer individual responses. In Bayesian analyses, the non restrictive assumption of randomness may be applied to a parameter that describes a distribution, such as the mean slope of individual performance trajectories (Question 1), the probability that an individual will start to spiral

²This is not a necessary assumption, but we use it as a simple example.

³Even when tests for finite samples exist, it is very unusual for psychological researchers to report them.

on a given trial, or it may even be one of a set of statistical models.

These flexible features of the Bayesian approach provide two benefits for the analyses of the individual level processes in response to failure. First is that the trial on which a failure occurs does not have to be fixed but can vary randomly across trials for individuals. Thus, analyses to address Questions 2 and 3 do not have to assume that the initial experience of failure is a fixed event that occurs at the same time, or on the same trial, for all individuals in a particular group. But, when the experience of failure does occur, be it on trial 3 or trial 10, the responses of entity theorists and incremental theorists will be different. The average performance differences of entity theorists and incremental theorists, even if measured across multiple trials (e.g., Wood and Bandura, 1989), does not directly test the model proposed by Dweck (1999) and others (e.g., Blackwell et al., 2007) which describe the processes at the individual level when responding to failure events.

Relatedly, Bayesian inference based on the marginal posterior distribution accounts for the joint uncertainty surrounding all unknown parameters. This means that a statement such as “the probability that entity theorists are more likely to exhibit spiraling behavior than incremental theorists is equal to 0.95,” accounts for the uncertainty not just in the location of the commencement of the spiral, but also for the uncertainty in the size of individual and group level regression coefficients and error variances. We can therefore be more confident that the effect is real than if we were to plug-in our best guess of the other unknown parameters and compute a *p*-value.

Psychologists interested in analyzing within-person processes at the individual level will also benefit from the fact that Bayesian analyses attach probabilities to each individual's compliance and non compliance with a hypothesis, rather than just reject or accept the hypothesis at the group level. For example, research Question 2 will be answered by computing the probability of the two competing models, spiraling or no spiraling, for each individual, based on data available for all individuals. The resulting posterior probability for an individual provides an estimate of the probability that he or she will spiral on future tasks, should we wish to predict the later performance of an individual. For example, we would predict that individual A, for whom the probability of spiraling is equal to 0.99, is much more likely to spiral following failure on a future task than individual B for whom the probability of spiraling is found to equal 0.51.

By way of contrast, the frequentist approach to hypothesis testing would classify both individuals as spirallers and predict that both would spiral following failure on a future task and not differentiate between the probability of each happening. Because the observed pattern of performance for an individual will show that they either spiral or do not spiral, the probabilities of the different models included in the model averaging process must add to 1.0. For example imagine two people, individual A and individual B. For individual A the predictions for spiraling and not spiraling following failure would be weighted by 0.99 and 0.01, respectively. For individual B, the predictions for spiraling and not spiraling following failure would be weighted by 0.51 and 0.49, respectively. Clearly, there would be much

greater uncertainty about the prediction for individual B than for individual A. Frequentist predictions based on model selection ignore the uncertainty associated with the model, and ignoring model uncertainty often leads to *p*-values that overstate the evidence for an effect (Hoeting et al., 1999).

As the number of possible hypotheses or models increases so do the advantages of model averaging over model selection (Raftery and Zheng, 2003). In this paper we average over a very large number of models; for each individual there are 11 possible models, the first specifying no spiral, and within the spiral hypothesis there are 10 sub models, one for each possible location of the trial on which spiraling begins, not allowing spiraling on the last two trials. Therefore, for all 28 individuals the number of possible models is 11^{28} , which is very large indeed. Likelihood based model selection using frequentist procedures, such as AIC or BIC, are not feasible when the number of models under consideration is very large. With such a large number of models we use Markov Chain Monte Carlo (MCMC) methods to stochastically search across the entire model space and predictions are based on a subset of models, rather than a single model, with these predictions weighted by their posterior probability (i.e., the probability of model allocation given the data). Model averaging allows the researcher to ask questions such as “what is the probability that individual *j* started to exhibit spiraling on trial *i*?”

3. METHODS

3.1. Participants

The participants were 28 managers from various organizations who were attending a 3-day executive training program at different times over a year. The 28 participants were all males and had an average age of 34.15 years (*SD* = 3.23 years).

3.2. Experimental Task

The experimental task required the participants to manage a computer simulation of a small furniture production and repair workshop containing 5 workers through 12 simulated weeks of business activity (i.e., trials). In this task participants managed the performance of five employees by assigning them to each of five tasks required to complete a weekly order. The five tasks and the 5 employees remained the same throughout the 12 trials. The challenge for the participants was to learn the optimal match of employees to tasks. The employee performance norm was set at 100 at the start of the task, allowing participants to make judgments about their employees' level of performance (including increase, decrease or otherwise). Trial by trial feedback included the task performance of each of the five employees and the overall team performance. The metric for both employees and team performance was hours used as a percentage of budgeted hours for the assigned weekly order, scored so that better performance resulted in higher feedback scores. By using this feedback to test decision options systematically, managers could discover the impact of alternative choices and thereby learn how to increase the organization's performance. Therefore, for each manager there were twelve trials that recorded workgroup performance indicative of managerial ability, which we used as

the dependent variable. Further details of the task are described in Wood and Bailey (1985).

The performance of workers in the simulation had two components; a deterministic component reflecting the consequence of the participant manager's decisions and a random component. The random component was included so that participants could not perfectly predict outcomes, which is a realistic representation of the business world in which managers operate. Note that we chose a dynamic computer simulation that was a novel experience for the participants, for which they had limited expertise and for which they were required to develop new strategies or adapt existing strategies (Wood and Locke, 1990). New or adapted strategies require greater cognitive effort, have a greater risk of further failure, and require greater persistence in their development and execution than well-known, routine strategies. It is these efforts that are potentially undermined by negative self-evaluations.

3.3. Measures

Prior to working on the furniture workshop simulation, participants completed an 8-item measure of their ITA. The eight ITA items were taken from the measures developed and validated by Dweck and her co-workers (Dweck, 1999) and included four entity type items, such as "People have a certain fixed amount of ability and they cannot do much to change it," and four incremental type items, such as "People can always substantially change their basic skills." All items had a 6-point Likert-type scale ranging from 1 = strongly agree to 6 = strongly disagree. The incremental items were reverse scored and the eight items were added to create a single scale ($\alpha = 0.87$, $Mean = 3.41$, $SD = 0.69$), with a higher score indicating a stronger incremental theory and a lower score indicating a stronger entity theory of ability.

A median split was deemed to be an appropriate method of ITA classification as it is the method of categorization for the ITA scale used in Dweck (1999). As a result, the raw data underlying the classifications of participants based on the median split are no longer available; only the coded data has been retained. We acknowledge that using a median split is an increasingly outdated procedure. Nevertheless, we argue that our data are still informative since an individual above the median is more likely to be classified as an incremental theorist than one below the median. Furthermore, the median split provides simpler inferences, although with some loss of granularity, than a continuous variable (e.g., consider the research questions in the Introduction).

Based on a median split of the ITA scores, 14 individuals were classified as entity theorists and 14 classified as incremental theorists. **Figure 1** shows the performance of the 28 individuals across 12 trials. Those that are classified as entity theorists are shown in red ($Mean = 108.42$, $SD = 12.68$) and those classified as incremental theorists are shown in blue ($Mean = 112.1$, $SD = 15.04$).

4. BAYESIAN HIERARCHICAL MODEL

We start this section with a hierarchical Bayesian representation of what are commonly called latent curve models (Gelman and

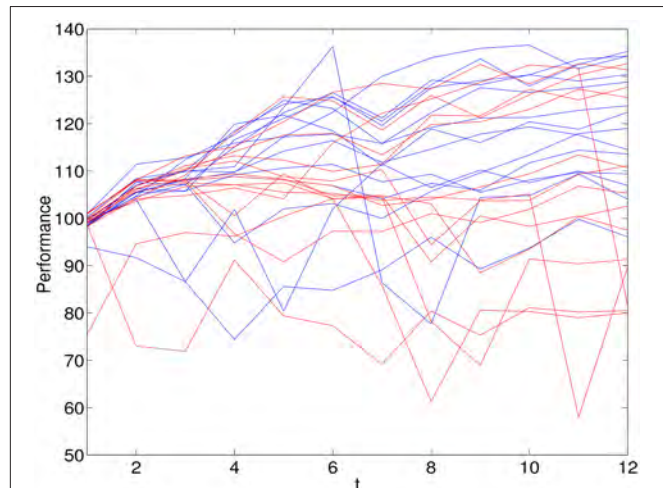


FIGURE 1 | Observations on performances over 12 trials for 14 individuals classified as entity theorists (red) and 14 individuals classified as incremental theorists (blue).

Pardoe, 2006; Gelman and Hill, 2007) and then demonstrate how the use of prior distributions, together with data augmentation, can be used to extend and tailor these models to answer the questions of interest to psychological researchers.

Consider a series of performance measures on J individuals across T trials. Let $\mathbf{Y} = (\mathbf{y}_1, \dots, \mathbf{y}_J)$, where $\mathbf{y}_j = (y_{j1}, \dots, y_{jT})'$ and y_{jt} is the performance of the j^{th} individual on trial t and denote $f(t)$ to be some function of time. Our purpose in this paper is to demonstrate a number of features of Bayesian methods and therefore we restrict our discussion in the paper to linear functions of time with normally distributed errors. However, in Appendix A in Supplementary Material, we relax these restrictions and consider a nonlinear monotonic function of time and another error distribution.

One possible Bayesian hierarchical model is

$$y_{tj} = \alpha_j + \beta_j t + \varepsilon_{tj}, \quad \varepsilon_{tj} \sim N(0, \sigma^2) \\ \alpha_j \sim N(\mu_\alpha, \tau_\alpha^2), \quad \beta_j \sim N(\mu_\beta, \tau_\beta^2), \quad \sigma^2 \sim \text{IG}(a, b) \quad (1.1)$$

where α_j and β_j are the regression coefficients for individual j and the notation $\text{IG}(a, b)$ indicates an inverse gamma distribution with shape and scale parameters a and b , respectively. Model Equation (1.1) is a hierarchical one; there are trials within individuals. The model allows individuals to have different regression co-efficients and hence different expected performance trajectories, but the regression co-efficients are restricted to a distribution that depends upon parameters common to all individuals. This distribution is assumed to be normal and the parameters in common are the means, $\boldsymbol{\mu} = (\mu_\alpha, \mu_\beta)$ and variances $\boldsymbol{\tau}^2 = (\tau_\alpha, \tau_\beta)$, of the regression coefficients. These assumptions are not necessary, but are commonly used in Bayesian methods for computational ease, and in frequentist methods because the asymptotic sampling properties of the estimators are known.

The error term in the first line of Equation (1.1) is the within-person variation and τ^2 represents the between individual

variation. As $\tau^2 \rightarrow (0, 0)$ then all individuals have exactly the same expected performance trajectory, while as $\tau^2 \rightarrow (\infty, \infty)$ individual expected trajectories have nothing in common with each other and may as well be estimated independently. Clearly the advantage of such a model is that individual trajectories can be estimated based on only a few data points, by “borrowing” information contained in data from other individuals. Note that with only a few data points individual trajectories can only be *estimated*; *inference* surrounding individual trajectories requires the specification of a data generating process such as Equation (1.1), or a large number of data points for each individual.

The model specification is completed by specifying a prior on the hyperparameters μ and τ . In constructing these priors we use a technique known as Empirical Bayes (Robbins, 1955; Efron, 2005) where the type of prior distribution is specified by the user and then frequentist techniques are used to determine the parameters that describe these prior distributions. For example both μ_α and μ_β are assumed to be independent and normally distributed, centered around the average of the maximum likelihood estimates of the individual regression coefficients, with standard deviations equal to half the range of these quantities. See Appendix C in Supplementary Material for a full discussion.

4.1. Extending and Tailoring the Model

One of the beauties of Bayesian statistics is that, having specified the basic probabilistic data generating process, data augmentation and MCMC techniques can be used to compute the desired characteristic of any posterior distribution. In this section we show how to extend the model in the previous section to answer the research questions described in the introduction.

4.2. Using Priors to Formulate Hypotheses and Impose Constraints

Research Question 1 is relatively straightforward to answer, so we discuss our solution to this before tackling Questions 2 and 3. In Equation (1.1) we represented a latent curve model as a hierarchical Bayes model in which the unobserved individual regression coefficients, the α 's and the β 's, are generated from a prior distribution. We now modify this prior to answer specific research questions. There is no reason to suppose, *a priori*, that an individual's ITA classification affects their performance before they have received any performance feedback; as argued above, it is the response to failure feedback and setbacks that differentiates entity and incremental theorists (Dweck, 1999). Therefore, we assume that the prior distribution for the intercept is the same for all individuals, $\alpha_j \sim N(\mu_\alpha, \tau_\alpha^2)$. However, in order to answer research Question 1 we parameterize our prior for the slope, β_j , to depend upon an individual's ITA classification. Let $\mu_\beta = (\mu_E, \mu_I)'$ and let $\mathbf{z}_j = (1, 0)$ if individual j is classified as an entity theorists and $\mathbf{z}_j = (0, 1)$ otherwise. Accordingly $\beta_j \sim N(\mathbf{z}_j \mu_\beta, \tau_\beta^2)$, so if an individual is classified as an entity theorist then $\beta_1 \sim N(\mu_E, \tau_\beta^2)$, and if an individual is classified as an incremental theorist, then $\beta_j \sim N(\mu_I, \tau_\beta^2)$. The difference in the mean slopes between the two classifications is given by $\mu_E - \mu_I$ and Question 1 is answered by exploring the posterior distribution $p(\mu_E - \mu_I | \mathbf{Y})$; if entity theorists increase performance

at a slower rate than incremental theorists then we would expect this distribution to have most of its support less than zero. Note that there is not much practical advantage in using a Bayesian method to answer research Question 1. A frequentist approach, such as restricted maximum likelihood (REML) estimation, would also suffice and we present a comparison of a frequentist and Bayesian analysis in the Results section.

Answering research Question 2 is more complex. As discussed in the introduction, the mean function must be monotonically increasing before and decreasing after the commencement of a spiral. We use the prior distributions of the regression coefficients to enforce these constraints. Suppose the regression function prior to the spiral is given by $\alpha_{1j} + \beta_{1j}t$, where the subscript 1 denotes the function before the spiral. If this function is monotonically increasing then the slope, β_{1j} , must be positive. Similarly suppose the regression function after the spiral is given by $\alpha_{2j} + \beta_{2j}t$, then the slope, β_{2j} , must be negative. In addition these two regression functions must intersect at the commencement of the spiral, which we call the cut point and denote by c_j . To ensure this we need the intercept of the second regression function, α_{2j} , to equal $\alpha_{1j} + c_j(\beta_{1j} - \beta_{2j})$. So we have three constraints (i) $\beta_{1j} > 0$, (ii) $\beta_{2j} < 0$ and (iii) $\alpha_{2j} = \alpha_{1j} + c_j(\beta_{1j} - \beta_{2j})$, all of which can be imposed in a logically consistent manner by the prior. We impose the first and second constraints by assuming that β_{1j} and β_{2j} have normal distributions constrained to be positive and negative, respectively. The third constraint is also formulated as a prior distribution, which is that the intercept α_{2j} is equal to $\alpha_{1j} + c_j(\beta_{1j} - \beta_{2j})$ with probability one. Such a distribution function is referred as a Dirac delta function. Note that it is not necessary to think of the prior for α_{2j} as a Dirac delta function, we do so here to show that Bayesian inference is a coherent framework for imposing all model assumptions.

4.2.1. Using Data Augmentation to Model Spiraling

In our response to Question 2 we not only want to identify individuals who spiral following failure but we also want to determine the likelihood of spiraling for each individual. That is, we want to be able to say, for example, that “the probability that participant 10 will exhibit spiraling behavior is 0.64.” Then, in order to address Question 3 we want to determine if the probability of spiraling behavior for each of the 28 participants is related to their categorization as an entity theorist or an incremental theorist. That is, in addition to modeling behavior at the individual level, researchers also want to understand how group level factors, such as ITA personality classification, affect these individual probabilities of spiraling. In this section we show how data augmentation can answer these questions by facilitating the MCMC scheme that performs the required multidimensional integration needed to estimate the marginal posterior distributions of interest.

To detect spiraling behavior we augment the data with a Bernoulli random variable (Be). For each individual we define S_j as

$$S_j = \begin{cases} 1 & \text{if a spiral occurs at any time for individual } j, \\ 0 & \text{otherwise.} \end{cases}$$

If an individual j exhibits spiraling behavior (i.e., $S_j = 1$) we augment the data again with another variable to indicate the point at which the spiral commences, the cut-point, c_j , so that $c_j = t|S_j = 1$ if individual j begins to spiral at time t . The cut-point is a discrete random variable, taking values $1, \dots, T - 2$ and we assume *a priori* that the spiral is equally likely to occur on any trial, therefore $\Pr(c_j = t|S_j = 1) = \frac{1}{T-2}$. Note, under this formulation we do not allow a spiral to begin for the last two trials. The reason for this is to reduce boundary effects and to estimate the regression co-efficient with some precision.

Conditional on S_j and c_j our model for the performance score of individual j on trial t is,

if $S_j = 1$ and $t < c_j$

$$y_{tj} \sim N(\alpha_{1j} + \beta_{1j}t, \sigma^2),$$

if $S_j = 1$ and $t \geq c_j$

$$y_{tj} \sim N(\alpha_{1j} + c_j(\beta_{1j} - \beta_{2j}) + \beta_{2j}t, \sigma^2)$$

with

$$\begin{aligned} \alpha_{1j} &\sim N(\mu_\alpha, \tau_\alpha^2), \quad \beta_{1j} \sim N_{C_+}(\mathbf{z}_j\boldsymbol{\mu}_{\beta_1}, \tau_{\beta_1}^2), \\ \beta_{2j} &\sim N_{C_-}(\mathbf{z}_j\boldsymbol{\mu}_{\beta_2}, \tau_{\beta_2}^2), \end{aligned} \quad (1.2)$$

and if $S_j = 0$ then

$$\begin{aligned} y_{tj} &\sim N(\alpha_{1j} + \beta_{1j}t, \sigma^2) \\ \alpha_{1j} &\sim N(\mu_\alpha, \tau_\alpha^2), \quad \beta_{1j} \sim N_{C_+}(\mathbf{z}_j\boldsymbol{\mu}_{\beta_1}, \tau_{\beta_1}^2), \\ \beta_{2j} &\sim \delta(x - a) \end{aligned} \quad (1.3)$$

where $a = 0$.

The notations N_{C_+} and N_{C_-} indicate a normal distribution constrained to be positive and negative, respectively. The notation $\delta(x)$ means that $\delta(x) = 1$ if $x = 0$, otherwise $\delta(x) = 0$. So that, in Equation (1.3), $\beta_{2j} = 0$ with probability one.

Note that conditional on an individual spiraling and the location of the cut-point, the estimate of the expected performance trajectory is piecewise linear; $\alpha_1 + \beta_{1j}t$ before the cut point and $\alpha_{1j} + c_j(\beta_{1j} - \beta_{2j}) + \beta_{2j}t$ afterwards. However, unconditional on these quantities the estimate of the mean performance trajectory is not necessarily piecewise linear. Indeed it will only be piecewise linear if the posterior probabilities of a spiral and corresponding cut-point both equal 1. **Figure 2** gives an example of the performance behavior of two individuals. **Figures 2A,C** show the estimated posterior mean, $\widehat{E}(y_{tj})$, and posterior probability, $\widehat{\Pr}(c_j|\mathbf{Y})$, respectively for individual 20. **Figures 2B,D** are the corresponding plots for individual 28. The fit in **Figure 2B** is close to piece-wise linear, reflecting the fact that the posterior distribution of c_j is tightly centered around $t = 1$. The nonlinear fit in **Figure 2A** is the result of averaging across several piecewise linear functions, where the averaging is with respect to the posterior distribution of the cut-point.

We denote the probability that an individual spirals by $\Pr(S_j = 1) = \pi$, so that $S_j \sim \text{Be}(\pi)$ and research Question 2 is

answered by computing $\Pr(S_j = 1|\mathbf{Y})$ for each individual. To answer research Question 3, we allow π to depend upon the ITA classification by modeling it as a logistic regression,

$$\pi_j = \frac{\exp(\mathbf{z}_j\boldsymbol{\delta})}{1 + \exp(\mathbf{z}_j\boldsymbol{\delta})},$$

where $\boldsymbol{\delta} = (\delta_E, \delta_I)$, so that the probability that an entity theorist spirals is $\pi_E = \frac{\exp(\delta_E)}{1 + \exp(\delta_E)}$ and the probability that an incremental theorist spirals is $\pi_I = \frac{\exp(\delta_I)}{1 + \exp(\delta_I)}$.

We now discuss the prior for $\boldsymbol{\delta}$. If we have no prior belief regarding the probabilities π_E and π_I , other than they must lie between 0 and 1, then the prior on $\boldsymbol{\delta}$ should reflect this. For example in the Appendix in Supplementary Material we use the prior $\boldsymbol{\delta} \sim N(0, c_8\mathbf{I}_2)$, where \mathbf{I}_2 is the 2×2 identity matrix, and show that the choice of $c_8 = 4$ corresponds approximately to a joint uniform prior. Having established a prior for $\boldsymbol{\delta}$, we answer research Question 3 by exploring the posterior distribution $p(\pi_E - \pi_I|\mathbf{Y})$. One way of ascertaining the strength of the relationship between the ITA personality type and the propensity to spiral is to see how strong our prior belief must be in order to conclude that there is no relationship. In the results section we show the impact of the value of c_8 has on the posterior density $p(\pi_E - \pi_I|\mathbf{Y})$.

Appendix D in Supplementary Material shows how data augmentation is used to facilitate the MCMC scheme that performs the multidimensional integration needed to estimate the marginal posterior distributions, $p(\mu_E - \mu_I|\mathbf{Y})$, $p(\pi_E - \pi_I|\mathbf{Y})$.

5. RESULTS

In this section we present the results for two models; one where the possibility of spiraling is ignored and the other where it is explicitly modeled. Results are categorized as (i) results regarding parameters common to groups of individuals; (ii) results regarding specific individuals; and (iii) results regarding the effect of priors on inference. Model diagnostics, such as residual plots, and simulation results which establish the frequentist properties of the method, are contained in Appendix B in Supplementary Material.

We present here results for a linear function of time and normal distributed errors. To minimise the risk that any findings are a result of model misspecification consequent upon the choice of a particular function of time, we also obtained results for a logistic growth function, and errors that have a t_v distribution. The results of these analyses are available in Appendix A in Supplementary Material and show that the conclusions drawn from the data are unaffected by assumptions regarding these error distributions and functions of time.

5.1. Results for Parameters Common to Groups of Individuals

First, we examine the results when spiraling is ignored, as described in Equation (1.1). Equation (1.1) could also be estimated under the frequentist paradigm and we did so using REML, calculated in the R package `lme4` (Bates et al., 2015).

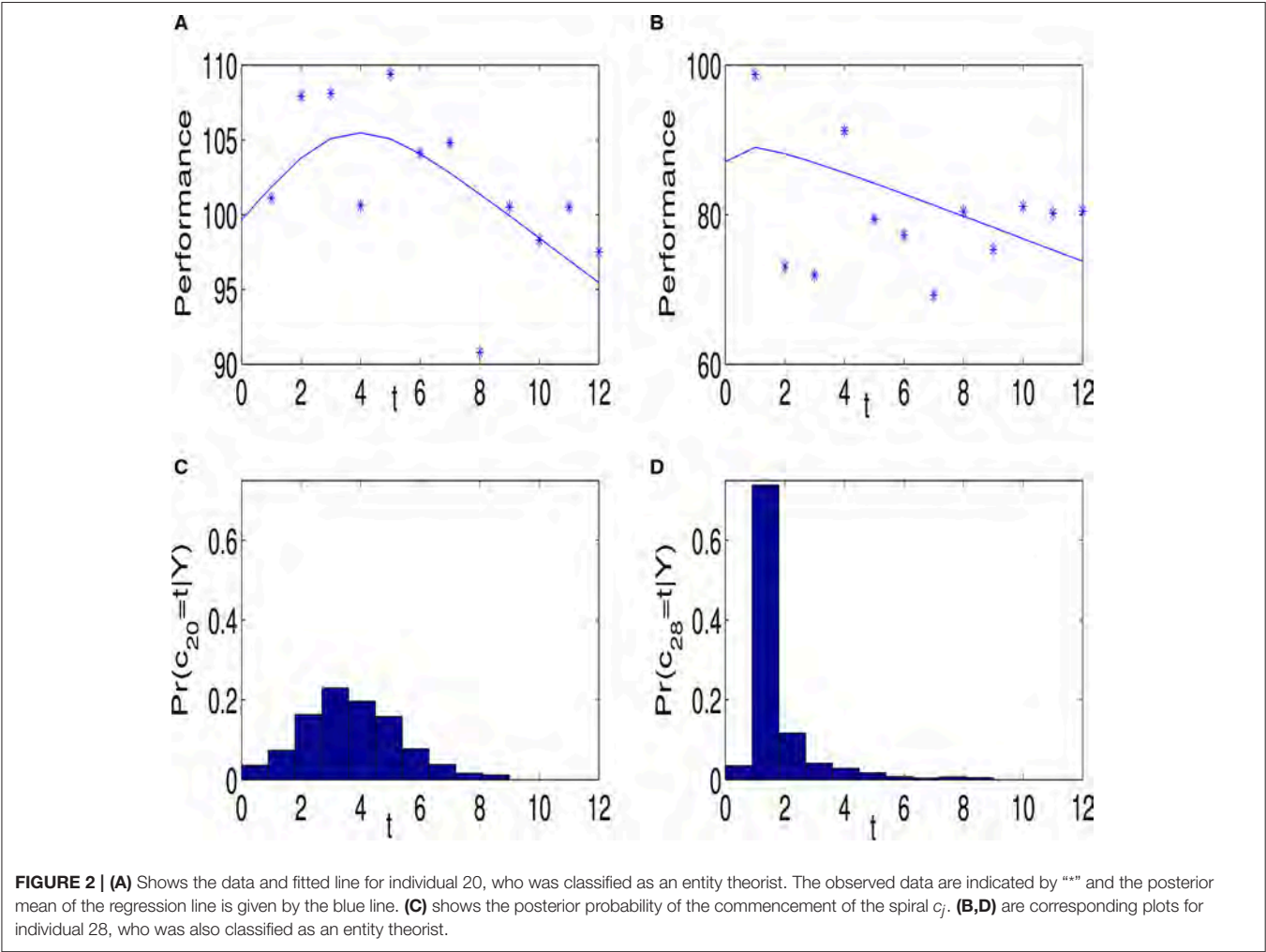


Table 1 reports the results when estimating the parameters common to groups of individuals using both frequentist and Bayesian techniques. The results are very similar⁴.

A Bayesian analysis of Equation (1.1) also allows us to easily estimate $p(\mu_E - \mu_I|Y)$, the posterior distribution of the difference between the average rate of learning for entity and incremental theorists. Figure 3A is a histogram estimate of this posterior distribution and shows support for research Question 1; on average entity theorists learn more slowly than incremental theorists, with probability 0.98. In other words, given the data and prior, the probability that incremental theorists learn at a faster rate is 0.98. Figure 3A reports this by showing ~ 0.98 of the mass of $p(\mu_E - \mu_I|Y)$ lies below zero.

As noted in the Introduction, when modeling spiraling behavior explicitly in our data, as in Equations (1.2) and (1.3), a frequentist analysis is not feasible. We therefore turn our attention to Bayesian analyses only for the rest of the article.

⁴ We note that, for the frequentist analysis, the sample size may be inadequate for Gaussian approximations to the sampling distributions of estimators and that sampling distributions of estimators of individual level trajectories are not available.

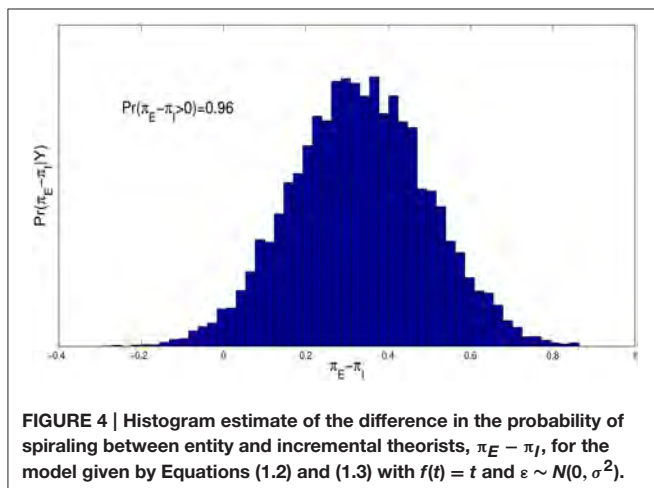
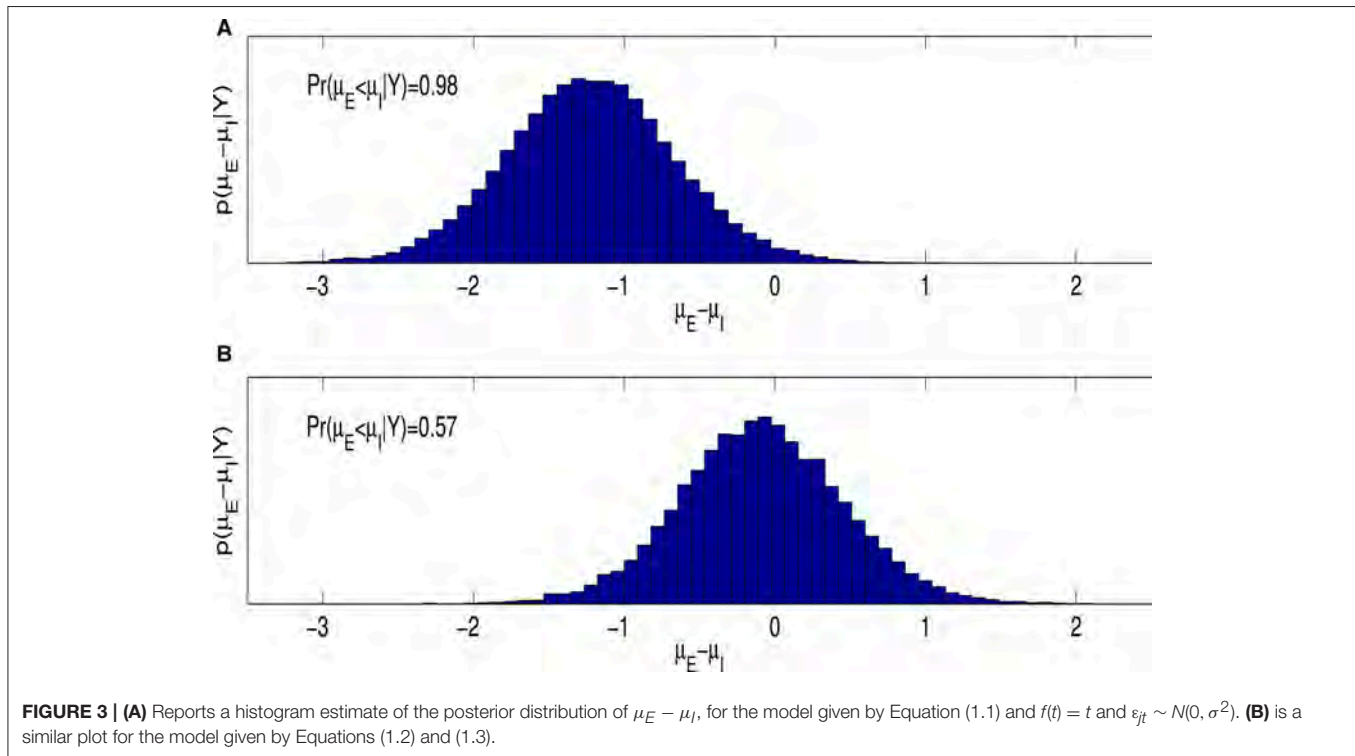
TABLE 1 | Overall performance baseline (μ_α) and performance trajectory (μ_β) as described in Equation (1.1) and estimated by a frequentist and Bayesian analysis.

	Frequentist $\hat{\mu}_\alpha$	Bayesian $\hat{\mu}_\alpha$	Frequentist $\hat{\mu}_\beta$	Bayesian $\hat{\mu}_\beta$
Incremental theorists	101.22 (1.77)	101.2 (2.17)	1.67 (0.31)	1.67 (0.38)
Entity theorists	102.87 (1.88)	102.88 (2.21)	0.3 (0.45)	0.32 (0.55)

Standard errors and posterior standard deviations are in brackets.

Figure 3B shows the histogram estimate of $p(\mu_E - \mu_I|Y)$ when the existence of spiraling is explicitly modeled. A comparison of the histograms in Figure 3 shows that the difference in the learning rate between the two ITA classifications disappears after controlling for the possible existence of spiraling behavior.

Figure 4 contains a histogram estimate of the posterior distribution, $p(\pi_E - \pi_I|Y)$, and shows that the probability of spiraling is much higher for entity theorists than for incremental theorists, with $p(\pi_E > \pi_I|Y) \approx 0.96$.



5.2. Individual Level Results

Figure 5 shows the individual posterior mean performance trajectories for entity theorists (red) and incremental theorists (blue), for the model that allows the possibility of spiraling. **Figure 5A** shows the fit for all individuals. **Figure 5B** shows the figure for those individuals for whom the probability of spiraling was < 0.5 , and **Figure 5C** the figure for individuals for whom the probability of spiraling was > 0.5 . The three panels of **Figure 5** show that while entity theorists are more likely to spiral, not all do. Five out of fourteen did not. Only one out of fourteen incremental theorists exhibited spiraling behavior. **Figure 5C** also shows that when it is very probable that an individual

spirals, the change in that individual's performance trajectory is substantial.

Table 2 shows the posterior probability of spiraling for all 28 individuals. The * and * indicate individuals classified as either an entity theorist or an incremental theorist, respectively, for whom the probability of spiraling is > 0.5 . An estimate of the median value of the point at which the spiral begins, \hat{c}_j , is given in the last column. This table shows that the probability of spiraling and the point at which this spiral begins varies between individuals of the same personality classification and demonstrates the need to model behavior at the individual level.

6. EFFECT OF PRIORS ON RESULTS

Figure 6 shows the impact that the choice of the prior variance of δ , c_δ , has on the posterior probability $\Pr(\pi_E > \pi_I | \mathbf{y})$. **Figure 6** shows that the conclusion that entity theorists are more likely to spiral than incremental theorists is largely unchanged in the range $1 < c_\delta < 20$. Indeed the strength of this result can be seen by examining how much prior information needs to be imposed before the result is no longer apparent. From **Figure 6** it can be seen that $c_\delta \leq 0.01$ before the $P(\pi_E > \pi_I | \mathbf{y}) \leq 0.5$. In other words we must be 95% certain *a priori* that the probabilities, π_I and π_E , lie in the interval $[0.45, 0.55]$, before we would conclude that, on the balance of probabilities, individuals classified as entity theorists are not more likely to spiral than those classified as incremental theorists. For a full discussion of the choice of c_δ see Appendix C in Supplementary Material.

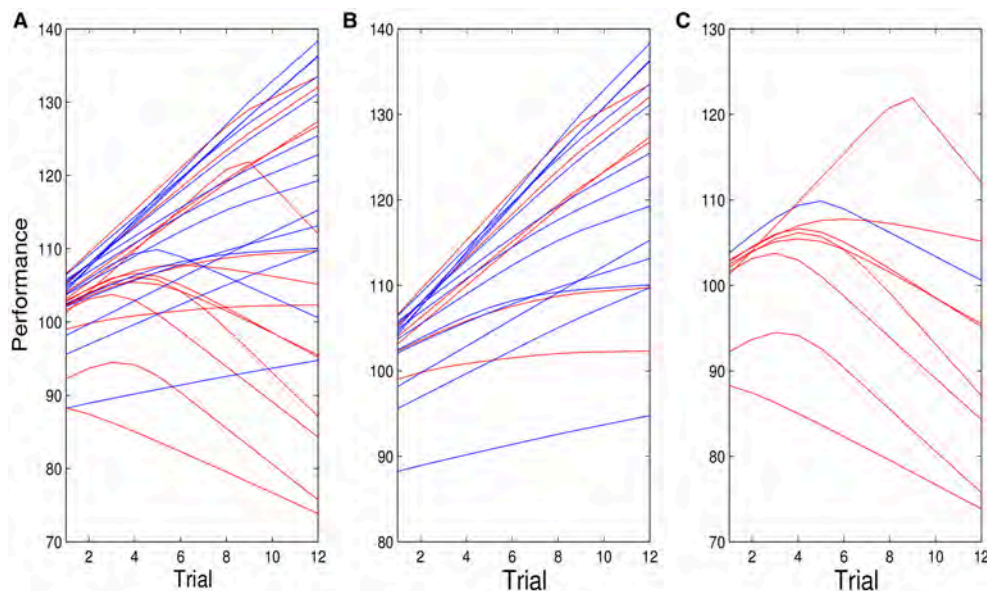


FIGURE 5 | (A) Posterior mean of all individual performance curves for entity (red) and incremental (blue) theorists for the model given by Equations (1.2) and (1.3), $f(t) = t$ and $\varepsilon_{it} \sim N(0, \sigma^2)$. **(B,C)** are similar plots for individuals for whom the probability of spiraling is <0.5 **(B)** and >0.5 **(C)**.

7. DISCUSSION AND CONCLUSION

In this paper we have presented a Bayesian analysis for the testing of within-person processes at the level of the individual, as well as providing the group level analyses that are usually reported in psychological research using frequentist statistical methods. The contributions and related implications of the reported study can be broken into three categories, which are discussed in turn. First, we discuss the advantages of the Bayesian method for psychologists who wish to study within-person processes at the level of the individual. Second, we discuss the results for the Bayesian analyses of the dynamic model of individual level performance outlined in the ITA model described by Dweck (1999) and the implications for testing other theories of motivation and personality at the individual level. Third, we discuss the functionality of the demands of Bayesian methods for psychologists.

The Bayesian approach provides several advantages over the more commonly used frequentist techniques for psychologists who wish to understand how within-person processes are manifest in the behavior of individuals. First, it allows inference at the individual level even when there are relatively few observations per individual, which is typically the case in longitudinal studies in personality and social psychology. In the current study, there were 12 observations per individual and we were able to test a complex dynamic model as specified by the theory. By way of contrast, if we were to rely on asymptotic arguments that underpin frequentist use of aggregate statistics for inference we would have required many more observations per person and a complex model of the type tested would require a sample of many multiples of that number. Psychological research is expensive and Bayesian methods are more efficient,

as well as being more effective in enabling inferences about individuals. This is not an argument for small samples; the cost of obtaining individual level inference is that one must specify a model that generates the data and prior distributions for parameters. Like frequentist methods, Bayesian methods provide more reliable inference with larger samples. Unlike frequentist methods, Bayesian inference is based on the posterior distribution that is calculated using the observed sample. Of course, in Bayesian statistics a small sample size may mean the prior distribution has a large influence on the posterior distribution. Note, however, that one can test the effects of prior specification on the results, as was done in this study.

Second, the specification of the prior required by Bayesian methods is a formal mechanism for spelling out the assumptions and prior knowledge of the theory to be tested. This is a discipline that is not required by frequentist approaches but one that will require psychologists to think more critically about the assumptions and current state of knowledge for the theories they employ. Psychologists may not think through the assumptions that underpin the frequentist approaches that they use because there is no formal mechanism or requirement for them to do so. Over time, repeated use of Bayesian methods will begin to lead to common knowledge of priors for different theories and research questions. The current state of knowledge about a relationship can be accumulated on a study-by-study basis. Bayesian methods can also include sensitivity analyses to test for the effects of different priors on the predicted outcomes, as was shown in the results of the current study. Such sensitivity analyses can be used when there is a question about the appropriate prior or when the circumstances suggest that an established prior may not be appropriate due to, for example, challenges to an assumption. The requirement to spell out assumptions and arguments when

TABLE 2 | Estimate of posterior means for individuals' probability of spiraling, $\hat{Pr}(S_j = 1|Y)$, and posterior medians of the commencement of the spiral, \hat{c}_j , for all individuals classified as entity theorists (red) and as incremental theorists (blue) with $f(t) = t$ and $\varepsilon_{jt} \sim N(0, \sigma^2)$.

Posterior probability of spiraling					
Incremental theorists			Entity theorists		
Individual #	$\hat{Pr}(S_j = 1 Y)$	\hat{c}_j	Individual #	$\hat{Pr}(S_j = 1 Y)$	\hat{c}_j
1	0.11	0	3	0.24	0
2	0.91*	4	5	0.10	0
4	0.09	0	10	0.10	0
6	0.04	0	13	0.05	0
7	0.12	0	14	0.61*	3
8	0.18	0	16	0.33	0
9	0.04	0	18	0.97*	4
11	0.09	0	19	0.99*	9
12	0.22	0	20	0.95*	4
15	0.38	0	21	1.00*	4
17	0.14	0	22	1.00*	3
23	0.02	0	24	0.34	0
25	0.08	0	26	1.00*	3
27	0.12	0	28	0.94*	1
Average	0.18			0.62	

Note that for individual 19, the high probability of spiraling is a result of a low performance score on trial 12. Figure 9 in Appendix A (Supplementary Materials) demonstrates how modeling the possibility of large deviations via a t_3 distribution mitigates the impact of outliers.

using Bayesian methods will enable more critical assessments of the cumulative knowledge in psychological research. It will also enable more critical evaluation of populist recommendations, often espoused by consulting firms, that are based on a single study of unknown validity or relevance to the big picture.

Third, Bayesian methods enable researchers to jointly estimate the uncertainty surrounding all parameters. For example, in the current study this enabled us to treat the trial on which an individual experienced their first incident of failure that either did or did not lead to spiraling as a random variable. For psychologists seeking to predict the outcomes of individual processes, the ability to model exogenous factors, such as a performance setback, an action by another person, or some other unexpected event, as random factors, greatly enhances the validity of attempts to model the effects of those events.

This study provided the first test of the individual level performance dynamics of ITA theory. The work of Dweck and colleagues (Dweck, 1999) plus other psychologists who have used ITA theory to develop their hypotheses has been based on an argument that entity theorists respond differently to failure than incremental theorists. In particular, entity theorists are more prone to negative self-evaluations following failure than incremental theorists and these negative self-evaluations are predicted to undermine subsequent performance and lead to spiraling. The data from this study are consistent with the ITA arguments, and further studies are underway to establish the reproducibility of these findings. The results of the current

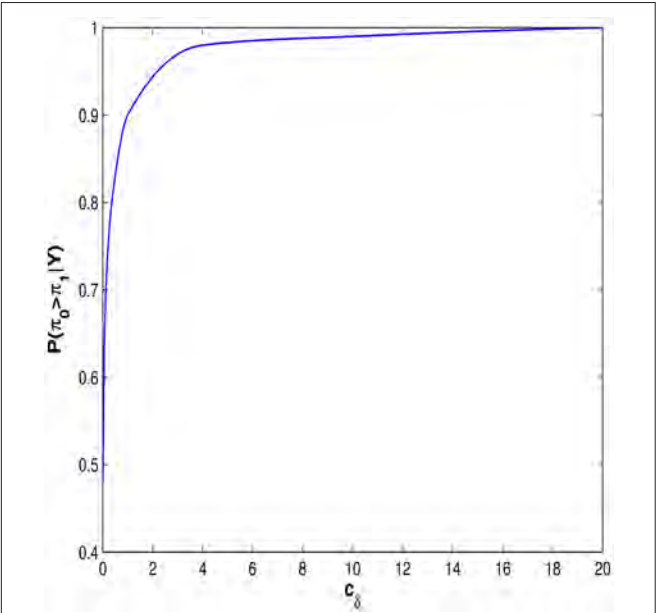


FIGURE 6 | The posterior probability that an individual classified as an entity theorist is more likely to spiral than an individual classified as an incremental theorist, as a function of the variance of the prior on δ .

study showed that those identified as entity theorists on a prior independent assessment were more likely on average to exhibit spiraling following an initial failure than those identified as incremental theorists.

We estimated the between-person effect based on the observed within-person response patterns using a bottom up, i.e., individual to group approach, rather than using group-level aggregate statistics to infer the existence of specific response patterns at the level of the individual (top down) as typically done. We also followed recent recommendations to investigate psychological phenomena as a function of time (see Roe, 2008). This enabled us to show not all individuals exhibited the outcomes predicted based on their categorization as either an entity theorist or an incremental theorist, and the onset of the spiraling behavior varied for individuals. These details, which are important for understanding the dynamics and potential limits of the theory are lost in the aggregate statistics of group level analyses. In order to capture these details, we need to model behavior at the individual level, and allow the timing of the commencement of spiraling to vary with individuals.

Approximately two-thirds of the participants classified as entity theorists exhibited spiraling behavior, while the remaining third did not. This is not an uncommon outcome for predictions based on personal characteristics, which are probabilistic and not deterministic. All assessments of the outcomes related to personality characteristics such as ITA have variability and counter indicative results that need to be explained. A further benefit of the Bayesian analyses is that it enables us to identify which of the specific participants categorized as entity theorists did not spiral. Additional knowledge of those individuals and their performance histories can then be explored to see if their

deviation from the prediction of the theory are due to problems in the arguments of the theory, boundary conditions of the theory or the fact that they, for whatever reason, did not experience failure during the 12 trials of the simulations. For example, some entity theorists may not have encountered the task conditions that produce failure or they may have discovered effective strategies in the early stages of their task experience. Without the experience of failure, an entity theorist does not experience the self-doubt that can undermine their subsequent performance and may behave like an incremental theorist. Without much larger samples, current frequentist methods cannot identify the performance responses of individuals to specific events. As a result, researchers who use those methods often ignore the variability in predicted outcomes or attribute it to error. Explanations, when offered, are at the group level and refer to characteristics of the sample, the task or the context.

The fact that Bayesian techniques provide individual estimates of the probability of spiraling also has practical implications. For example, if a teacher or counselor was to provide advice to a student identified as an entity theorist, that advice would almost certainly be different for a student with a 0.95 probability of spiraling following failure in an exam than one whose probability of spiraling is found to equal to 0.51. As noted earlier, the hypothesis selection approach of frequentist statistics would label both as spirallers. The capability of social and personality psychologists to provide more nuanced, individual level analyses of individuals who vary from the mean in their assigned personality category will benefit the clinicians and practitioners who use those categories in their assessments of individuals and resulting interventions. The replication and generalization of the results in further studies will, hopefully, lead to the development of robust priors, this means *a priori* reflections regarding expected effects of tasks, performance profiles and personality constructs. Also, our results might bring spiraling as a general class of response patterns into a more process-orientated focus of attention for different psychological theories that specify differential reactions to success and failure. Another benefit of a Bayesian approach is that it allows updating of estimated probabilities as new evidence comes to hand (rather than abandon old findings and subscribing to new ones, which often is perceived by practitioners as disorientating).

Finally, we turn to the functionality of Bayesian methods for psychologists interested in the study of within-person processes at the individual level. Given the advantages outlined, we might ask why aren't more social and personality psychologists Bayesian? For established scholars whose careers have been built on the understanding and use of frequentist methods, operationalized through standardized statistical packages such as SPSS, AMOS, and Minitab, the use of Bayesian methods will present some challenges. Converting the formal mathematical model of the theory into a statistical model requires the use of a range of sampling scheme techniques, such as MCMC, Importance Sampling (IS), and Sequential Monte Carlo (SMC), to efficiently explore the entire model space. The application of these schemes is a non-trivial task and one that often requires mathematical and programming expertise (Browne and Draper, 2006). The flexibility of Bayesian methods to tailor models to

answer specific problems, which is one of its strengths, makes the development of off-the-shelf standardized methods problematic. For some researchers who have not had any training in Bayesian statistics these hurdles may seem insurmountable, but not for others. Over many decades, psychology scholars have introduced increasingly sophisticated statistical methods, ranging from factor analyses to growth curve modeling. Depending upon the timing of one's career, scholars have learnt new methods either during their PhD studies or on the job. Over time the introduction of Bayesian statistics training in social sciences will, hopefully, produce a growing body of psychologists who are adept in the flexible application of Bayesian methods and there is evidence that this is a current trend (Andrews and Baguley, 2013).

Of course, not all psychologists interested in the study of dynamic individual level processes need to become experts in Bayesian techniques. Our experience in this research is that collaboration between psychologists and Bayesian statisticians can benefit both disciplines (O'Hagan et al., 2006). Scholars who develop Bayesian methods benefit because often the application of current methods to real problems leads to the development of new methods. Psychologists benefit by being able to construct formal models of their theory and to employ flexible statistical models that provide more direct individual level tests of their theory than less flexible frequentist models. In the current collaboration, the interaction with the Bayesian scholars required clear specification of the arguments and assumptions of the within-person processes in ITA theory and how they would be manifest in an observed pattern of performance over multiple trials, which were then incorporated into the formal model. The specification of the formal model led to greater clarity in the specification of the arguments for the ITA theory and the use of highly flexible Bayesian methods enabled the testing of the specified processes at the level of individuals.

Bayesian techniques have the advantage of being more adaptable for specific scientific questions than frequentist techniques. Programs such as R and Winbugs do provide pre-programmed software for some of the standard Bayesian methods used in the analyses of mixture models. However, programmed off-the-shelf software is not yet available for the Bayesian techniques used in the analyses of the complex mixture models required to address specific questions such as those addressed in this manuscript. However, the manuscript provides an explicit description of the MCMC scheme and Matlab code and data can be provided by the authors upon request. The spiraling model may well be one of a general class of models for different psychological theories that specify differential reactions to success and failure, as many social cognitive theories do. For similar, but not identical, applications we argue the collaboration between statisticians and psychologists is necessary to surmount these challenges.

AUTHOR CONTRIBUTIONS

EC, JL, SC: contributed the development of the Bayesian methods, the data modeling and statistical analyses. RW, NB, JB:

contributed the psychological conceptualization and theorizing, as well as study design and implementation.

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SUPPLEMENTARY MATERIAL

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Situation Change: Stability and Change of Situation Variables between and within Persons

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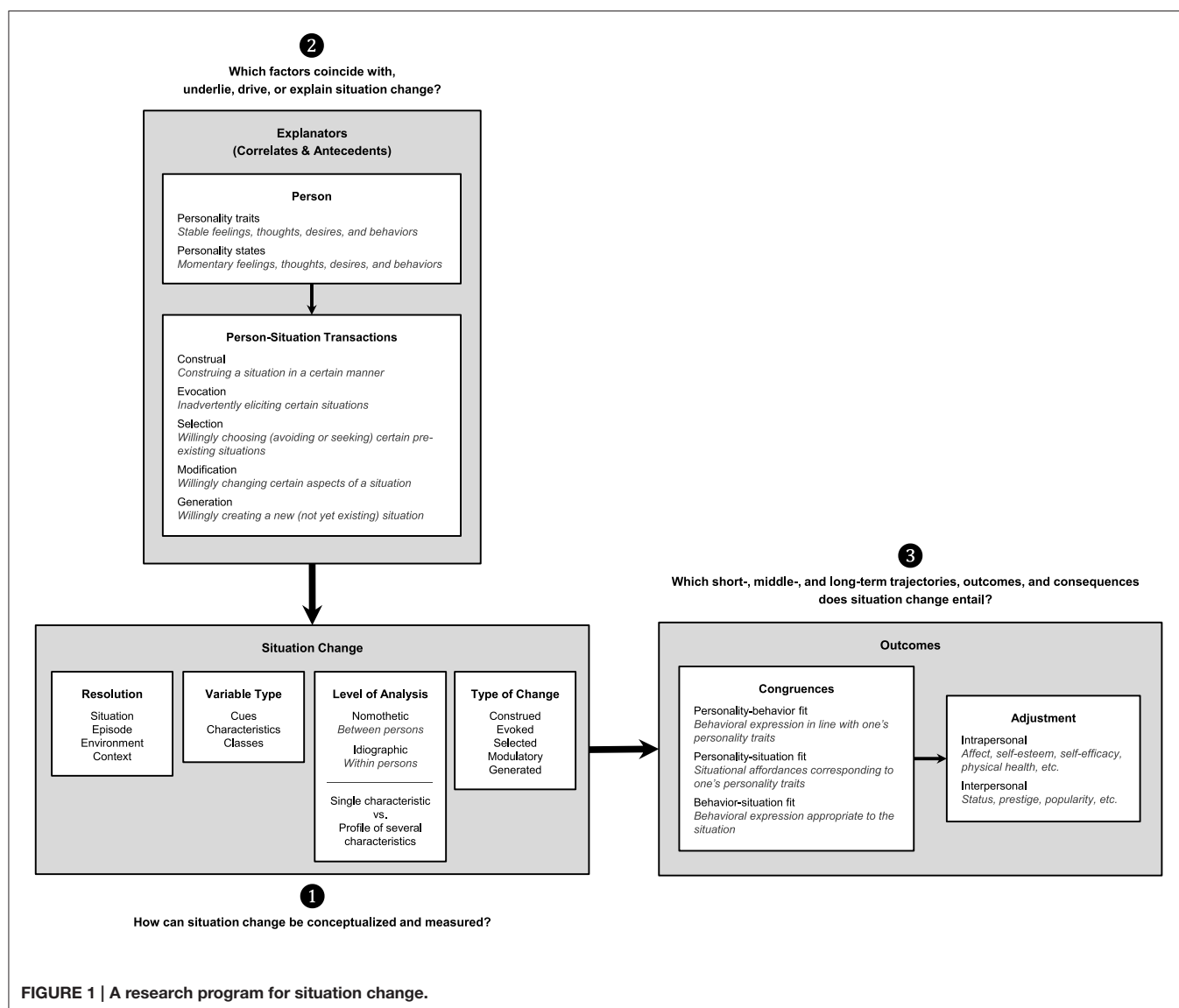
When, how, and why situations flow into one another is important for understanding dynamic personality processes, but the topic of situation change has traditionally been a thorny issue in personality/social psychology. We explore conceptual and methodological issues in research on situation change: (1) What is situation change, which variables could we measure, and how can situation change be methodologically captured and analyzed (at between- and within-person levels)? (2) Which person-situation transaction mechanisms (situation management strategies) could entail stability and change of situations in daily life? (3) How do single or repeated instances of situation change impact short-, middle-, and long-term outcomes (e.g., intra- and interpersonal adjustment)? Besides laying out a research program for situation change, we present preliminary data from participants who wore mini-video cameras recording their situations so that they could be rated later in the lab. We demonstrate rater consensus on when situations change, mean-level changes of situation characteristics across situations, similarity of situation characteristics across adjacent situations, and inter-individual differences in intra-individual situation change in change networks.

Keywords: situations, situation change, person-situation transactions, situation management strategies, Situational Eight DIAMONDS, individual differences

SITUATION CHANGE

When, how, and why does one situation end and another other begin? Studying *situation change* has been a thorny issue in psychology for several reasons. Research on situations in general has faced recurring problems, such as the conceptualization, taxonomization, and measurement of situational information (Hogan, 2009). The lack of a clear and consensual understanding of what situations are and how they can be described and measured obviously makes the study of situation change practically impossible. Thus, the topic of situation change—as the stability vs. variability of situations or how situations flow into each other—has received relatively little attention so far although its importance has been already understood (e.g., Argyle et al., 1981; Magnusson, 1981c). Recently, however, situation research has begun to receive renewed interest and increasing attention (Reis, 2008), resulting in several advances that may be useful when studying situation change (e.g., Rauthmann et al., 2015a,b). As such, this article seeks to lay the foundation for such research by addressing three major questions (along with specific sub-questions; see **Figure 1**):

- (1) Conceptualization and Measurement:
What is situation change? How can it be captured and studied?
- (2) Correlates and Antecedents:
Which variables explain (= coincide with or predict) situation change?



- (3) Trajectories and Outcomes:
How does situation change unfold? Which variables does situation change predict?

THE IMPORTANCE OF (STUDYING) SITUATION CHANGE

Before we address the three major issues outlined above, we summarize reasons why it is important to study situation change in the first place. First, most of psychology (save developmental psychology) is focused rather on static structures. As such, much of situation research is devoted to understanding “the situation” or certain (experimentally manipulated) stimuli. In such research, situational variables are static in the sense that they do not or cannot change. However, real life is lived in a flowing stream of situations that are ever changing. If it is

our goal to understand the everyday lives of people, we must develop theories and methods to study dynamic aspects of situations. Elaborations on situation change should serve to fill this lacuna. Second, while it is important to acknowledge that situations change at all, it will be good to know *how* (i.e., in which ways) they change. The types of situation change may tell us something about the people in those changed or changing situations. If it is our goal to predict behavior (not just central tendencies such as the mean, but also other parameters of entire density distributions of personality expressions; see Fleeson and Gallagher, 2009), we should also take into account in which ways the situations change. For example, some situations may change suddenly and abruptly, while others may drag along and change gradually. In such cases, different behavioral processes will undoubtedly be involved. Third, understanding *why* situations change will elucidate person-situation transactions, or more specifically, “person-to-situation” transactions. Personality and

situation characteristics are correlated (Ickes et al., 1997; Rauthmann et al., 2015c), and these correlations may emerge because of what people “do” to their situations (and also what these situations, cumulatively over time, do to them). How people navigate and “manage” their daily situations should, to a great deal, determine further information processing, behavior, and other outcomes (e.g., health). For example, in the corresponsive principle of personality development (Roberts and Wood, 2006), it is posited that people seek out situations that “fit” their personalities, while those sought after situations, in turn, deepen and consolidate the personalities that have led to seeking them out. Such person-situation transactions in personality development could benefit from better understanding situation change.

CONCEPTUALIZING AND MEASURING SITUATION CHANGE

The measurement of situation change hinges upon how it is defined. Generally, three broad questions need to be answered:

- (1) Resolution: *At what level of abstraction are “situational variables” located?*
- (2) Variable Type: *Which types of “situational variables” are used?*
- (3) Analytic Level: *Are analyses conducted nomothetically (between-person level) or idiographically (within-person level)?*

Resolution

Rauthmann et al. (2015b) clarified that there are different phenomena that have been referred to as “the situation” in extant theory and research: situation, episode, environment, and context. These terms are hierarchically nested within each other. Several situations (e.g., being greeted by friends, getting something to drink, listening to loud music, a vivid conversation, etc.) can be linked together so that they form an ongoing episode (e.g., a party episode with many different situations in it). Situations and episodes are embedded into the environment of a person (i.e., one’s habitual socio-ecological surroundings) which itself is, in turn, couched into a larger context (e.g., history, epoch, zeitgeist, socio-culture). This work is concerned with situations as momentary and fleeting phenomena that dynamically flow into each other. It is the flow, or the segmentation of this flow, that is so daunting to situation change research. In examining stability and change of situations, we inevitably will also touch upon episodes which are at a lower resolution because they are more abstract (and could potentially subsume several situations that have changed yet are still sufficiently similar to group together). Though the change of one’s environment (and context) is also an interesting topic, this presupposes that we have knowledge on situation change because environments are, to a great part, a function of recurring, typical, or “crystallized” situations and episodes of a person (Rauthmann et al., 2015b).

Variable Type

Objective vs. Subjective Demarcations

Demarcations of situations can be generally viewed from a more objective or more subjective perspective (Fiske, 1977;

Raush, 1977; Craik, 1981; Magnusson, 1981a,b,c). The objective perspective stresses either (a) physically existent or “objectively” quantifiable information in the environment (stimuli) or (b) consensually agreed upon “quasi-objective” facts, while the subjective perspective, in contrast, experiences or perceptions of people (that need not be shared with others, but can be idiosyncratic; see Rauthmann, 2012 and Rauthmann et al., 2015a,b for details).

This basic distinction is important to the question of situation change. For example, the episode “going home from the gym” includes (at least) three spatially distinct environments: gym, way home, at home. This could imply three physically demarcated situations, yet the psychological situation of the walking individual may not have changed within these three environmental settings (Stebbins, 1969) as he/she might have been thinking all the walking time about what to cook later (and would thus classify the entire situation episode as “planning what to do”). So: Has the “situation” changed or not? In objective terms it has (because of the variation in the physical world), but in subjective terms it has not (because of no variation in the cognitively represented world). However, there are also examples, where a change in space results in a change in the (perceived) situation as different rules and roles become salient and predominant. Suppose the individual from before comes home, greets his/her spouse (room: hallway; role: spouse), goes on to play with the kids (room: children’s room; role: parent), then cooks dinner (room: kitchen; role: chef), eats with family (room: dining room; roles: spouse + parent), and after that works on a project for the meeting the next day before going to bed (room: home office; role: worker). In this example, the different rooms are associated with different roles which are, in turn, associated with different generative behavioral rules (Argyle et al., 1981). Thus, situations may be demarcated in physical and psychological terms as each room comes attached with different meanings, roles, and rules. Taken together, there may be discontinuities in the physical and psychological situations with various transitions to different situational structures (Magnusson, 1981a,b,c).

Situational Information

Generally, there are three types of situational information (Rauthmann, 2015; Rauthmann et al., 2015c): cues, characteristics, and classes. *Cues* (e.g., amount of people, number of books, lighting, noise, etc.) circumscribe distal stimuli in the physical environment that are objectively measurable. They have been mainly used for experimental social-psychological research and often comprise PEARLS (Noftle and Gust, 2015): *persons* (any other persons around someone), *events* (anything happening around someone), *activities* (what people are doing), *roles* (the formal and social roles that people inhabit), *location* (the space and time in which a situation is couched), and *states* (people’s ambient thoughts, feelings, and desires). Note here that particularly roles and states pertain more to aspects of or within a person that accompany a situation, and do not necessarily belong to or define it (Rauthmann et al., 2015a).

Characteristics (e.g., intellectual, adverse, terrifying, etc.) describe meanings and interpretations that people form about single or multiple cues once they have explicitly and/or

implicitly processed them. They can be used to describe situations similar to how people are described with personality dimensions (de Raad, 2004; Edwards and Templeton, 2005). Recently, Rauthmann et al. (2014) proposed to taxonomize situation characteristics into the Situational Eight DIAMONDS Model, containing *Duty* (Does work need to be done?), *Intellect* (Is deep cognitive information processing relevant?), *Adversity* (Is someone under threat?), *Mating* (Is the situation erotically charged?), *pOsitivity* (Is the situation enjoyable?), *Negativity* (Could the situation turn negative?), *Deception* (Is mistrust an issue?), and *Sociality* (Is meaningful social interaction and relationship building possible?). This taxonomy integrates most dimensions from previous situation literature (see Rauthmann, 2015 for a review) and also includes some that have not been routinely found (i.e., *Intellect*, *Deception*). Additionally, it has already spawned well-validated assessment tools (32-item measure: Rauthmann et al., 2014; 24-item measure: Rauthmann and Sherman, 2015a; 8-item ultra-short measure: Rauthmann and Sherman, 2015b). Further, the DIAMONDS model has proven useful in substantive empirical research, including (a) predicting personality expressions in an experience sampling study (Sherman et al., 2015), (b) understanding the temporal contiguities among and between personality states and situation characteristics (Rauthmann et al., in revision), (c) predicting contact and construal of situations by personality traits (Rauthmann et al., 2015c), and (d) tracking people's situations on Twitter (Serfass and Sherman, 2015). Further, Rauthmann (in press) has demonstrated how the DIAMONDS dimensions essentially capture evolutionarily important motivational processes and content. Taken together, the DIAMONDS dimensions offer a broad and useful taxonomy of the psychological characteristics of situations. As such, we will make use of this taxonomy in our empirical part later.

Classes (e.g., work situations, interpersonal situations, etc.) denote types or groups of entire situations with similar cue constellations (e.g., all situations with people in them may be "interpersonal situations") or similar levels or profiles of situation characteristics (e.g., all situations which score highly on *pOsitivity* and *Sociality* may denote "pleasant social interaction situations"). The most prominent and inclusive taxonomy comes from van Heck (1984, 1989) who identified 10 situation classes: interpersonal conflict, joint working and information exchange, intimacy and interpersonal relations, recreation, traveling, rituals, sport, excesses, serving, and trading.

As **Figure 2** summarizes, situation change may be studied according to whether (or to what extent), when, how, and why cues, characteristics, and/or classes change. Ideally, situation change would be tackled for cues, characteristics, and classes simultaneously in one design, but theory, preferences of researchers, and/or design restrictions (e.g., participant burden, financial costs, etc.) may limit the ways in which situation change is studied. Thus, we present here briefly different ways of examining situation change.

Change of Cues

The first row of **Figure 2** concerns the change of situation cues. One could think of this in a nomothetic sense (i.e., the

data are averaged across many participants in a study and thus capture processes at the between-persons level) or in an idiographic sense (i.e., the data come from one participant only and thus capture within-person processes). Though cues could, in principle, also be reported by participants (e.g., by asking them which cues they noticed in their situation; see Sherman et al., 2010 for this methodology), this approach hinges upon several assumptions. First, it assumes that people can actually report objective cues. In reality though, we suspect that people are more likely to report some interpretation of cues or even characteristics. Second, this approach assumes that cues are only important if they are consciously noticed and reported. However, cues may also work outside of consciousness (i.e., be implicitly processed) and generate behavioral consequences. As such, if cues should be in the focus, then we would advise measuring them as directly as possible (not via participants)¹. One potentially fruitful avenue for this approach lies in the use of convolutional neural networks to detect and extract cues from streams of photographs. Changes in photostreams can be used as one indicator of situation change (Bolaños et al., 2015).

For objective cues, **Figure 2** shows the proceedings of 4 cues (Cues 1–4) through 4 time points (t_n to t_{n+3}). As can be seen, there are 3 cues (Cues 1–3) available at t_n , 4 cues (Cues 1–4) at t_{n+1} and t_{n+2} , and 2 cues (Cues 2 and 3) at t_{n+3} . If objective cues of situations are the benchmark criterion, then any change in objective cues denotes situation change. In Row 1, situation change then occurs from t_n to t_{n+1} and from t_{n+2} to t_{n+3} , while the situation remains stable from t_{n+1} to t_{n+2} . Attending to the objective cues of situations allows a micro-perspective on the situation(s) studied (depending on how many cues are sampled, of course) because researchers can distinguish cues that are constantly present (Cues 2 and 3), are available only for a limited time (Cue 1), or briefly appear and disappear (Cue 4). For simplicity, we assumed in **Figure 2** that cues are either present or not, thus limiting situation change to the quantity and types of cues available. However, it is also possible that (a) two or more cues "interact" with each other or form a cue conglomerate (many cues are grouped together) and/or (b) a cue changes into a different cue (i.e., change in nature). Thus, in addition to quantity, also the quality of cue changes should be examined. Studying situation change in terms of the change of objective cues in quantity and quality represents an *environment-driven approach*, and researchers must effectively strive to "catalog" the (natural or standardized laboratory) environments their participants are in. The catalog should be either exhaustive (i.e., striving to measure all quantifiable environmental information) or theory-driven (i.e., only specific cues are assessed, tailored to a specific theory or model), but not be purely *ad-hoc* (except for exploratory purposes).

¹It may be an interesting task to catalog objective cues in a situation and contrast these with the cues participants noticed and reported. Of course, participants cannot process all cues and will not find all of them relevant (or recall them). Thus, the selection of cues that participants nominate are likely the most important and salient ones to them (e.g., a book), and these may be tied strongly to perceived situation characteristics (e.g., intellectual).

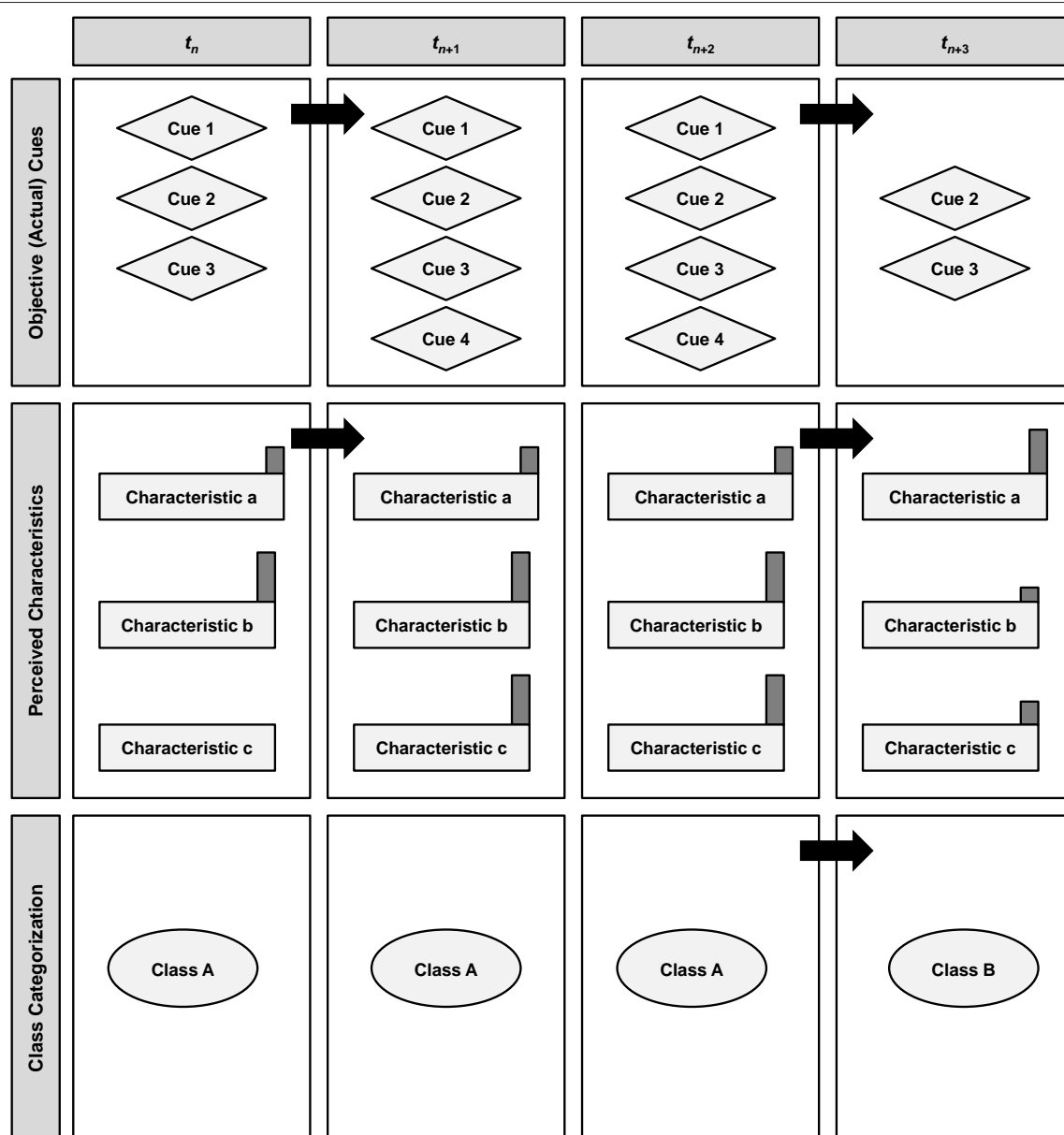


FIGURE 2 | Change of different situation variables. Thick black arrows denote a change.

Change of Characteristics

If researchers want to emphasize more phenomenological aspects of situations, then they can focus on whether and to what extent the *psychologically important* characteristics of situations change. Row 2 of **Figure 2** concerns the change of situation characteristics (Characteristics a-c). Again, such change may be examined at the within-person or the between-person level, though **Figure 2** illustrates characteristics change within one individual only. As can be seen, all three situation characteristics (a, b, and c) exist in some quantity in each situation; however, the salience, importance, or relevance of each characteristic can vary at each time point. This is illustrated in **Figure 2** with gray bars on top

of each characteristic: the higher the bar, the more defining the characteristic is of the situation at a given time point. Thus, if psychological characteristics of situations are the benchmark criterion, then any change in the salience or the importance of situation characteristics (which are used to describe a situation) denotes situation change. As can be seen in **Figure 2**, the gray bars of Characteristics a, b, and c are identical at t_{n+1} and t_{n+2} , indicating that the individual perceived those situations as psychologically identical. At t_{n+3} , however, the importance of the three characteristics shifts, such that Characteristic a now gains relatively more weight than Characteristics b and c. Thus, situation change in terms of the change of psychological

characteristics would have occurred from t_n to t_{n+1} and from t_{n+2} to t_{n+3} .

The segmentation of situations according to their psychological characteristics presents a more molar approach as opposed to the molecular approach taken when examining cue changes. As such, this approach will not be as measurement-heavy as with cues, but it does require input from at least the participant(s) in the situation. This may make some researchers uncomfortable because situation characteristics now are essentially people's perceptions only (which is no problem with perceived cues because they have a real-life counterpart cue that can be physically measured). As such, a situation variable is essentially a person variable (a perception). However, Rauthmann et al. (2015a) showed that this problem can be tackled by employing multiple perceivers (or sources of ratings) when characteristics are to be rated (for empirical applications, see Sherman et al., 2010, 2012, 2013; Rauthmann et al., 2015c). In their terminology, participants physically in the situation and affected by it are termed "raters *in situ*;" bystanders or confederates in the situation but not acting or personally detached from it "raters *juxta situm*;" and laboratory assistants not in the situation and detached from it "raters *ex situ*." Obtaining ratings from other sources than raters *in situ* grants the opportunity to derive scores shared between raters *in situ* and raters *juxta situm* and/or *ex situ* (= consensual aspects of the situation) and not shared between different raters (= idiosyncratic aspects of the situation) (see Rauthmann et al., 2015c).

Change of Classes

At a considerably high level of abstraction, researchers may be interested whether or to what extent the class of a situation changes (not just its single cues or some set of characteristics). Situation classes can be derived in two ways. First, situation class membership can be assessed directly by asking raters *in situ*, *juxta situm*, and/or *ex situ* (including the researchers) to categorize the situation into a certain group or type of situations. Second, situation class membership can be assessed indirectly by grouping situations with similar (a) cues (or cue constellations) or (b) levels or profiles of situation characteristics (measured by ratings *in situ*, *juxta situm*, and/or *ex situ*) together. Regardless of which of these methods is used, the result is an abstract, nominal categorization of a situation to a certain class (e.g., a threat situation, a work situation, etc.). If class memberships of situations are the benchmark criterion, then any change in class membership denotes situation change. As with cues and characteristics, such class membership change may be studied between and within persons.

Row 3 of **Figure 2** depicts changes in class membership. As can be seen, the situations at t_n to t_{n+2} belong to Class A, while the situation at t_{n+3} belongs to Class B². Thus, situation change occurs from t_{n+2} to t_{n+3} . (Note that this also corresponds to how cues and characteristics change as, on average, the cues and characteristic levels are at t_n to t_{n+2} more similar to each other

than to those at t_{n+3} where the situation seems to have changed markedly).

Analytical Level

As alluded to in the previous explanations of **Figure 2**, situation change may be examined nomothetically or idiographically. *Nomothetic analyses* concern estimates of situation change across individuals (usually for situations that are similar for the population of participants studied), allowing to examine inter-individual differences in between-person analyses. For example, interesting between-person questions are: Do some people experience more situation change than others? Are inter-individual differences in the level of neuroticism related to perceiving more frequent situation changes?

Idiographic analyses, on the other hand, concern the stability or variability of situations (cues, characteristics, classes) within individuals, allowing to examine intra-individual differences in within-person analyses. For example, interesting within-person questions are: How often does Alex experience adverse situations? Do such adverse situations lead to more Adversity down the road or are those situations only single (but intense) instances? Do they occur with certain regularity? Do they change into other situations (e.g., they start as adverse, but usually end pleasant)?

Ideally, situation change studies would cater to both between- and within-person questions as nomothetic and idiographic perspectives and analyses, respectively, are not irreconcilable opposites, but can be combined. For example, experience sampling or ambulatory assessment methodology (Shiffman et al., 2008), where participants report upon their current situation and mental states several times a day for several days (prompted by their smartphones or PDAs), grants the opportunity to examine real-time person-situation transactions at both a between- and within-person level (see Fleeson, 2007; Sherman et al., 2015). We believe that particularly this methodology will be quite useful in exploring and understanding situation change at different data-analytical levels.

Analysis of Change Data

Methodological and data-analytic advances in analyzing Intensive Repeated Measurements in Naturalistic Settings data (Moskowitz et al., 2009) will likely be the most fruitful way of studying situation change *in vivo*. Consensus about when change occurs can be examined qualitatively via subjective impressions of change points (e.g., by asking raters *in situ* and/or *ex situ* when a situation has changed). However, a more convincing case for consensus on situation change can be made by not only examining consensus on whether a situation has changed, but also by assessing how and to what degree the situation has changed. This will be best achieved by approaches that quantify characteristics of situations. As such, situation change can also be quantitatively assessed by determining to what extent (*in situ*, *juxta situm*, or *ex situ*) ratings of the psychological characteristics of the same situation correlate higher with each other than ratings of the psychological characteristics of different, but temporally adjacent, situations. Quantity of situation change, for each individual, can be measured at the level of a single

²In principle, a situation could also belong to (two or more classes). However, for simplicity sake and illustrative purposes, our example assumes that a situation can only belong to one class at a time.

situation characteristic or at the level of profiles. To measure the former, one could compute the within-person standard deviation (SD) of each DIAMONDS situation characteristic (rated either *in situ*, *juxta situm*, or *ex situ*) across time (see Fleeson, 2001, 2007 who quantified variability in personality expressions and situation characteristics across time like this). To measure the latter, one could correlate the DIAMONDS profile scores for one situation with the DIAMONDS profile scores for another (or all other) situation(s). Such profile correlations reflect “situational similarity” (Sherman et al., 2010); low(er) profile correlations would reflect strong(er) differences in situations across time. We can then attempt to explain both of these measures of average situation change via correlation/regression with personality or changes in momentary states (Question 2). Lastly, average situation change can be used as a predictor of outcomes such as momentary personality, affect, or self-esteem (Question 3). Beyond these rather simple analyses, situation change can also be modeled using more advanced techniques. For example, differential equation modeling (Deboeck, 2011) can be used to identify within-person, non-linear patterns of situation change (e.g., oscillation) over time, and the nested nature of the data (situations within participants) will require, for some questions, multilevel models (Nezlek, 2012) or autoregressive models (Eid et al., 2012).

Empirical Examples

Below, we present some findings from preliminary data where we demonstrate different data-analytical procedures of studying situation change. First, we quantify situation change as the consensus between different raters on when a situation has changed. Second, we zoom in on situation change by examining how much characteristics change. We perform these two analyses for one individual only to demonstrate an idiographic approach. After that, we perform different analyses on a data set with $N = 60$ participants to demonstrate a nomothetic approach. First, we examine mean-level change of situation characteristics

for two persons only (to demonstrate individual differences). Second, we quantify change at the level of single situation characteristics (within-person SDs) and characteristic profiles. Lastly, we illustrate how the relationships among situation characteristics may change across situations in dynamic network analyses. All data were gathered in accordance with the United States Department of Health and Human Services code of federal regulations title 45, part 46 (45 CFR 46) and approved by the Florida Atlantic University Institutional Review Board. All subjects gave written informed consent in accordance with the Belmont Report.

Data Set #1: Agreement on Situation Change

Determining the existence of psychological phenomena (e.g., personality) is a much more difficult task than determining the existence of physical objects (e.g., other people, a book, a cake) because psychological constructs lack concrete physical existence. However, using the time-honored practice of *consensus*, psychology has had no trouble demonstrating the real and meaningful existence of a large number of psychological constructs. We propose that the same practice can be used to determine the existence of situation change: if people reasonably agree that a situation has changed, then we can say with probabilistic certainty that it has indeed consensually changed.

In a pilot project aimed at examining this hypothesis, we had one participant wear a mini-video camera (about the size of a thumb) on his shirt from the moment he woke up for a little over an hour. We then enlisted nine research assistants to independently view the recorded video. They indicated, based on their own subjective interpretations, each time the situation the participant was in changed. The results from this task are displayed visually in **Figure 3**. As can be seen, the raters differed in their perceptions of whether or not a situation changed (e.g., Rater 3 indicated more frequent changes than Rater 9), as indicated by a change in color

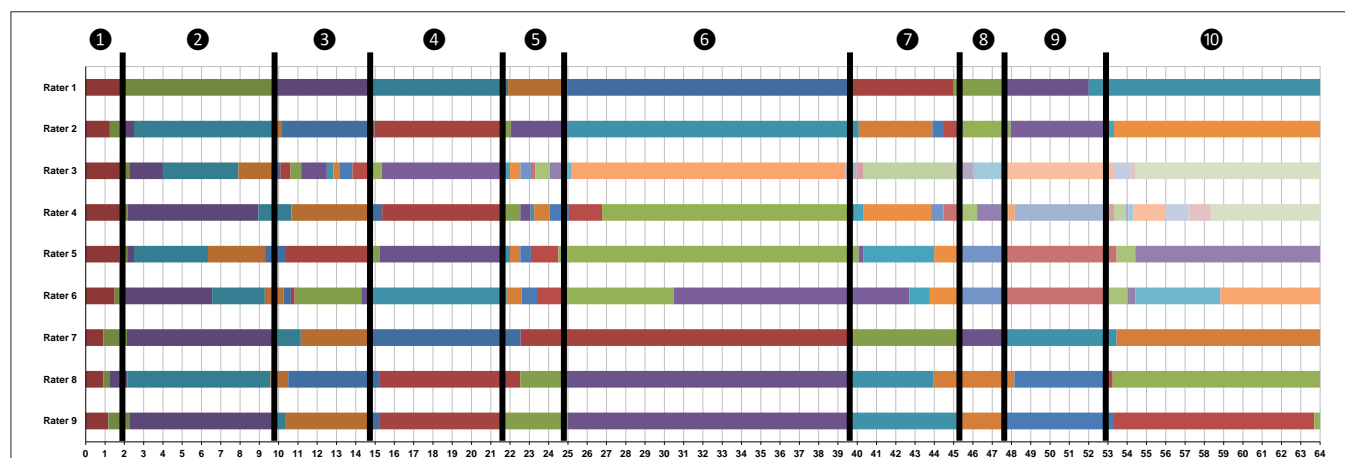


FIGURE 3 | Situation changes according to 9 independent judges (Data set #1). Change in colors from left to right represent each rater's individual change point. Black bars represent consensual change points. Time (in minutes) is depicted along the x-axis. Situation descriptions: (1) Taking dogs outside; (2) Watching dogs come back in; (3) Feeding dogs; (4) Driving to work; (5) Stop at coffee shop for coffee; (6) Continue driving; (7) Walk into office; (8) Sitting in office; (9) Walking to class; (10) In class.

in **Figure 3**. However, raters also demonstrated approximate consensus about when situation change occurred, as indicated by the vertical black bars. From these ratings, it appears that the individual wearing the mini-video was in approx. (at least) 10 different situations (or situational episodes). Thus, we suspect that situation change is indeed a real phenomenon that can be detected by others with reasonable amounts of consensus. However, this exercise only treats situation change as a binary phenomenon (a situation has either changed or not) and does not allow us to delve into the more substantive questions of why a situation has changed or which aspects have changed.

Data Set #1: Change of Characteristics

To quantify situation change with respect to a more fine-grained analysis of situation characteristics in our pilot video, we sampled two separate 30 s clips from each of the 10 different situations indicated between the black bars in **Figure 3** (i.e., 20 total clips). Two groups of research assistants ($n = 4$ in each group) then watched one of the 30 s clips from each of the 10 situations (clip order was counter-balanced) and rated the psychological characteristics of the situation shown in those clips using the RSQ-8 (32 items; Rauthmann et al., 2014). The participant's (rated) DIAMONDS characteristics are plotted in **Figure 4**. As can be seen, the participant's situations were relatively high on Duty (while Adversity and Deception were low), and Intellect gradually increased across situations (as the person approached school and eventually arrived in class).

If the black bars noted in **Figure 3** represent actual situation change, then we would expect to find that the 30 s clips from the same situation are rated as more psychologically similar than 30 s clips from different situations. This is indeed what we found. Specifically, ratings of the same situation were more

similar to each other (average $r = 0.35$) than ratings of different situations (average $r = 0.22$). Such results suggest that people are sensitive to situation change and that the RSQ-8 may be used to identify situation change concerning psychological characteristics. Of note, this result also indicates that the pilot participant's situations showed some stability across time ($r = 0.22$), which will be addressed shortly.

The ability to quantify situation change is crucial for this research because it allows us to investigate further questions such as: (1) How much situation change does a person experience across the day? (2) How consistent is change across time (e.g., hours, days)? (3) How much within- and between-person variance is there in situation change? These questions can be addressed at both the level of a single situational characteristic (e.g., How much does a person's experience of Duty change across time?) and of the situational profile (e.g., How stable/variable is profile of situation characteristics that a person experiences across time?). As noted, the answer to this last question for the pilot participant was $r = 0.22$. This finding suggests that, while there was some stability in this person's situational experience over time, there was also a great deal of variability. Such variability can be visualized, as done in **Figure 4**, which shows average coder ratings of the Situational Eight characteristics in each situation. As can be seen, there was a large amount of variability in the pilot participant's situation characteristics across time. Further, some situation characteristics showed more variability than others. Adversity (green line) was relatively low and stable across time for this participant. Intellect (red line) showed more variability and generally increased over time (which is nice to see because the 10th situation was in a college classroom). Lastly, in terms of their overall Situational Eight profiles, Situations 1 and 2 look more similar to each other than Situations 7 and 8.

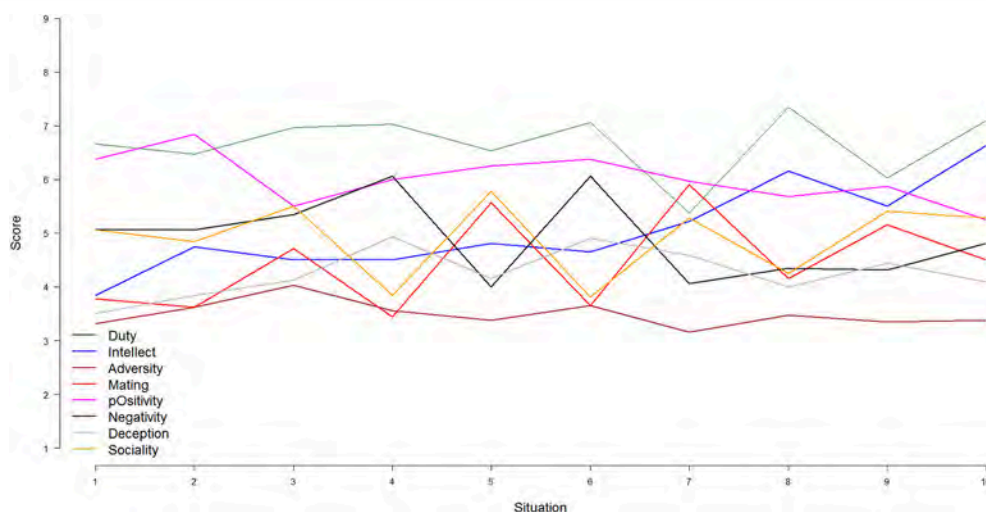


FIGURE 4 | Mean-level changes of the Situational Eight DIAMONDS over a 1 h period (10 situations) of one participant (Data set #1). Duty: green; Intellect: blue; Adversity: brown; Mating: red; pOstivity: magenta; Negativity: black; Deception: gray; Sociality: orange. Situation descriptions: (1) Taking dogs outside; (2) Watching dogs come back in; (3) Feeding dogs; (4) Driving to work; (5) Stop at coffee shop for coffee; (6) Continue driving; (7) Walk into office; (8) Sitting in office; (9) Walking to class; (10) In class.

Data Set # 2: Inter-Individual Differences in Situation Change

So far, we have demonstrated how situation change could be studied for one individual with idiographic analyses. However, many psychologists may be interested in how situations change generally or in comparing situation change between different individuals (see Dalal et al., 2015 for a review). To this end, we ran a follow-up study with $N = 60$ participants (undergraduate students) who now wore mini-video cameras for 24 h. Participants were asked to record, for approx. 30s, each new situation they encountered (this

time we allowed them to use their own definition of what constituted a new situation). These videos were later rated by 4 research assistants on the Situational Eight DIAMONDS situation characteristics with two items per dimension from the RSQ-8 (Rauthmann et al., 2014) for economic reasons. We then formed aggregate scores of the DIAMONDS for each situation (across the 4 research assistants). For illustrative purposes here, we chose two individuals with more than 10 situations sampled: For showing differences in mean-level changes, we selected Subject 29 (19 situations) and Subject 30 (10 situations).

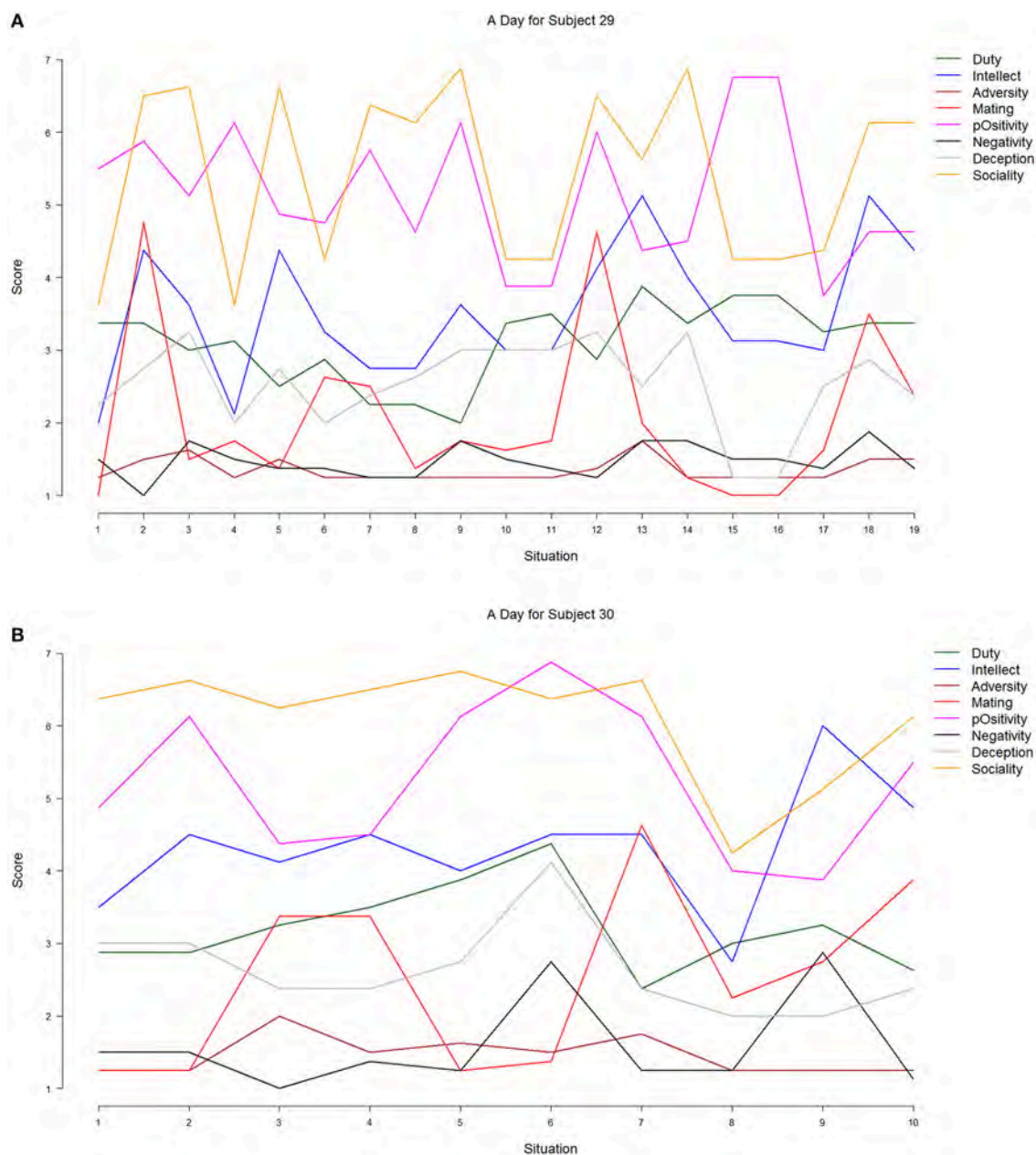


FIGURE 5 | Mean-level changes of the Situational Eight DIAMONDS for two participants (Data set #2). Duty: green; Intellect: blue; Adversity: brown; Mating: red; pOstivity: magenta; Negativity: black; Deception: gray; Sociality: orange. **(A)** Subject 29, **(B)** Subject 30.

We simply plotted the DIAMONDS composite scores across the respective situations from Subjects 29 and 30 (see **Figure 5**) to get a picture of inter-individual differences in mean-level changes (as in **Figure 4**). As can be seen, there were commonalities and differences between both participants. As for the commonalities, the situations of both participants could be characterized, on average, as more social and positive than deceptive, adverse, and negative. This is consistent with other research finding that the typical situation, even across different countries, is mildly positive and social (Guillaume et al., 2015). However, there were also differences between both participants. Subject 29's situations seem to change more strongly than Subject's 30s; they showed more mean-level changes across different situation segments. This may be a first hint at inter-individual differences in the *degree* of situation change.

Data Set # 2: Single- and Profile-Level Analyses

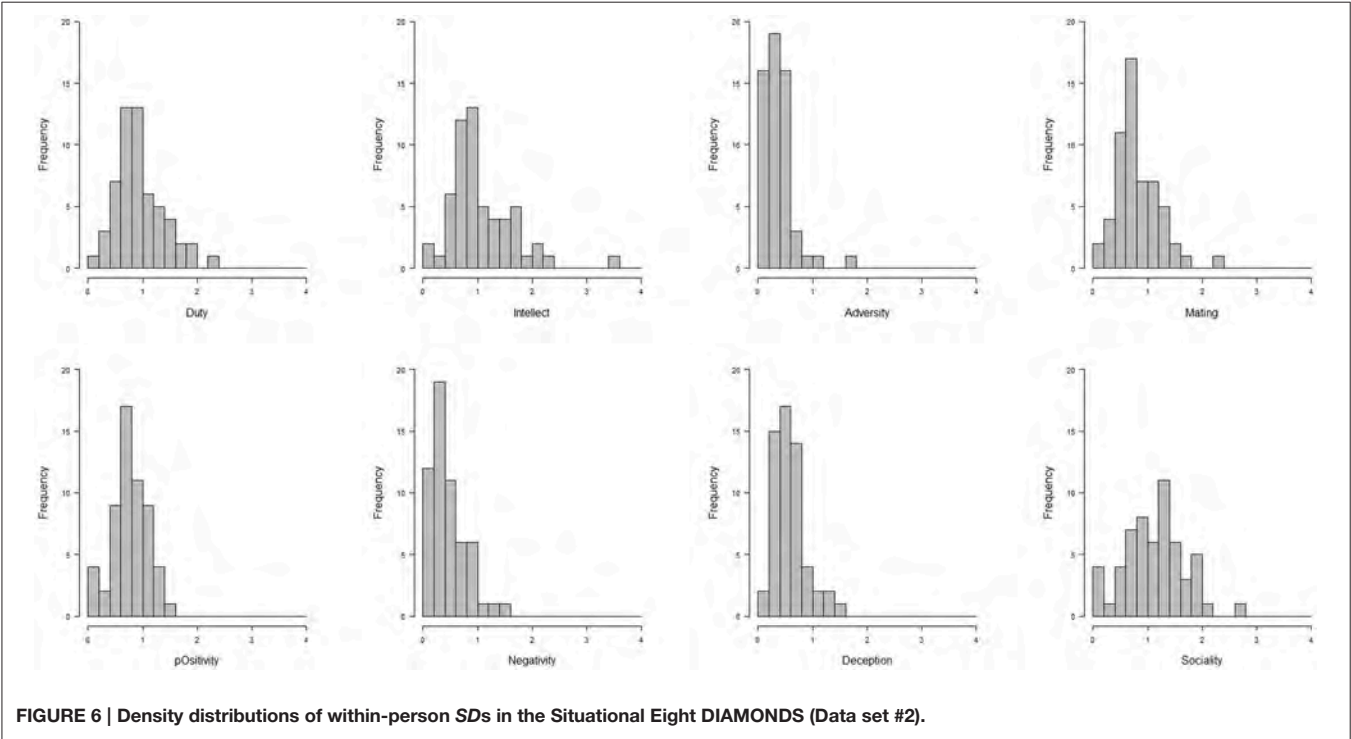
Situation change in terms of variations in situation characteristics can be analyzed for each single characteristic or for a profile of characteristics. At the single characteristics level, the within-person *SD* (across all situations) indexes the amount of change. As can be seen in **Table 1**, Sociality and Intellect showed, on average, the most variation, while Adversity and Negativity the least. **Figure 6** additionally shows the density distributions of within-person *SD*s for all DIAMONDS. As can be seen, there are sizeable individual differences in Duty, Intellect, and Sociality, while there are less in the other characteristics dimensions. This inter-individual variation could, at some point, be explained by other individual difference variables, such as self- or peer-reported personality of participants.

At the profile level, the correlation between a profile of characteristics in one situation and the profile in the next

TABLE 1 | Descriptive statistics of within-person SD of situation experiences.

Dimension	<i>n</i>	<i>M</i>	<i>SD</i>	Median	[min to max]	Skewness	Kurtosis	<i>SE</i>
Duty	57	0.94	0.44	0.88	[0.00–2.30]	0.77	0.45	0.06
Intellect	57	1.06	0.59	0.90	[0.00–3.45]	1.28	2.90	0.08
Adversity	57	0.37	0.28	0.35	[0.00–1.65]	2.08	7.02	0.04
Mating	57	0.80	0.41	0.70	[0.09–2.30]	1.10	1.80	0.05
pOsitivity	57	0.76	0.31	0.69	[0.00–1.42]	–0.21	–0.40	0.04
Negativity	57	0.46	0.32	0.40	[0.00–1.50]	1.04	0.66	0.04
Deception	57	0.57	0.30	0.54	[0.00–1.50]	0.88	1.05	0.04
Sociality	57	1.11	0.55	1.16	[0.00–2.74]	0.14	0.20	0.07

n = 57 (from *N* = 60) because 3 people only recorded 1 situation. Within-Person *SD* = within-person standard deviation.



situation indexes situational similarity or stability (see Sherman et al., 2010). One can then compute such correlations for all pairs of situations and average the profile correlations for each person. The grand average profile similarity across all participants was 0.79 (median = 0.79, $SD = 0.44$; min = -0.06 , max = 1.00), indicating that Situational Eight DIAMONDS profiles remained, on average, relatively stable within persons. However, as **Figure 7** (histogram of average within-person profile similarities for all pairs of situations) shows, there were also relatively large individual differences in average situational similarities. This suggests that, for some people, there is more, and for others less profile stability (i.e., they show more severe changes in situational experiences). These individual differences could, again, be explained by other individual differences variables (e.g., personality) at some point.

Data Set # 2: Dynamic Networks of Situation Change

The preceding analyses are fairly static and do not readily allow inferences about temporal dynamics of the interrelations between situation characteristics. Thus, we used network analyses to examine processes of situation change. This involved several steps: For Subjects 55 and 58 (those with the largest numbers of situations sampled), we (a) within-person centered the DIAMONDS composite scores for each situation, (b) stored each of those as a matrix (with 1 row and 8 columns), (c) multiplied that matrix by its transpose to create a matrix of cross-products (treating this matrix of cross-products as a similarity matrix), and (d) repeated Step c for each consecutive pair of situations (i.e., each situation transition). We then were able to model these data with the R package “qgraph” (Epskamp et al., 2012; see also Costantini et al., 2015) as a network, consisting of the Situational Eight DIAMONDS, across the situations of the participants. In these networks, the arrows represent temporal associations from t_n to t_{n+1} (i.e., how prior pOsitivity predicts later Sociality and so on). **Figure 6** shows gif-animated networks of how the Situational Eight DIAMONDS characteristics change across situations for Subject 55 (27 situations) and 58 (23

situations). Changes are between adjacent situations only (e.g., a participant's Situation 1 to his/her Situation 2, Situation 2 to 3, and so on). Red arrows reflect negative associations and green arrows positive associations; thicker arrows mean stronger (positive or negative) associations. Note that we have modeled the change of *relationships* among and between the DIAMONDS in the network animations.

As can be seen in **Figure 8**, when only looking at transitions from Situation 1 to Situation 2, there were again commonalities and differences between the change networks of Subjects 55 and 58. For example, both participants had in common that prior Adversity predicted less later Sociality. However, there were also differences. For example, prior pOsitivity predicted more later Duty for Subject 55, while it was less for Subject 58. Indeed, Adversity was generally more “active” in Subject 58's change network: It predicted more later Duty and less later Sociality and it was predicted by less prior Sociality and pOsitivity. Because both participants were not in the same situation but in different ones, the apparent differences found here may be spurious: Both participants could actually be fairly similar, but their situations are just actually different. To account for this explanation, we also computed the average situation change networks of Subjects 55 and 58 (see **Figure 9**). As can be seen, the inter-individual differences were not as pronounced once we examined *average* change, though they did not disappear. For example, Adversity still had a more prominent role in Subject 30's network.

To get a glimpse of how strong inter-individual differences of intra-individual situation change networks were, the online Supplemental Materials contain an .avi video clip “AvgChangeForEachSubject” that depicts the average situation change networks for all participants. Note, however, that the number of situations differed substantially between participants ($M = 9.62$ different situations, $SD = 6.19$, min = 1, max = 27).

EXPLAINING SITUATION CHANGE

If situation change exists and if it can be quantified, the next important question is determining the factors that might explain, or at least be associated with, situation change: *Why* do situations change? Our pilot findings described above indicated that there was both consistency and variability of situation experiences and change across time. Though empirical literature has almost nothing to say about situation change, there is good reason to expect that stable personality dimensions will be associated with situation change. For example, experience sampling research assessing momentary affective states has shown that individuals high in Neuroticism are more likely to experience dramatic shifts in affect (Eaton and Funder, 2002). Thus, we would anticipate that individuals high in Neuroticism also experience more variability in their situations over time. Not only focusing on stable personality dimensions, we might also anticipate that changes in momentary personality expressions (Fleeson, 2001, 2007) or transient goals (e.g., what a person needs, wants, desires, or intends in a given situation) correspond with situation change. Additionally, person-situation transactions may help explain situation change.

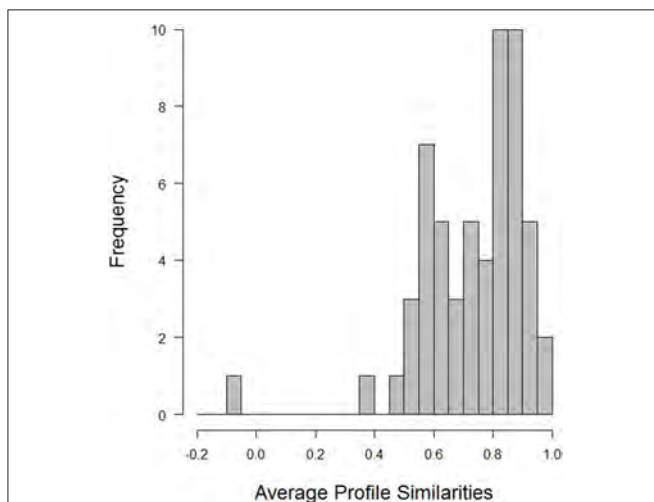


FIGURE 7 | Density distribution of average profile similarities.

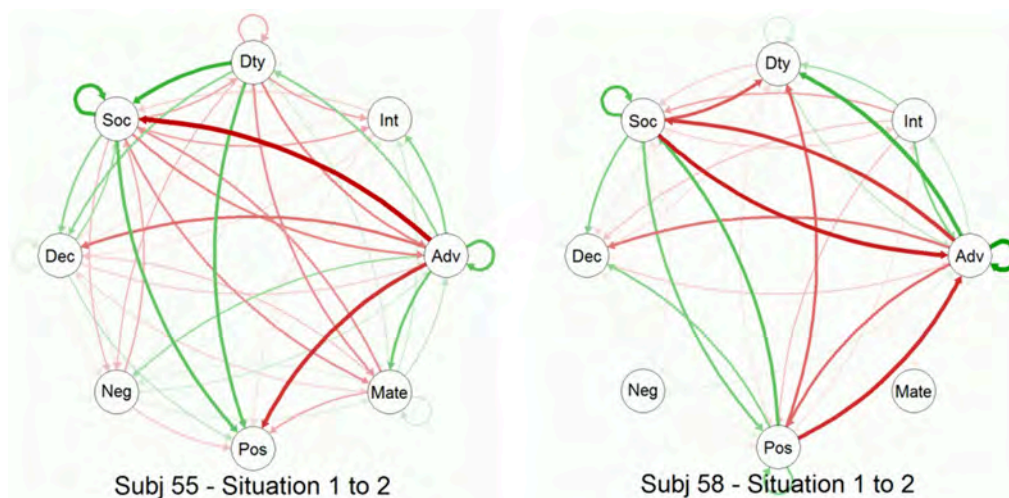


FIGURE 8 | Animated situation change networks of two participants across time. Situation change networks are animated GIFs. Red arrows: negative prediction; green arrows: positive prediction. Dty: Duty; Int: Intellect; Adv: Adversity; Mate: Mating; Pos: pOsitivity; Neg: Negativity; Dec: Deception; Soc: Sociality. The animated gif forms can be found in the Supplemental materials.

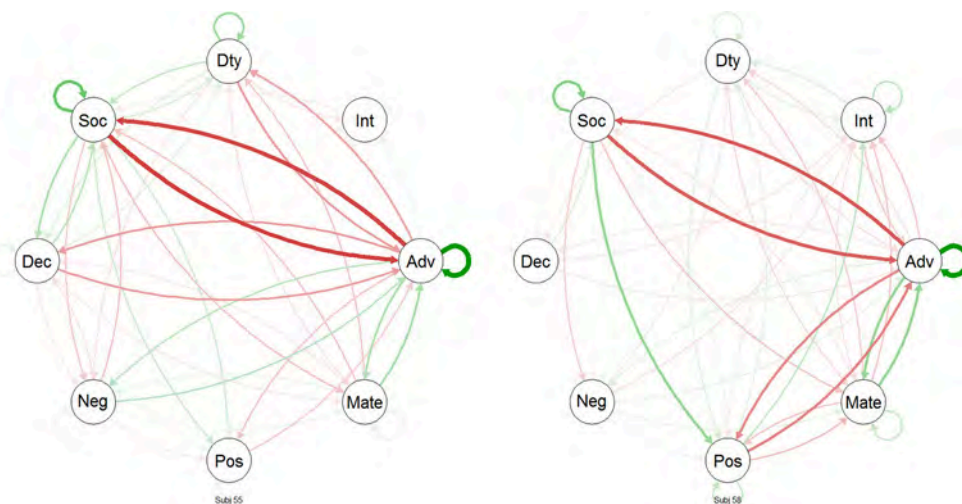


FIGURE 9 | Average situation change networks of two participants. The networks represent the averages across all situation-to-situation changes from Figure 6. Red arrows, negative prediction; green arrows, positive prediction. The.avi video clip “AvgChangeForEachSubject” in the online Supplemental Materials shows average situation change networks for all participants. Dty: Duty; Int: Intellect; Adv: Adversity; Mate: Mating; Pos: pOsitivity; Neg: Negativity; Dec: Deception; Soc: Sociality.

Person-Situation Transactions: Situation Management Strategies

Many situations seem to “simply change on their own,” but generally people can also influence their situations in different ways; they are not merely passively or randomly “exposed” to situations, but also shape and define them (Plomin et al., 1977; Buss, 1981, 1987; Scarr and McCartney, 1983; Snyder and Ickes, 1985; Ickes et al., 1997; Caspi and Roberts, 2001). **Table 1** gives an overview of six possible person-situation transactions, which we refer to as *situation management strategies*, that allow people to “manage” situations by experiencing or shaping situations

(differently than before). Situation management strategies refer to how people deal with, navigate in, and govern their daily situations and can thus explain situation change. Broadly, such management can be voluntary (\approx explicit, conscious, intentional, deliberate, effortful, systematic) or involuntary (\approx implicit, unconscious, unintentional, indeliberate, effortless, capricious). To better contrast the different strategies in **Table 2**, they are evaluated in terms of (a) intentionality of utilizing the strategy, (b) effort for the strategist, (c) control granted to the strategist, and (d) (physical) activity of the strategist while pursuing the strategy (**Table 3**).

TABLE 2 | Situation management strategies in extant literature.

Person-situation transactions: situation management strategies	Scarr and McCartney (1983): genotype → environment effects	Buss (1987): person-environment correspondence processes	Caspi and Roberts (2001): person-environment transactions
Construal	?	?	Reactive
Maintenance	(Passive)	?	?
Evocation	Evocative	Evocation	Evocative
Selection	Active	Selection	Pro-active
Modification	?	Manipulation	?
Generation	Active	Manipulation	?

Terms from the authors (in columns) were matched with the six situation management strategies. Parentheses () mean that the term may probably describe the respective strategy. Question marks (?) mean that there is probably no direct analog.

TABLE 3 | Overview of major types of important situation management strategies.

Strategy	Individual difference variables		Properties			
	Situation ...	Individual differences in the tendency to ...	Intentionality	Effort	Control	Activity
Construal	Constructor	Uniquely construe situations differently from the consensus	/	/	++	---
Maintenance	Sustainer	(Passively) remain in a situation without changing it, thereby possibly maintaining it	/	/	--	--
Evocation	Conjurer	(Unwillingly) elicit certain situations	---	---	--	/
Selection	Picker	(Willingly) select certain situations (without creating them)	+	/	++	+
Modification	Engineer	(Actively) modulate situations in a certain goal-serving way	+++	++	++	++
Generation	Creator	(Pro-actively) create situations in a certain goal-serving way	+++	+++	+++	+++

+++ : extremely strong; ++ : very strong; + : strong; / : strong to weak; - : weak; -- : very weak; --- : extremely weak. These distinctions are only approximations (by the two authors of this work) and will need to be empirically challenged with real data.

Construal

People may distinctly perceive situations differently from how other people see them. We refer to this strategy as *situation construal*, and there may be individual differences in the extent to which people are situation constructors. Construal can be intentional and effortful (e.g., during cognitive restructuring mechanisms) or unintentional and automatic (e.g., because of motives and values, but also psychopathology). Construing situations in a certain manner (e.g., trying to find the silver lining in an otherwise dire situation) may grant the situation constructor at least cognitive control over the situation by changing it in his/her unique perceptions. Because construal resides only at the mental level, no physical activity is involved.

Maintenance

People may remain in and maintain a situation, thus fostering the stability of a situation and consequently inhibiting change. We refer to this strategy as *situation maintenance*, and there may be individual differences in the extent to which people are situation sustainers. Maintenance can be intentional (especially while bearing or sitting out a situation) or unintentional. Depending on the characteristics of the situation, it may require effort to remain in the situation or not. Maintaining a situation should usually not result in much active control, except if the *status quo* needs to be upheld against change (e.g., if one wants a situation to stay as it is, but other parties want change). The strategy is marked by passivity although active resistance may be used to achieve maintenance

of an already existing situation (to preserve it as it is). To our knowledge, maintenance has so far not been sufficiently conceptually addressed in traditional transaction models (e.g., Buss, 1987).

Evocation

People may engender certain situations without specific intentions of doing so³. We refer to this strategy as *situation evocation*, and there may be individual differences in the extent to which people are situation conjurers. Situation evocation captures genuinely unintentional elicitations of situations (e.g., when one's behavior triggers reactions of others, thus changing the situation). Accordingly, usually no effort has been invested in bringing about the elicited situation because the situation was neither planned nor intended. As a result, the situation conjurer only has limited options to control the inadvertent situation, and he/she may be active or not during the evocation process⁴.

Selection

People may choose (i.e., approach or avoid) certain situations. We refer to this strategy as *situation selection*, and there may

³If situations are engendered in an intentional and/or goal-directed way, then they utilize modification or creation.

⁴By not doing anything, people can elicit adverse situations (see, e.g., laissez-faire leadership: Furtner et al., 2013). Thus, evocation does not require physical activity to take place. Should a person, however, actively “provoke” a situation, then this falls under either situation modification (if the provoked situation is an escalation of an already existing one) or situation creation (if the provoked situation is created out of the blue).

be individual differences in the extent to which people are situation pickers. Selection is usually an intentional process (e.g., thinking about where to go), but situations may also not be explicitly sought because (a) situations can traverse “naturally” into different situations (e.g., another person joins and the situation changes), (b) people more or less “just go with the flow” instead of deliberately selecting every new situation to engage in, and (c) people can only select situations within the limits of a given pool of possible situations to choose from. As such, the effort in choosing situations may be more or less, depending on whether a situation is intentionally sought after (e.g., a romantic date) or unintentionally just happens (e.g., a stimulating conversation). However, since intentional selection includes not only the promotion but also the avoidance of certain situations, this strategy allows the utilizer a certain amount of control and requires some level of activity.

Modification

People may actively change an existing situation into something different (e.g., in a goal-serving way). We refer to this strategy as *situation modification*, and there may be individual differences in the extent to which people are situation engineers. Modification differs from selection in that not a new or qualitatively different situation is sought, but an already existing one actively “worked on” and transformed. As such, it harbors a high degree of control and activity, relatively to the other strategies. Modification also differs from evocation in that modulations are conducted intentionally and with some amount of effort (time, energy, etc.).

Creation

People may pro-actively and purposefully create new situations in the service of their goals. We refer to this process as *situation creation*, and there may be individual differences in the extent to which people are situation creators. Creation differs from modification in that not a pre-existing situation is transformed, but an entirely new one willingly created. As such, the creation strategy harbors, relative to all other strategies, the highest levels of intentionality (creation is purposeful and goal-oriented), effort (creation requires resources), control (creation implies control over the creative process), and activity (creation requires work).

Different Types of Situation Change through Different Situation Management Strategies

Taking the previous explications into account, we can now ask, for each person, to what extent the situation (i.e., cues, characteristics, classes) changed because (a) he or she perceived it differently (*construal change*), (b) it was changed by something outside of his or her control (*evocative change*), (c) he or she left for another situation (*selective change*), (d) he or she actively changed it (*manipulative change*), or (e) he or she created an entirely new situation (*generative change*)? By categorizing situation changes in this manner we can more specifically assess the associations between types of change (construal, evocative, selective, manipulative, generative) and personality and momentary states. For example, questions to be asked then include: (1) Are certain personality

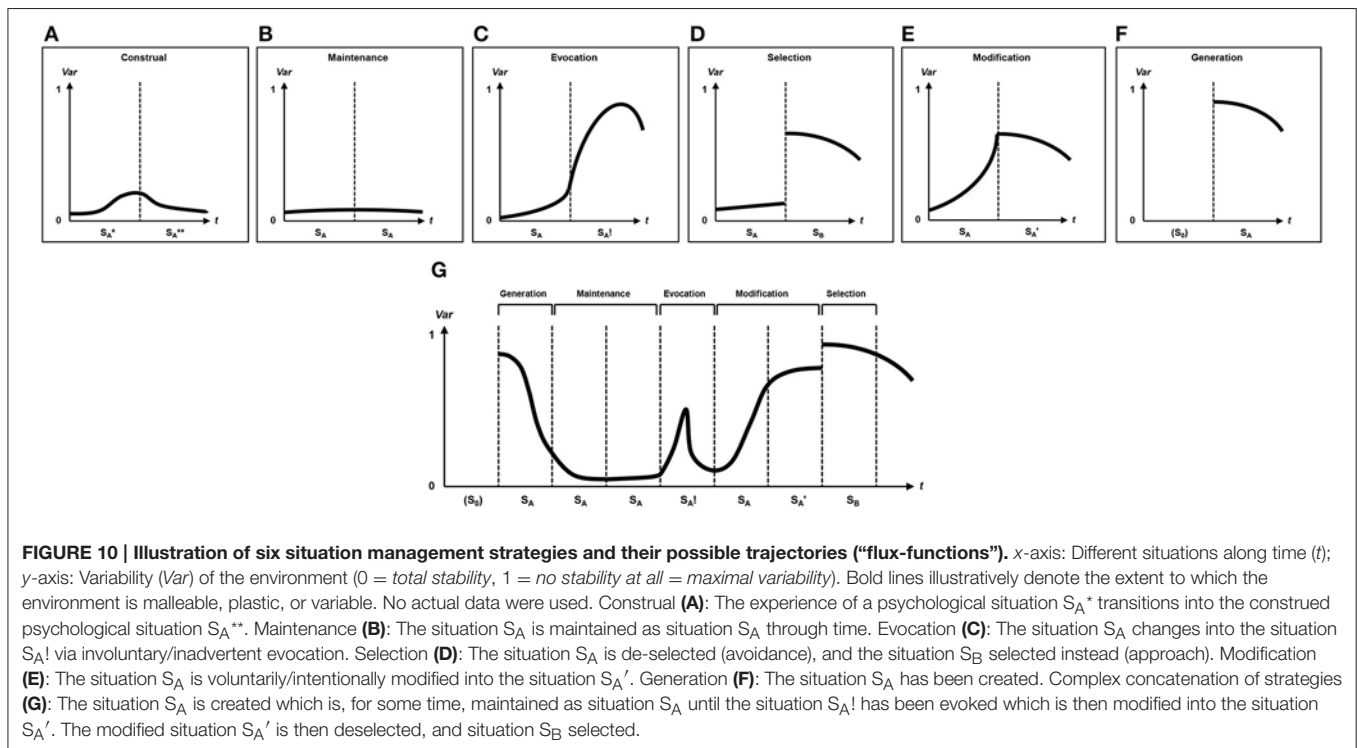
dimensions associated with a tendency toward particular kinds of situation change? (2) Does the presence of particular goals or affective states predict different kinds of situation change?

It can be a difficult task disentangling which strategy (Table 2) has been used by a person and, by extension, which type of situation change has occurred, but we believe that each strategy leaves characteristic “traces” in how strongly and fast situations are changed within a person. We refer to these traces as *flux functions* which describe the continuous change of situations within an individual over a certain time span. Thus, situation change can be examined in response to different situation management strategies.

Hypothesized (but fictitious) flux functions are presented in Figure 10 for each strategy. The *x*-axis represents time and shows for Figures 10A–F two different situations. The *y*-axis represents variability of the actual or perceived environment (with 0 denoting total stability and 1 denoting maximal change). Figure 10A illustrates construal (construal situation change) where the experience of a psychological situation S_A^* transitions into the construed psychological situation S_A^{**} . Figure 10B illustrates maintenance (which does not yield situation change, but stability) where the situation S_A is maintained as situation S_A through time. Figure 10C illustrates evocation (evocative situation change) where the situation S_A changes into the situation $S_A!$ via involuntary/inadvertent elicitations. Figure 10D illustrates selection (selective situation change) where the situation S_A is de-selected (avoidance), and the situation S_B selected instead (approach). Figure 10E illustrates modification (manipulative situation change) where the situation S_A is voluntarily/intentionally modified into the situation S_A' . Figure 10F illustrates Generation (creative situation change) where the new situation S_A has been created. Lastly, Figure 10G illustrates a complex concatenation of strategies (showing all types of situation change) where the situation S_A is created which is, for some time, maintained as situation S_A until the situation $S_A!$ has been evoked which is then modified into the situation S_A' . The modified situation S_A' is then deselected, and situation S_B selected. To our knowledge, no empirical study has so far examined any form of flux function so that this approach represents a novel avenue for future research.

Zooming in on the Processes of Change

We should try to dig further and inquire about the underlying processes of situation change: *Why* do people change situations? It is likely that motivational processes (such as goals, needs, and motives) play a key role here (see Yang et al., 2009). People's goals may not only shape the way they perceive situations (Rauthmann, in press), but also how they respond to them. According to Yang et al. (2009), situations may be understood in terms of their goal content and their goal processes. Regarding content, evolutionarily important goals may be particularly important (see Brown et al., 2015) as recurring ancestral presses have likely attuned our perceptual systems to motive categories that historically fostered survival and reproductive fitness in the environment of evolutionary adaptedness. Regarding processes,



what is happening or could happen to people's goals is important: Can they be achieved or are they blocked? Empirical studies (e.g., Edwards and Templeton, 2005; Yang et al., 2006) lend support to the idea that people broadly perceive situations in terms of whether they foster or hinder goal pursuit and attainment. Situations may change, in part, because people change their momentary goals, intentions, and strategies. This is also in line with recent theory and research that emphasizes the role of social-cognitive mechanisms behind the manifestation of personality traits into personality expressions (Fleeson, 2012; Fleeson and Jayawickreme, 2015). Because personality expressions and concurrent situation characteristics are intertwined (Sherman et al., 2015; Rauthmann et al., in revision), it is plausible that situation change can be similarly predicted by goal processes as can be personality expressions (e.g., McCabe and Fleeson, 2012). Taken together, attending to people's enduring and momentary goals (that are activated and salient in a given situation) should be fruitful because they may be able to illuminate why (i.e., for what reasons and for what anticipations of outcomes) people attempt to maintain or change a situation in the first place.

TRAJECTORIES AND OUTCOMES OF SITUATION CHANGE

What are the outcomes and consequences of situation change? If situation change can be quantified (Question 1) and categorized and explained (Question 2), it becomes reasonable to ask about the consequences of situation change. Generally, effects of

situation change may manifest at short-, middle-, and longer terms (see Figure 1).

For short-term consequences, we can ask: What kinds of behaviors are enacted as a result of (different kinds and magnitudes of) situation change? For example, we would expect that transitioning from a situation characterized by low Duty (e.g., there is no work to be done) to one that is high in Duty (e.g., work needs to be done) would result in a person expressing more conscientious behavior (e.g., organizing, working hard). To the extent that this person can be characterized and also describes him- or herself as a generally conscientious person, this person may experience authenticity because of increased personality-behavior fit (cf. Jones et al., under review). Additionally, the person may experience mild positive affect, self-esteem, and self-efficacy in dealing with the conscientiousness-affording situation because there is personality-situation fit (Rauthmann, 2013). Lastly, a person with appropriate responses to a situation, or behavior-situation fit, may be said to be well-adjusted to his or her surroundings and thus also garner positive social consequences (e.g., respect, reputation, more pay, etc.). Thus, situation change may stand in the service of short-term personality-behavior, personality-situation, and behavior-situation fit, and all three types of fit may entail middle- to long-term intrapersonal (e.g., affect, self-esteem) and interpersonal (e.g., status, popularity) adjustment. For example, via habitual (= typical and repeated) situation changes people may be able to cumulatively “optimize” their surroundings according to their needs and personalities. Thus, in the long haul, short-term situation changes may stand in the service of long-term developmental regulation (Haase et al., 2013) where

people actively manage their surroundings and development (Baltes, 1997; Roberts and Caspi, 2003). For example, the corresponive principle (Roberts, 2005, 2006; Roberts and Wood, 2006) specifies that (a) people modulate their situations and environments according to their traits (see Gosling et al., 2002, 2008 for personality-manifestation in personal environments) and that (b), in turn, these traits are consolidated by the selected situations and environments (e.g., via socialization processes). Thus, particularly developmental psychologists and researchers interested in personality development may attend to understanding situation change processes better.

Nonetheless, there are also several other interesting questions, such as: (1) To what extent does overall situational variability (a lot vs. little change) impact how individuals are feeling, thinking, and behaving? (2) How do individuals adjust their goal strivings as a result of situation change? (3) Does personality moderate the associations between situation change and these outcomes? Answers to these questions will provide a greater understanding to two of psychology's most important outcomes: Why do people behave the way they do, and what makes a person feel good or bad?

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SUMMARY AND CONCLUSION

There are many ways in which situation change can be studied, depending on (a) the resolution of interest (situation—episode—environment—context), (b) the situation variables used as benchmark criteria for change (cues—characteristics—classes), (c) the measurement of situation variables (e.g., actual—perceived; *in situ*—*juxta situ*/*ex situ* rated; -oriented), (d) the level of analysis (between-person—within-person, variable-oriented—profile), and (e) the type of situation change studied (construal—evocative—selective—manipulative—generative). We hope that this article could make researches aware of this diversity and alert to important questions as well as intriguing ways of answering them. Situation change remains as of yet an overlooked concept that can enrich personality, social, and developmental psychology.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <http://journal.frontiersin.org/article/10.3389/fpsyg.2015.01938>

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Retrospective Ratings of Emotions: the Effects of Age, Daily Tiredness, and Personality

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Remembering the emotions we have experienced in the past is the core of one's unique life-experience. However, there are many factors, both at the state and trait level that can affect the way past feelings are seen. The main aim of the current study was to examine the impact of individual differences on systematic biases in retrospective ratings compared to the momentary experience of basic emotions such as sadness, fear, happiness, and anger. To this end, an experience sampling study across 2 weeks was conducted using a younger and an older age-group; the experience of momentary emotions was assessed on 7 randomly determined occasions per day, the retrospective ratings being collected at the end of each day about that day, as well as at the end of the study about the previous 2 weeks. The results indicated that age and daily tiredness have significant effects on retrospective emotion ratings over a 1-day period (state level), enhancing the retrospective ratings of negative emotions and decreasing the ratings of felt happiness. Whereas personality traits influence the more long-term emotion experience (trait level), with all Big Five personality traits having selective impact on retrospective emotion ratings of fear, sadness, happiness, and anger. Findings provide further evidence about the systematic biases in retrospective emotion ratings, suggesting that, although retrospective ratings are based on momentary experience, daily tiredness and personality traits systematically influence the way in which past feelings are seen.

Keywords: retrospective ratings, emotional memory, age, daily tiredness, personality

INTRODUCTION

Remembering one's emotions over time is at the core of human life experience, and we all have emotional memories that are vivid and lasting. Recent research suggests that people remember their emotions quite accurately both after 90 days (Barrett, 1997) and after 1 year (Röcke et al., 2011). However, retrospective ratings of experienced affect are also susceptible to systematic biases. It has been found that individuals retrospectively overestimate both positive and negative affect when comparing momentary reports with end-of-day ratings (Thomas and Diener, 1990; Parkinson et al., 1995). Age, among other individual difference factors, has also been found to influence both the momentary and retrospective ratings of emotions (Röcke et al., 2011). In addition to individual differences and the respondent's current mood, memory about emotional experiences can also reflect the emotion regulation strategies used in a particular situation. Emotion regulation refers to attempts to influence one's subjective emotion experience and expression, involving both up- and down-regulation, as well as antecedent-focused and response-focused emotion regulation

(Gross et al., 2006). Emotion regulation strategies are thought to differ across age-groups (Urry and Gross, 2010), and across emotion categories (Gross et al., 2006). A recent study by Shallcross et al. (2012) showed that the nature of age-related decreases in emotional processing is best understood across discrete emotions. The current study extends research on retrospective emotion by comparing retrospective and momentary emotion reports. Further, the impact of daily tiredness and personality on such reports are explored.

Momentary vs. Retrospective Reports

Current study used experience sampling methodology to capture ratings of emotional experiences as dynamic psychological processes. The advantages of experience sampling compared to nomothetic approaches, is the focus on individuals' current or very recent experiences and the usage of multiple assessments over time in everyday life (Trull and Ebner-Priemer, 2009). Retrospective self-reports may be biased by variety of heuristics, the retrieved emotional states are summarized by taking also into account the personal relevance and significance of reported experiences, as well as social expectations (e.g., Wilhelm and Grossman, 2010). However, repetitive self-ratings and frequent monitoring may produce other biases, for example response shifts (Schwartz et al., 2006). It has been found that individuals retrospectively overestimate both positive and negative affect when comparing momentary reports with retrospective ratings (Thomas and Diener, 1990; Parkinson et al., 1995). The Accessibility Model of Emotional Self-Report by Robinson and Clore (2002) proposes different levels of remembering based on accessibility principles, and makes the distinction between momentary emotions, short-term retrospective reports (i.e., end of day), and longer-term reports (i.e., a week or multiple weeks), with each of these judgments being influenced by different sources of knowledge. Short-term judgments are influenced by more episodic forms of memory biases or episodic knowledge such as salient experiences and current affective state. By contrast, longer-term retrospective reports are influenced by more semantic forms of knowledge, including the beliefs and theories about self, and one's personality. The age, neuroticism, extraversion, and tiredness can be expected to influence retrospective emotion ratings, but there is no clear timeline distinction provided by previous studies (Carstensen et al., 2011; R  cke et al., 2011).

According to accessibility model of emotional self-reports, the current emotions are accessed directly based on experiential knowledge, specific moments from the past can be retrieved from the episodic memory, but also from the semantic knowledge—the situation-specific beliefs and identity-related beliefs (Robinson and Clore, 2002). The amount of time between the event and the recall defines the extent of accessible episodic memories, and the shift from episodic to semantic memory, i.e., situation-specific and identity-based beliefs (Tulving, 1984; Robinson and Clore, 2002). According to the two-process model, the recollection of emotion experience over the longer time-frame (i.e., *last few weeks*) has found to rely on semantic memories, whereas for shorter periods (i.e., *past day*) the episodic knowledge is used (Robinson and Barrett, 2009). There is evidence that contrary

to peak-end rule in memories for pain experiences (Redelmeier et al., 2003), the retrospective evaluations of multiepisodic emotion experience across 1 day rely rather on averaged ratings of emotions (Miron-Shatz, 2009; R  cke et al., 2011).

There are distinct types of memory biases in retrospections due to episodic (factors affecting retrieval of event-related context) vs. semantic knowledge or beliefs about emotions (Robinson and Clore, 2002). Personality can be viewed as a source of beliefs that contribute differentially to online and retrospective emotion reports, with being related rather to semantic memory (Robinson and Clore, 2002). Age is another factor that can be expected to interfere with both online and retrospective emotion reports, the question is whether more as a short-term (retrieving the context of event) or long-term (regarding event-specific or general beliefs about the influence of age on emotion experience). Thirdly, the everyday tiredness can be expected to act more as an episodic biasing factor inferring the recollection of contextual details of experience as tiredness itself is rather situational and contextual feature.

Age and Emotional Memory

Previous studies have suggested that age differences in emotional long-term memory reflect a memory retrieval bias, meaning that the emotional life of older people is different, as emotional memories have a different meaning for them (Spaniol et al., 2008). It has also shown that older people tend to experience specific mood states (e.g., nocturnal regrets) that are rare in younger adults (e.g., Schmidt et al., 2011).

According to socioemotional selectivity theory, older adults are expected to endorse more positive stimuli during memory retrieval than younger adults (Carstensen et al., 2011). Urry and Gross (2010) proposed a SOC-ER (selection, optimization, and compensation with emotion regulation) framework of emotion regulation processes that facilitate the emotional positivity effect. According to this framework, older adults use more effective situation selection by reducing the probability of engaging in social situations that might elicit negative emotions and deploy more attention to positive information. A meta-analysis of memory and attention for emotional stimuli, for example, reflected smaller negativity preferences for older than for younger adults (Murphy and Isaacowitz, 2008). Nevertheless, although older adults have been found to rate the valence of remembered events more positively, this effect appears to reflect a generally positive overall mindset rather than emotion regulation strategies related to personal autobiographic memory (Schryer and Ross, 2012). Findings about emotion experience and the positivity effect in older age are mixed, however. Charles et al. (2010), for instance, found that reduced exposure to daily stressors in older age partially explained age-related reductions in negative affect.

Shallcross et al. (2012) found differences across emotion categories, with lower levels of experienced anxiety and anger, but not sadness. Regarding age differences in the recall of experienced emotions, Gr  hn et al. (2005) found no aging bias favoring memory of positive material, whereas R  cke et al. (2011) suggested that the correspondence between momentary and retrospective ratings are similar at older and younger ages. Previous studies suggest that life context creates emotional

stability in older age; that is, the exposure, not the reactivity, to daily stressors has been found to differ between younger and older people (Sliwinski et al., 2009; Brose et al., 2013).

Taken together, previous studies suggest age differences in emotional lives, but there is no clear consensus about the role of emotional vs. contextual processes leading to emotional positivity in older age. The role of proactive and reactive emotion regulation strategies is a critical factor in understanding the emotional world during aging, whether the positivity effect comes from the lesser experience of negative emotions, or is the experience regulated down by cognitive reappraisal reflected in retrospective emotion ratings. The focus of the current study is to explore whether experienced daily emotions moderate the positivity of retrospective evening ratings—whether the positivity is moderated by the experience and whether the pattern is similar for different emotion categories.

Personality and Retrospective Emotion Ratings

In addition to age, personality traits could also be expected to interact with emotion recall. There are systematic links between personality and the affective experience, with neuroticism predisposing the experience of more negative, and extraversion more positive emotions (Costa and McCrae, 1992; Watson and Clark, 1992). According to Robinson and Clore (2002), personality-related beliefs can bias reports about retrospective emotion experiences as personality constitutes a source of knowledge that can be used when reporting emotions felt in the past.

More recent studies have found other Big Five personality traits, in addition to neuroticism and extraversion to be also associated with individual differences in emotional processes in daily life (Komulainen et al., 2014). Conscientiousness have found to predict lower levels of negative affect, agreeableness is associated with lower negative and higher positive affect, whereas openness is related to higher stress-reactivity (Komulainen et al., 2014). Neuroticism and extraversion have been found to influence retrospective ratings, with more neurotic people remembering having experienced more negative emotions and more extraverted people more positive emotions (Barrett, 1997).

However, age and valence effects in emotional memory do not change when neuroticism is included as a covariate (Spaniol et al., 2008). Thus, there is no clear consensus about the extent to which personality traits influence the formulation of retrospective emotion ratings, and about whether there are any differences at the time level (the influence of recent vs. long-term emotional memories).

Daily Tiredness and Emotional Processing

Daily tiredness is a common phenomenon in everyday life, a universal sensation that is considered a natural response to life strain, caused by strenuous activities and emotional stress (Mengshoel, 2010). The life satisfaction and positive affect experienced during the day has been found to be strongly influenced by sleep quality and tiredness, among other variables (Kahneman et al., 2004). Previous studies have suggested that

impaired sleep quality leads to low positive affect (Sonnentag et al., 2008; Bower et al., 2010), whereas the association between sleep and mood is bi-directional (Vandekerckhove and Cluydts, 2010). Zohar et al. (2005) found that fatigue resulting from sleep loss, amplified negative emotions as a reaction to an unpleasant event and suppressed positive affect as a response to positive event. Sleep loss and tiredness have been linked to increased emotional lability and deficits in emotion regulation (Dahl and Lewin, 2002; Yoo et al., 2007). In the context of the accessibility model of emotional self-report (Robinson and Clore, 2002), the daily tiredness can operate as a systematic retrospective bias at the episodic memory level, being specific to time and space, and affecting the accessibility to contextual details of event. In addition to accessibility, tiredness can be expected to influence short-term memory about emotion events via mood congruency mechanisms (Rusting and DeHart, 2000) or general arousal level can act as an interference factor (Robinson and Clore, 2002).

Although previous work supports the widespread lay assumption that sleep quality and tiredness appear to be linked to affective functioning, there is need for ambulatory designs for stronger inferences (Bower et al., 2010). Previous studies have also reached to contradictory results, as a study by Peeters et al. (2006) found no relationships between sleep quality and daily affect, whereas Bower et al. (2010) provided evidence that sleep quality is a predictor of positive affect. However, previous studies have also suggested that subjective feeling of fatigue is better predictor of depression than sleep problems (Koffel and Watson, 2009). On the other side, higher levels of trait positive affect as a disposition, not a state, have found to be associated with better overall sleep quality (Ong et al., 2013). Poorer sleep quality impairs individual's ability to use cognitive reappraisal to regulate negative emotions (Mauss et al., 2013). A recent review, Deliens et al. (2014) conclude that exposure to emotional experiences changes sleep-patterns, with emotional disturbances developing after sleep problems.

Taken together, previous studies suggest that sleep plays important role in one's ability to manage emotional information. While, overall, there is more research about illness-related fatigue, emotion studies have so far paid less attention to daily tiredness as a possible influencing factor of the retrospective ratings of experienced emotions. Walker and Harvey (2010) conclude that while mood and tiredness resulting from impaired sleep, are unquestionably linked, the exact nature and outcomes of this relation remains to be determined. Kashani et al. (2012) found that individuals reporting a natural trend for high stress levels reported also a greater daytime sleepiness, tiredness, poorer sleep quality and duration. It is also proposed that personality traits might modulate the link between emotional experiences and sleep quality, whereas the exact nature of this relation is not clear (Deliens et al., 2014).

The current research includes state-level daily tiredness rated at the end of day and trait-level tiredness across 2 weeks as possible influencing factors in retrospective emotion rating, leading, thus, to the possible enhancement of retrospective ratings of negative emotions and to the possible reduction of positive affect.

Aims of the Current Study

Taken together, previous studies have suggested the link between sleep quality and emotion experience, as well as the link between personality traits (i.e., neuroticism and extraversion) and remembering one's emotional experiences. The main aim of the current study was to determine sources of systematic bias in retrospective ratings of the momentary experience of four emotions: fear, sadness, and anger as prototypical negative emotions, and happiness as prototypical positive emotion (Russell and Barrett, 1999; English and Carstensen, 2014), both over a period of 1 day and of 2 weeks. More specifically, it is assumed that retrospective ratings are formulated not only on the basis of experienced emotions, but are also influenced by participant's daily tiredness, age, and personality traits, and that these patterns differ meaningfully across emotion categories. As the purpose of biases in memory for emotions is to enhance one's emotional coping and support coherent self-view (Robinson and Clore, 2002), the systematic biases might differ across discrete emotions.

In summary, we hypothesized that the tiredness, personality traits and age moderate the relationship between momentary emotion ratings and retrospective ratings of 1 day (hypothesis 1) and 2 weeks (hypothesis 2), with meaningful differences across the two time-frames. It was also expected that there is interaction between age and experienced emotion that influences the way in which past feelings are remembered and serves as an emotion regulation strategy (hypothesis 3). As previous studies have suggested Big Five personality traits to have different impact on daily emotional life, the impact of personality traits on the retrospective emotion ratings was expected to differ across the four measured emotion categories (hypothesis 4).

MATERIALS AND METHODS

Ethical Considerations

The Research Ethics Committee of the University of Tartu approved the study, and all participants provided written informed consent. All the research procedures were conducted in accordance with the Declaration of Helsinki.

Participants

This study is a part of a larger research project concerning emotion experience in daily life (see also Kõõts et al., 2011, 2012). The sample of this project consisted of 110 participants (70 women and 40 men), with ages ranging from 19 to 84 years. All participants were ethnic Estonians and received EEK 520 (about EUR 33) for taking part. The first group of participants ($n = 55$; 42 women and 13 men) was recruited from 2 day centers. The age of participants in this group ranged from 61 to 84 years, with a mean age of 68.2 ($SD = 5.5$). About one-third (36%) of these older respondents had higher education. The second group of participants ($n = 55$; 28 women and 27 men) consisted of undergraduate students from the University of Tartu, and was recruited via advertisements placed in university academic buildings and residence halls. Students came from different faculties of the university and those majoring in psychology were

not eligible to participate. The mean age of students was 21.3 years ($SD = 1.0$), ranging from 19 to 23 years.

Procedure

Experience Sampling Data

The study consisted of 14 days of experience sampling using iESP software (<http://seattleweb.intel-research.net/projects/ESM/iESP.html>). Participants were signaled randomly 7 times per day during average waking time, to report their current emotions (i.e., up to 99 possible assessments per participant). There were 10,667 measurement trials of momentary emotion across all participants, with an average of 97 measurement trials per participant. The response rate was 82.8%, which is considered to be within normal range for an experience-sampling study (Zelenski and Larsen, 2000). Participants were asked to indicate on a 4-point Likert-type scale (1—not at all to 4—to a large extent), as used in other ESM studies (Mroczek et al., 2003; Gerstorf et al., 2009; Thompson et al., 2011), the extent to which each of the seven basic emotions (anger, happiness, contempt, disgust, fear, sadness, and surprise), as well as six other emotion-related features (disappointed, irritated, in physical pain, sleepy, hungry, and tired) described their current emotional and physiological state as quickly and accurately as possible. Considering the focus of the current paper, four emotions were included in subsequent analyses: happiness ($M = 2.05$, $SD = 0.62$), fear ($M = 1.12$, $SD = 0.25$), and sadness ($M = 1.34$, $SD = 0.44$), and anger ($M = 1.11$, $SD = 0.22$). Momentary tiredness was included as a variable of interest ($M = 1.83$, $SD = 0.64$).

Additional Measures

For the whole period of 14 days, participants were asked in the evening to recall their emotions for the day. The evening questionnaire consisted of 21 terms about emotional and physiological state, with the instruction to assess the extent to which they had experienced the respective states, averaging these across the day on a 4-point Likert-type scale (1—not at all to 4—to a large extent). The questionnaires were brought back at the end of the study. The four emotions were used for current study: happiness ($M = 1.24$, $SD = 0.97$), fear ($M = 1.24$, $SD = 0.57$), and sadness ($M = 1.57$, $SD = 0.83$), and anger ($M = 1.29$, $SD = 0.68$); and tiredness ($M = 2.28$, $SD = 0.97$).

Participants completed the Estonian version (Allik and Realo, 1997) of the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), which asks the extent to which they had experienced different emotions during the previous 2 weeks, at the end of the experience sampling period. For current study, the respective items from PANAS reflecting the four emotion terms of happiness ($M = 2.78$, $SD = 0.80$), fear ($M = 1.45$, $SD = 0.78$), and sadness ($M = 2.15$, $SD = 0.96$), and anger ($M = 1.85$, $SD = 0.86$); and tiredness ($M = 2.46$, $SD = 0.87$) were used.

At the beginning of the study, participants also filled in the Estonian version (Kallasmaa et al., 2000) of the Revised NEO Personality Inventory (NEO-PI-R; Costa and McCrae, 1992).

Analyses

As a first step, experienced emotions were averaged separately for each emotion category (sadness, fear, happiness, and anger),

to produce a mean of all momentary affect ratings across 1 day. There were 1535 mean daily ratings across all participants. Previous studies have suggested mean average momentary assessment to be the best predictor of retrospective ratings of emotions (Röcke et al., 2011).

The Multilevel Regression Analysis Predicting Evening Retrospective Emotion Ratings

A multilevel regression approach was used to explore the moderating role of personality traits and daily tiredness, in addition to experienced momentary emotion, in predicting the retrospective emotion ratings across 1 day and across the 2 weeks. A series of multilevel models was conducted in the Mixed module of IBM SPSS 20.0 with restricted maximum likelihood estimation (REML). The retrospective emotion ratings of $Fear_{ij}$, $Sadness_{ij}$, $Happiness_{ij}$, and $Anger_{ij}$ were modeled using a multilevel random intercept model in which the Level 1 random intercept was predicted by mean momentary emotion ratings, personality traits and daily tiredness. As the first step, a no-predictor model was developed to partition the variance in retrospective emotions into within- and between-person components, in order to determine how much of the variance lies between people. Next, a two-level model for analyzing both within- and between-person variability was built. At Level 1, respective retrospective emotion_{ij} represents the emotion rating for participant j at in the evening or across the 2 weeks i as the outcome variable, where β represents the intercepts, r is the respective residual component, ε represents the error term:

Level 1 Model:

$$\text{Evening rating of } fear_{ij}, sadness_{ij}, anger_{ij} \text{ or } happiness_{ij} = \beta_{0j} + r_{ij} + \varepsilon_{ij}.$$

At Level 2, a set of predictors was added to the model. It was proposed that the age, personality traits (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) and tiredness might explain differences in retrospective emotion ratings between individuals at the end of the day. The momentary emotions were taken into account, to control the effect of personality traits and tiredness above momentary emotions.

Level 2 Models:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} \text{respective mean momentary emotion}_j + \mu_{0j} + \varepsilon_{ij},$$

$$\begin{aligned} \beta_{0j} = & \gamma_{00} + \gamma_{01} \text{respective mean momentary emotion}_j \\ & + \gamma_{02} \text{tiredness at the end of the day}_j + \gamma_{03} \text{neuroticism}_j \\ & + \gamma_{04} \text{extraversion}_j + \gamma_{05} \text{openness to experience}_j \\ & + \gamma_{06} \text{agreeableness}_j + \gamma_{07} \text{conscientiousness}_j + \gamma_{08} \text{age}_j \\ & + \gamma_{09} \text{age} * \text{mean momentary emotion}_j + \mu_{0j} + \varepsilon_{ij}, \end{aligned}$$

where μ_{0j} and ε_{ij} refer to random error terms, i.e., the random part of the model.

In addition, as previous studies have suggested age differences in emotion experience, the interaction between age and momentary emotion were taken into account, indicated as $\text{age} * \text{mean momentary emotion}$.

The model criteria were explored in order to examine the improvement of the null model and the following fixed-effects model. The intraclass correlation (ICC), describing the proportion of between-persons variance to the total variance was also calculated at each level.

The Linear Multiple Regression Analysis Predicting Retrospective Emotion Ratings across the 2 Weeks

A linear multiple regression analysis was used to explore the role of personality traits and tiredness in predicting retrospective emotion ratings over the period of 2 weeks. The main purpose of the analysis was to explore whether retrospective ratings of experienced emotions over the 2 weeks are formed on the basis of evening and/or daily emotional experiences, and whether the influence of age, tiredness, and personality traits is similar to evening evaluations. As the data had only between-people variance, a linear multiple regression analysis was used with the emotion experience of the five measured emotions over the 2-week period as the dependent variable and momentary emotion, evening evaluations, age, personality, and daily tiredness as predictor variables.

RESULTS

First, the correlations between the mean of momentary emotion ratings, mean evening emotion ratings, and 2-week ratings, measuring the experience of the respective emotions across the two study weeks, were explored. Emotion ratings taken at different moments in time were all significantly correlated (Table 1); correlations were moderate, similar to previous studies (Röcke et al., 2011). Thus, the results are in accordance with previous studies, suggesting that people's perceptions of their past emotional experiences are only in part derived from their momentary experiences, and other significant influencing factors can be expected to exist (Barrett, 1997).

TABLE 1 | Pearson correlations between mean momentary emotion ratings, evening ratings, and 2-week ratings of respective emotions.

Emotion	Two-week and mean momentary emotion	Two-week and evening ratings of daily emotions	Mean daily and evening ratings
Happiness	0.38**	0.36**	0.43**
Fear	0.22**	0.42**	0.30**
Sadness	0.34**	0.47**	0.50**
Anger	0.18**	0.31**	0.40**

$N = 1484$.

**Correlations are significant at the $p < 0.01$ level (2-tailed).

Retrospective Emotion Ratings across 1 Day

Hypothesis 1 predicted that age, personality traits and tiredness moderate the relationship between momentary emotion ratings and retrospective emotion ratings of happiness, fear, sadness, and anger across the period of 1 day.

The results of the null model, Level 1 random intercept model, and Level 2 fixed-effects models are presented comparatively in **Tables 2–5**, separately for each of the four emotions.

First, the effects of mean momentary emotion ratings were explored. The experienced mean momentary emotions had significant effect on retrospective emotion ratings for all emotions (fear: $\gamma = 0.483, p < 0.01$; sadness $\gamma = 0.628, p < 0.01$; happiness $\gamma = 0.543, p < 0.01$; anger: $\gamma = 1.130, p < 0.01$). The reductions in variance estimates (R^2) suggest that the mean of momentary emotion ratings of the respective emotion accounts for about 3 (fear) to 10 (happiness) percent of the within-people variability, and for about 18 (fear) to 42 (anger) percent of the between-persons variability in evening emotion ratings. Thus, a significant portion of the variability in means of evening ratings across people can be attributed to differences in the daily emotion experience. However, the Wald Z test suggests that, even after controlling for the mean of momentary emotion ratings within-people, a statistically significant amount of variation in outcomes still remains both within- and between people for all four emotions ($p > 0.05$).

Next, the effect of Level 2 fixed predictors was explored. Individuals who reported more tiredness at the evening, tended to enhance the retrospective ratings of negative emotions (the effect of tiredness for fear: $\gamma = 0.036, p < 0.01$; for sadness $\gamma = 0.141, p < 0.01$; for anger: $\gamma = 0.058, p < 0.01$) and

reduced retrospective rating of happiness $\gamma = -0.142, p < 0.01$, compared to reported mean momentary emotion.

The Level 2 models suggest that tiredness impacts the evening ratings of all measured emotions, magnifying negative emotions and reducing happiness. Retrospective evening ratings of happiness were associated with neuroticism ($\gamma = -0.004, p < 0.05$) and extraversion ($\gamma = 0.010, p < 0.01$). There were no significant effects for evening retrospective ratings for other emotions ($p > 0.05$). The effects of age were included in model both as single predictor, but also in interaction with reported mean momentary emotions (hypothesis 3). Older adults have found to report less negative emotions and more positive emotions in general (Carstensen et al., 2011), however, it is possible that in situations where negative emotions are experienced, the retrospective ratings of older adults may be different. The age effect on retrospective emotion ratings was significant only for anger ($\gamma = 0.018, p < 0.01$), suggesting that older adults tended to retrospectively enhance the experienced anger compared to mean momentary assessments. There was a significant interaction between mean momentary emotion and age in predicting retrospective emotion ratings for sadness ($\gamma = -0.010, p < 0.01$), for fear ($\gamma = -0.006, p < 0.05$), for anger ($\gamma = -0.020, p < 0.01$), and for happiness ($\gamma = -0.005, p < 0.01$), supporting the hypothesis 3. Thus, the more older adults experienced both negative and positive emotions, the more it was biased in evening retrospective ratings as less intense. Adding fixed predictors significantly improved the model, there was observable R^2 -change at between-people level for all measured emotions. The hypothesis 1 was partly supported as daily tiredness and age were found to moderate the relationship between momentary emotion ratings and retrospective ratings

TABLE 2 | The evening ratings of fear—results of the mixed models analysis of the null model and fixed effects random intercept model.

Model	Predictors	–2RLL	Estimates of fixed effects					Estimates of covariance parameters				
			EST	SE	df	F	Sig.	ICC	Wald Z across subjects	Wald Z within subjects	R ² change Level 1	R ² change Level 2
The null model	Intercept	2207	1.24	0.03	109.15	1418.66	0.00	32.14%	6.39**	26.43**		
The fixed effects models	Intercept	2145	0.69	0.07	994.07	87.88	0.00	28.47%	6.19**	26.41**	3.19%	18.62%
	Mean momentary fear		0.49	0.06	1479.20	68.64	0.00					
	Intercept	2194	0.48	0.22	320.24	4.82	0.03	23.66%	5.70**	26.38**	0.39%	22.43%
	Mean momentary fear		0.80	0.13	1480.70	38.97	0.00					
	Age		0.00	0.00	492.30	0.03	0.86					
	Tiredness		0.04	0.02	1478.37	5.01	0.03					
	Age*daily emotion		–0.00	0.00	1415.72	6.42	0.01					
	N		0.00	0.00	100.89	0.05	0.83					
	E		–0.00	0.00	102.75	0.01	0.91					
	O		–0.00	0.00	100.80	0.10	0.75					
	A		0.00	0.00	99.58	0.17	0.68					
	C		0.00	0.00	101.80	0.05	0.83					

** $p < 0.001$; N, neuroticism; E, extraversion; O, openness to experience; A, agreeableness; C, conscientiousness; –2RLL refers to –2 Restricted Log Likelihood.

TABLE 3 | The evening ratings of sadness—results of the mixed models analysis of the null model and fixed effects random intercept model.

Model	Predictors	−2RLL	Estimates of fixed effects					Estimates of covariance parameters				
			EST	SE	df	F	Sig.	ICC	Wald Z across subjects	Wald Z within subjects	R ² change Level 1	R ² change Level 2
The null model	Intercept	3151	1.58	0.05	109.12	852.18	0.00	42.42%	6.72**	26.44**		
The fixed effects models	Intercept	2997	0.74	0.08	573.28	96.22	0.00	31.46%	6.16**	26.37**	7.33%	42.26%
	Mean momentary sadness		0.63	0.05	1466.88	181.58	0.00					
	Intercept	2940	−0.07	0.21	186.93	0.10	0.75	15.92%	4.96**	26.34**	3.54%	7.23%
	Mean momentary sadness		1.01	0.09	1220.47	134.23	0.00					
	Age		0.00	0.00	351.81	1.27	0.26					
	Tiredness		0.14	0.02	1402.41	48.49	0.00					
	Age*daily emotion		−0.01	0.00	1216.66	27.95	0.00					
	N		0.00	0.00	97.83	1.47	0.23					
	E		−0.00	0.00	99.23	1.16	0.28					
	O		0.00	0.00	96.72	1.58	0.21					
	A		0.00	0.00	96.19	1.59	0.21					
	C		−0.00	0.00	97.22	0.05	0.83					

** $p < 0.001$; N, neuroticism; E, extraversion; O, openness to experience; A, agreeableness; C, conscientiousness; −2RLL refers to −2 Restricted Log Likelihood.

TABLE 4 | The evening ratings of happiness—results of the mixed models analysis of the null model and fixed effects random intercept model.

Model	Predictors	−2RLL	Estimates of fixed effects					Estimates of covariance parameters				
			EST	SE	df	F	Sig.	ICC	Wald Z across subjects	Wald Z within subjects	R ² change Level 1	R ² change Level 2
The null model	Intercept	3732	2.43	0.06	109.24	1722.76	0.00	35.54%	6.52**	26.42**		
The fixed effects models	Intercept	3562	1.31	0.09	683.31	202.90	0.00	30.06%	6.27**	26.40**	10.43%	30.17%
	Mean momentary happiness		0.54	0.04	1495.66	205.58	0.00					
	Intercept	3565	1.35	0.31	174.30	19.05	0.00	27.04%	5.87**	26.36**	3.60%	16.87%
	Mean momentary happiness		0.71	0.07	1493.89	92.34	0.00					
	Age		0.01	0.00	304.66	1.64	0.20					
	Tiredness		−0.14	0.03	1486.85	31.78	0.00					
	Age*daily emotion		−0.01	0.00	1462.99	8.62	0.00					
	N		−0.00	0.00	100.12	4.54	0.04					
	E		0.01	0.00	102.09	19.31	0.00					
	O		−0.00	0.00	100.17	0.57	0.45					
	A		−0.00	0.00	98.95	1.42	0.24					
	C		−0.00	0.00	100.18	0.04	0.85					

** $p < 0.001$; N, neuroticism; E, extraversion; O, openness to experience; A, agreeableness; C, conscientiousness; −2RLL refers to −2 Restricted Log Likelihood.

across 1 day. Surprisingly, personality traits had no significant influence on emotional experience across 1 day, except for happiness.

Retrospective Ratings across 2 Weeks

Next, the retrospective ratings over the 2-week period were assessed in order to test the hypothesis 2.

The results of the multiple regression analysis (Table 6) suggest tiredness, personality traits, and age to be important predictors of emotion evaluation over the 2-week period, supporting the hypothesis 2. Hypothesis 4 predicted that the influence of personality traits on retrospective emotion ratings differs across the measured emotion categories. Nearly all personality traits are significantly related to trait-level emotion

TABLE 5 | The evening ratings of anger—results of the mixed models analysis of the null model and fixed effects random intercept model.

Model	Predictors	-2RLL	Estimates of fixed effects					Estimates of covariance parameters				
			EST	SE	df	F	Sig.	ICC	Wald Z across subjects	Wald Z within subjects	R ² change Level 1	R ² change Level 2
The null model	Intercept	2973	1.29	0.03	109.22	1708.09	0.00	17.37%	5.47**	26.43**		
The fixed effects models	Intercept	2760	0.05	0.09	1279.38	0.27	0.60	13.24%	4.95**	26.41**	7.33%	42.26%
	Mean momentary anger		1.13	0.07	1493.09	235.00	0.00					
	Intercept	2765	-0.65	0.21	512.41	9.07	0.00	7.96%	3.84**	26.40**	2.49%	44.78%
	Mean momentary anger		1.89	0.14	1464.14	173.82	0.00					
	Age		0.02	0.00	878.16	21.87	0.00					
	Tiredness		0.06	0.02	1150.66	9.66	0.00					
	Age*daily emotion		-0.02	0.00	1399.89	40.79	0.00					
	N		0.00	0.00	104.21	1.64	0.20					
	E		-0.00	0.00	108.37	3.03	0.08					
	O		0.00	0.00	104.49	0.55	0.46					
	A		-0.00	0.00	103.41	0.89	0.35					
	C		0.00	0.00	105.22	0.12	0.73					

** $p < 0.001$; N, neuroticism; E, extraversion; O, openness to experience; A, agreeableness; C, conscientiousness; -2RLL refers to -2 Restricted Log Likelihood.

TABLE 6 | Multiple regression analysis of emotion ratings across the 2 weeks—mean of respective momentary emotion ratings, respective evening emotion ratings, personality traits, tiredness, and age as predictors.

Two-week emotion rating	Model summary			Predictors (Standardized coefficient beta)								
	R	R ²	SE	N	E	O	A	C	Age	Mean of momentary emotion ratings	Evening ratings	Tiredness
Fear	0.54	0.29	0.66	0.12**	-0.21**	0.04	0.06	0.04	-0.24**	0.13**	0.31**	0.10**
Sadness	0.70	0.45	0.71	0.28**	-0.13**	0.11*	0.03	-0.06*	-0.27**	0.09**	0.22**	0.05**
Happiness	0.55	0.30	0.75	-0.31**	0.13**	0.24**	0.08*	-0.10*	0.22**	0.26**	0.15**	0.08**
Anger	0.59	0.34	0.70	0.15**	0.05	0.15**	0.03	-0.13**	-0.27**	0.03	0.18**	0.04

* $p < 0.05$; ** $p < 0.001$; N, neuroticism; E, extraversion; O, openness to experience; A, agreeableness; C, conscientiousness.

ratings, with the trait neuroticism being important predictor for all emotion categories ($p < 0.05$). The retrospective ratings of fear are influenced by higher neuroticism ($\beta = 0.12$, $p < 0.001$) and lower extraversion ($\beta = -0.21$, $p < 0.001$). The retrospective ratings of sadness are predicted by personality traits of neuroticism ($\beta = 0.28$, $p < 0.001$), extraversion ($\beta = -0.13$, $p < 0.001$), openness to experience ($\beta = 0.11$, $p < 0.05$), and conscientiousness ($\beta = -0.06$, $p < 0.05$). The retrospective ratings of happiness are predicted by all big five personality traits: neuroticism ($\beta = -0.31$, $p < 0.001$), extraversion ($\beta = 0.13$, $p < 0.001$), openness to experience ($\beta = 0.24$, $p < 0.001$), agreeableness ($\beta = -0.08$, $p < 0.05$), and conscientiousness ($\beta = -0.10$, $p < 0.05$). The retrospective ratings of anger are predicted by neuroticism ($\beta = 0.15$, $p < 0.001$), openness to experience ($\beta = 0.15$, $p < 0.001$), and conscientiousness ($\beta = -0.13$, $p < 0.001$). There are also differences across

emotion categories, with the assessment of experienced anger and sadness across the 2 weeks depending more on evening ratings than momentary emotions—if the emotion is strong enough to be presented in evening ratings, then it also affects the emotion experience across the 2 weeks.

DISCUSSION

The current study extends previous research by exploring the effect of momentary emotions, daily tiredness, and personality on the retrospective ratings of four emotions across two age-groups across different time frames.

Previous studies have demonstrated age-related positivity effect in emotion experience (Carstensen et al., 2011). This emotional positivity can be also reflected in retrospective emotion ratings. Consistent with the third hypothesis, the

association of age and retrospective emotion ratings is moderated by the felt momentary emotions. The stronger were the momentary emotions, the stronger was the age effect, suggesting that retrospective reduction of the intensity of experienced emotions may serve as one of reactive emotion regulation mechanisms behind the positivity effect.

The Impact of Personality on Retrospective Emotion Ratings

Consistent to our fourth hypothesis, the associations between personality traits and retrospective emotion ratings differed both across emotions and time frames. The retrospective ratings of happiness are linked to personality traits of extraversion and neuroticism already in the evening ratings of the past day. At longer time frame, all Big Five personality traits have impact on emotional memories about happy feelings. Memories about experienced fear are influenced only by neuroticism and extraversion. Retrospective ratings of sadness are strongly related to neuroticism, but are also predicted by extraversion, openness and conscientiousness. Retrospective ratings of anger, however, are predicted by neuroticism, openness, and conscientiousness. However, a significant part of variability in all retrospective emotion ratings was still left unexplained by the model; this might be due to the influence of emotions experienced at the moment of recall that were not measured in the current study (i.e., situational beliefs or self-esteem as proposed by Robinson and Clore, 2002). Our study extended the results of recent study on the association between daily affect and personality traits (Komulainen et al., 2014) that showed the role of all Big Five personality traits in emotion processes. Similarly, conscientiousness was associated with lower affect levels, whereas openness to experience predicted retrospective enhancement of experienced emotions.

Taken together, current study shows the role of personality traits in affecting memories of experienced emotions, with all Big Five personality traits having a significant role in formulating retrospective emotion ratings.

Tiredness and Retrospective Emotion Ratings

Tiredness is a very common condition; it can be physical, psychological, or social. In any case, we can assume it to have an impact on one's emotional world, whereas experienced emotions can be both a cause and a consequence of tiredness. Previous studies have rather focused on sleep quantity and quality and related affect regulation problems, our findings contribute to the current knowledge of the association between tiredness and retrospective assessments of experienced emotions. There is significant influence of daily tiredness on retrospective emotion ratings across 1 day. The feeling of tiredness at the end of the day makes one to enhance the experienced negative emotions of fear, sadness and anger. In addition, the experienced happiness is seen less intense when rated at the state of evening tiredness. This result is in accordance with previous studies and supports the theorized link between the experience of tiredness and anxiety (Jiang et al., 2003; Kahneman et al., 2004). Alternatively, it has

been suggested that pre-sleep period at the evening is the first quiet time during the day available to review the day's events and one's own behavior, that may lead to more precise self-perception (e.g., Schmidt and Van der Linden, 2009). In addition, tiredness also influences retrospective ratings across 2 weeks. In general, the reported subjective feeling of tiredness is linked to affective functioning, similar to the results reported by sleep studies (Bower et al., 2010). It is suggested that at the end of the day, people have a quiet moment in order to analyze the experienced events and behavior. Findings provide further evidence for the accessibility model of emotional self-report (Robinson and Clore, 2002), suggesting that, although retrospective ratings are based on momentary experience, daily tiredness and personality traits systematically influence the way in which past feelings are seen. Our study confirms that tiredness systematically influences the memories about experienced emotions, and may, thus, lead to more negative view of life.

Age and Retrospective Ratings

Age-related differences in both emotion experience and emotional memory are well documented by previous research. The current study confirms age patterns found in previous studies, suggesting that the emotional world becomes more stable as people age (Carstensen et al., 2011). One important contribution of the current study is that age effects in retrospective ratings were found to be moderated by the experience of respective momentary emotions. The current study provides empirical support for the SOC-ER framework by Urry and Gross (2010), suggesting that the positivity effect in older adults is achieved by more effective situation selection, which brings about less negative and more positive emotions. Age-related shift of retrospective emotion rating toward more positive look is more reflected at trait-level emotion experience, and less at state level. If, however, the situation selection approach does not work and older people experience negative emotions, then the retrospective ratings are used as means for emotion regulation. The memories of experienced emotions are regulated to less intense, compared to momentary ratings. Whereas, this retrospective reassessment takes place also in the case of experienced happiness. Previous studies also show that for older people the intentional suppression of unwanted memories is more difficult (Anderson et al., 2011). Perhaps this is the wisdom that comes with experience: the use of proactive vs. reactive emotion regulation strategies. However, when momentary emotions are experienced, there is a stronger impact on emotional life for older than for younger people.

The Remembering of Past Emotions

The current study also investigated the remembering past emotions, and the factors that can be associated with the distortion of these memories. The results indicate that even when momentary emotions, age effects, personality traits, and daily tiredness are taken into account, a significant amount of variability is still left to be explained. This might reflect the influence of post-event emotions and reappraisals that shape the emotional memory. This finding is in line with previous research suggesting that a tendency exists to achieve coping in

the present by reconstructing the past (Levine and Safer, 2002). Also, in the context of the accessibility model of emotional self-report (Robinson and Clore, 2002), current research suggests that personality processes are involved rather in the long-term modification of emotional memory than during that of 1 day, operating based on semantic knowledge and one's beliefs about emotions. Also, age has more influence at trait-level, suggesting that older people tend to assess experienced emotions retrospectively into positive direction. Interestingly, tiredness can also be regarded as systematic biasing factor that interferes emotion reports both at online level, tied to specific situations, as well as at the level of semantic memory over longer periods of time.

Implications and Limitations

Identifying the systematic biases in retrospective emotion ratings that are produced by trait-level variables like age and personality traits can foster the better understanding of individual differences in daily emotional life. Our findings contribute to the current knowledge of the associations between momentary and retrospective emotion ratings, further confirming the existence of recall bias in retrospective assessment of emotions. From methodological point of view, previous studies (e.g., Sato and Kawahara, 2011) have used evening emotion ratings vs. 2-week ratings of mood. The results of our study suggest also the evening emotion ratings to be subject of both state- and trait level biases. The results further suggest that when using retrospective emotion ratings, both in clinical or research setting, one should also take into account the current psychological state (e.g., tiredness) and also the trait-level influence factors (e.g., age and personality traits). Previous studies have shown the influence of neuroticism and extraversion on remembering the past emotions (Barrett, 1997). Our study makes specific contribution in showing that also openness to experience, conscientiousness and agreeableness as traits shape the memories about emotional experiences.

Several potential limitations of the study can be noted. The most important limitation of our study is that the study sample included only two age-groups, and therefore the results cannot directly be generalized to whole population. We only used emotion ratings averaged across 1 day, future studies could also look for peak-end rule in memories of experienced emotions.

In addition, the evening questionnaires were paper-and-pen questionnaires, leaving the possibility of back-filling. Future research could be directed to advancing the understanding of other biases in memory for emotions at different points of time (e.g., different coping strategies used in different situations, etc.), and could include also middle-aged people to shed light into emotional changes across the entire lifespan.

CONCLUSIONS

Taken together, the results of the current study showed that systematic biases in retrospective emotion ratings across 1 day come from tiredness and age, whereas retrospective emotion ratings across the 2 weeks are also influenced by personality traits. Considering tiredness, personality traits, and the age effect provides new insight into individual differences in retrospective emotion ratings in the context of accessibility model of emotional self-report (Robinson and Clore, 2002). The current study replicated the previous findings of a positivity effect in emotional experience with age and extended the prior literature by showing that age-related positivity in emotional life can be partially attributed to successful use of retrospective reassessment as an emotion regulation strategy. Personality traits, however, appeared to influence a more long-term view of past emotional experience, compared to the 1-day perspective. Future research could be directed to advancing the understanding of other biases in memory for emotions, and could include also middle-aged people to shed light into emotional changes across the entire lifespan.

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The curvilinear relationship between work pressure and momentary task performance: the role of state and trait core self-evaluations

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Whereas several studies have demonstrated that core self-evaluations (CSE)—or one's appraisals about one's own self-worth, capabilities, and competences—relate to job outcomes, less is known about the mechanisms underlying these relationships. In the present study, we address this issue by examining the role of within- and between-person variation in CSE in the relationship between work pressure and task performance. We hypothesized that (a) work pressure relates to task performance in a curvilinear way, (b) state CSE mediates the curvilinear relationship between work pressure and task performance, and (c) the relationship between work pressure and state CSE is moderated by trait CSE. Our hypotheses were tested via a 10-day daily diary study with 55 employees in which trait CSE was measured at baseline, while work pressure, task performance, and state CSE were assessed on a daily basis. Bayesian multilevel path analysis showed that work pressure affects task performance via state CSE, with state CSE increasing as long as the employee feels that (s)he is able to handle the work pressure, while it decreases when the level of work pressure exceeds the employees' coping abilities. Moreover, we found that for people low on trait CSE, the depleting effect of work pressure via state CSE happens for low levels of work pressure, while for people high in trait CSE the depleting effect is located at high levels of work pressure. Together, our findings suggest that the impact of work pressure on task performance is driven by a complex interplay of between- and within-person differences in CSE.

Keywords: core self-evaluations, task performance, state, trait, within-person, between-person

INTRODUCTION

Most studies on the role of personality in work and organizational settings have focused on the Big Five dimensions, arguing that they cover a large part of what is referred to as personality (Barrick and Mount, 1991; Barrick et al., 2001). Whereas this claim has indeed been supported by a bulk of empirical research, it has also become clear that the Big Five personality dimensions are not all encompassing, with one important example being that they “fail to capture chronic differences in how individuals evaluate themselves” (Kacmar et al., 2009, p. 1572). Owing to this, scholars have started to study traits that tap more into self-evaluations. One personality dimension that is particularly relevant in this respect and that is gaining more and more popularity in the work and organization

domain is core self-evaluations (CSE)—or the appraisals a person makes about his/her own self-worth, capabilities, and competences (Judge et al., 1998).

core self-evaluations is a broad personality dimension consisting of four lower-order dimensions: self-esteem (i.e., the worthiness that is attributed to oneself as a person); generalized self-efficacy (i.e., one's beliefs about his/her ability to handle situations and solve problems); locus of control (i.e., one's beliefs regarding his/her capacity to influence life's events); and neuroticism (i.e., one's inclination to focus on negative aspects of the self and experience negative affect; Judge et al., 2003). The validity and importance of CSE for the work and organizational domain has been supported by studies that demonstrated its predictive validity over and beyond each of the four separate CSE sub-dimensions (Erez and Judge, 2001), and over and beyond each of the Big Five personality dimensions (Judge et al., 2008) for the prediction of important work outcomes such as performance and job satisfaction.

Although previous research has shown that there is a relationship between stable, between-person differences in CSE and stable, between-person differences in job outcomes, no studies have focused on *if* and *how* CSE relates to job outcomes on a day-to-day basis. Nevertheless, such an understanding is important, both from a theoretical and a practical point of view. Theoretically, shifting the attention from between- to within-person fluctuations implies that CSE is no longer conceptualized as fixed, but rather as something that dynamically fluctuates as a function of everyday experiences. Hence, it becomes important to not only study the consequences of CSE, but also its day-to-day antecedents; an endeavor that will significantly increase our understanding of the mechanisms underlying the elicitation and functioning of CSE at work. On a practical level, conceptualizing CSE as a construct that is subject to within-person variation might open the door for job (re)design that takes into account these within-individual fluctuations or for various types of managerial interventions aimed at increasing employee CSE. In the present paper, we aim to expand our understanding of the mechanisms underlying day-to-day fluctuations in CSE by examining (a) how day-to-day variation in work pressure is related to day-to-day variation in CSE, (b) how variable, within-person differences in CSE dynamically interact with stable, between-person differences in CSE, and (c) how within- and between-person differences in CSE together relate to job performance.

Within-person Fluctuations in CSE

Although CSE has traditionally been conceptualized as a stable personality trait (Judge et al., 1998), recent research indicates that it not only varies between but also within individuals (Schinkel et al., 2004; Debusscher et al., 2015b; Dóci and Hofmans, 2015). This is not surprising as self-efficacy, self-esteem, and neuroticism—all being sub-dimensions of CSE—have been shown to consist of a stable, between- as well as a variable, within-person component (Heatherton and Polivy, 1991; Bandura, 2006; McNiel and Fleeson, 2006; Debusscher et al., 2014, 2015a). Thus, even though individuals are inclined to habitually view themselves in a more positive or negative light, recent research suggests that their self-evaluations vary across time and in different circumstances

(Judge and Kammeyer-Mueller, 2004); an idea that closely aligns with the new framing in personality psychology that focuses not only on between-, but also on within-person fluctuations (Fleeson, 2001; Funder, 2009). In line with this, the present study aims to reconcile the stable trait and the variable state perspectives by examining how state and trait CSE dynamically interact in daily working life.

To do so, we start from the Core Self-evaluations Job Affect Multilevel (CSEJAM) model of Judge et al. (2012). According to this model, variation in one's work and life environment trigger variation in state CSE, which in turn relates to job affects and affect-driven behaviors. Turning to the interplay between trait and state CSE, Judge et al. (2012), in their CSEJAM model, argue that trait CSE moderates the relationship between the situational triggers and state CSE because it influences the extent to which the work and life environment trigger increases or decreases in state CSE. In other words, the CSEJAM model conceptualizes trait CSE as individual differences in the sensitivity to CSE-relevant situational provocation; a conceptualization that is also adopted in well-known person-situation interactionism models such as Trait Activation Theory (Tett and Guterman, 2000) and the Traits as Situational Sensitivities Model (Marshall and Brown, 2006).

In the present study, we draw on the CSEJAM model to study the relationships between work pressure, trait and state CSE, and task performance. The reason for focusing on work pressure as an antecedent and task performance as an outcome of state CSE is threefold. First, work pressure and task performance are everyday constituents of working life (Minbashian et al., 2010). Second, they are elements of all working environments, and therefore they generalize across tasks and situations. Third, research shows that a stressful working environment relates to correlates of CSE, such as stress, anxiety (Wood et al., 2011), self-efficacy, hope, optimism, and resiliency (Newman et al., 2014), while CSE (Chang et al., 2012) as well as its different subdimensions (Judge and Bono, 2001) has been shown to relate to task performance. In what follows, we will first discuss the within-person relationships between work pressure, state CSE, and task performance, and subsequently, we will discuss the moderating effect of trait CSE.

Relating Work Pressure to Task Performance: The Mediating Role of State CSE

Recent research suggests that not all job demands are alike and that it is important to distinguish between hindrance and challenge demands (LePine et al., 2005). Hindrance demands, such as role conflict or red tape, are typically perceived as opposing personal growth and achievement, which implies that, even if employees are able to overcome them, they offer little to no potential gain (Cavanaugh et al., 2000). Instead, challenge demands such as task complexity and work pressure are perceived by employees as opportunities to learn and achieve, and therefore they create an opportunity for personal growth and goal achievement (Cavanaugh et al., 2000). However, besides their motivational effect, challenge demands are also energy-draining, manifested in the positive relationship with psychological strain and ill health

(Boswell et al., 2004; LePine et al., 2004, 2005; Podsakoff et al., 2007).

The theory and empirical research on challenge demands suggest that work pressure has the potential to stimulate as well as deplete work outcomes; a dual function that is supported by an inverted U-shaped relationship between challenge demands on one hand and performance, motivation, job satisfaction, and other important work outcomes on the other hand (Xie and Johns, 1995; De Jonge and Schaufeli, 1998; Zivnuska et al., 2002). To explain this curvilinear relationship, researchers often draw on the Yerkes-Dodson law (Yerkes and Dodson, 1908) and activation theory (Gardner, 1986; Gardner and Cummings, 1988). Both theories suggest that at very low levels of activation, people are apathetic. Therefore, increases in work-related stimulation have an energizing effect when the current stimulation level is low. However, when the activation level is already high, increasing the level of work pressure further, might trigger the individual's feeling that s/he can no longer cope with the high demands (Boswell et al., 2004; Webster et al., 2010), and under these conditions, performance, motivation, and other work-related outcomes start to deplete. Therefore, drawing on the Yerkes-Dodson law (Yerkes and Dodson, 1908) and activation theory (Gardner, 1986; Gardner and Cummings, 1988), we expect within-person variation in work pressure to relate to within-person variation in task performance in an inverted U-shaped way.

Hypothesis 1: Work pressure has an inverted U-shaped within-person relationship with task performance.

As mentioned above, work pressure has an energizing effect as long as the individual feels that s/he is able to cope with the demands at hand, while it becomes counterproductive if the level of work pressure exceeds the individual's coping abilities (Boswell et al., 2004; Webster et al., 2010). Because state CSE reflects the momentary appraisals a person makes about his/her own self-worth, capabilities, and competences to cope with the environmental demands (Judge et al., 1998), we expect variation in perceived work pressure to trigger variation in state CSE. In particular, when working under little work pressure, people may feel in control, but at the same time they might feel understimulated, frustrated, and passive (Gardner, 1986; Gardner and Cummings, 1988; Zivnuska et al., 2002). As a result of this mixture of experiences, their state CSE will be sub-optimal. Instead, when experiencing a level of work pressure that is demanding but feasible "people are likely to believe that there is a positive relationship between efforts expended on coping with these demands, and also likely to believe that if these demands are met, valued outcomes will occur." (LePine et al., 2005, p. 765). Under these conditions the person's sense of self-esteem (Rodell and Judge, 2009), self-efficacy, and control is enhanced because of the perceived relationship between efforts and results, while positive emotions are triggered (LePine et al., 2005) because the person expects to obtain valued outcomes. This mixture of ingredients (i.e., high self-esteem, self-efficacy, and control, combined with low negative emotions or low state neuroticism) represents an optimal level of state CSE. Finally, when work pressure grows further it might become overwhelming, thereby depleting the sense of self-efficacy and self-worth, evoking the feeling that the

person is no longer in control, and boosting state neuroticism because of increased feelings of anxiety (Zivnuska et al., 2002). In other words, when job demands become excessive, they exhaust one's personal resources—which in this study are captured by CSE—(Bakker et al., 2003, 2004). This idea of a curvilinear relationship between job demands and how one acts, feels, and thinks has been supported by research showing that challenge stressors relate curvilinearly to anxiety and emotional exhaustion (Xie and Johns, 1995; De Jonge and Schaufeli, 1998). In summary, we suggest that the relationship between work pressure and state CSE is inverted U-shaped; it peaks at moderate levels and declines at low and high levels of work pressure.

Hypothesis 2: Work pressure has an inverted U-shaped within-person relationship with state CSE.

In the foregoing, we have argued that within-person variation in work pressure triggers within-person variation in CSE, and that performance varies as a function of the extent to which the individual feels that s/he can cope with the situational demands, which in the present study is captured by the level of state CSE. Although there is to the best of our knowledge only one within-person study on the positive relationship between CSE and task performance (Debusscher et al., 2015b), meta-analytical research has shown that, at the between-person level, CSE (Chang et al., 2012) as well as its four sub-dimensions (Judge and Bono, 2001) is positively related to task performance. An important reason for the positive relationship between CSE and task performance is that individuals who are high on CSE are better at setting goals, working toward them, and are as a result more motivated to perform their jobs. Indeed, both in a lab experiment and a field study, Erez and Judge (2001) demonstrated that CSE related to task motivation, persistence, goal setting, goals commitment, activity level, and task performance. Building on these findings, we hypothesize that day-to-day variation in state CSE relates positively to day-to-day variation in task performance, which, when combined with the foregoing hypotheses, implies that state CSE is expected to mediate the curvilinear within-person relationship between work pressure and task performance.

Hypothesis 3: State CSE mediates the inverted U-shaped within-person relationship between work pressure and task performance.

The Impact of Trait CSE on the Within-person Work Pressure-state CSE Relationship

Following the CSEJAM model (Judge et al., 2012) and person-situation interactionism models, we expect trait CSE to moderate the relationship between work pressure and state CSE. This expectation follows from the conceptualization of traits as individual differences in the sensitivity to situational provocation. Moreover, it relates to the concept of contingent units of personality, which represent the extent to which a single individual's expression of a personality trait is contingent upon a specific feature of the situation (Minbashian et al., 2010). Building on the idea of traits as situational sensitivities, we argue that trait CSE relates to contingent units of CSE (i.e., the extent to which CSE is contingent upon work pressure).

In particular, and in line with Trait Activation Theory (Tett and Guterman, 2000) and the Traits as Situational Sensitivities Model (Marshall and Brown, 2006), we expect the within-person relationship between work pressure and state CSE to be weaker for people high on trait CSE than for people low on trait CSE. That is, for a person high in trait CSE, we expect the level of state CSE to be less contingent upon the level of work pressure because they are less susceptible to it. This reasoning is in line with the finding that people high in trait neuroticism react more strongly to negative environmental features than people low in neuroticism, even when confronted with relatively small problems (Suls and Martin, 2005; Debusscher et al., 2015a). In the same vein, Bolger and Schilling (1991) demonstrated that people high in trait neuroticism have an increased reactivity to stressful situations. Regarding self-efficacy, O'Connor et al. (2009) demonstrated that people with low trait self-efficacy are more susceptible to hassles than people high on trait self-efficacy. Finally, for self-esteem, it has been shown that people high in trait self-esteem are protected from the effects of external factors (Mossholder et al., 1981). As emotional stability (being the counterpart of neuroticism), high self-esteem, and high self-efficacy are indicators of high CSE, these findings suggest that people high in trait CSE might be less susceptible to variation in work pressure than low trait CSE people.

Hypothesis 4: Trait CSE moderates the within-person relationship between work pressure and state CSE, such that the relationship is stronger in individuals with lower trait CSE.

MATERIALS AND METHODS

Participants

Fifty-five employees (33 women) from different Belgian companies participated in the study. On average, respondents were 44.31 years old ($SD = 11.29$) and their mean company tenure was 15.65 years ($SD = 11.97$). Fifteen participants had a secondary school degree, 12 completed a higher professional education, and 28 completed higher academic education. In terms of job content, 16 worked in logistics and distribution, 13 in governmental and non-profit organizations, 6 in health care, 6 in telecom, 4 in the financial sector, 1 in chemistry and pharmacy, 3 in human resources, 2 in communication, and 4 in other jobs. Ten participants worked part-time (seven participants worked 4 days, one participant worked 3 days, and two worked 2.5 days a week), and they only filled out the daily questionnaires on days on which work was done.

Procedure

The study was approved by the Human Research Ethics Committee of the Vrije Universiteit Brussel (Dossier ECHW2015-17). We recruited participants in several ways. We posted a call on the intranet of the Flemish education networks, in the alumni newsletter of the Vrije Universiteit Brussel, and we emailed personal contacts. In these calls, we explained the goal of the study and stressed that the anonymity of records would be ensured. We only contacted people again who indicated that

they were willing to participate in the study (via email or orally).

Participants were enrolled in a 10-day daily diary study in which trait CSE was measured at baseline, while work pressure, state CSE, and task performance were assessed daily. For the daily diary part, participants received an email each working day including a link to a survey in which they had to report on their level of work pressure, state CSE, and level of task performance, and they did so for 10 consecutive working days. At the beginning of each survey, we again stressed that the data would be made anonymous. Moreover, participants could stop participating in the study whenever they wanted. All scales, as well as the items within each scale, were randomized. Following this procedure, we collected 327 out of a maximum of 550 (55 employees \times 10 days) data points, corresponding to a response rate of 59.45 percent.

Measures

Trait CSE

Trait CSE was measured using the twelve-item CSE-scale of Judge et al. (2003). An example item of this scale is "Overall, I am satisfied with myself." The items were rated on a seven-point scale, ranging from "completely disagree" to "completely agree." The alpha reliability coefficient of this scale was 0.84.

State CSE

Because personality states can be defined as momentary enactments that have "the same affective, behavioral, and cognitive content as their corresponding traits" (Fleeson, 2012, p. 52), state CSE was also measured using the trait CSE-scale of Judge et al. (2003). To allow for a momentary or state measure of CSE, we slightly adapted the items (e.g., "Since this morning, I was satisfied with myself"). The items were rated on a seven-point scale, ranging from "completely disagree" to "completely agree." To test the reliability of the scale, we used the multilevel confirmatory factor analysis approach of Geldhof et al. (2014), which revealed that the within-person omega reliability coefficient was 0.73.

Work Pressure

Work pressure was measured using the three-item scale of Bakker et al. (2003). Similar to the state CSE scale, we slightly adapted it to allow for daily ratings of work pressure (e.g., "Today, I had too much work to do"). All items had to be rated on a seven-point scale, ranging from "completely disagree" to "completely agree." The within-person omega reliability coefficient was 0.80.

Task Performance

Task performance was measured using the seven-item task performance subscale of Williams and Anderson (1991). Similar to the state CSE scale, we slightly adapted it to allow for momentary self-ratings of performance (e.g., "Since this morning, I adequately completed assigned duties"). The seven items had to be rated on a seven-point scale, ranging from "completely disagree" to "completely agree." The within-person omega reliability coefficient equaled 0.75.

TABLE 1 | Means, standard deviations, intra-class correlations and correlations for all study variables.

	M	SD	ICC _{between-person}	ICC _{within-person}	1	2	3
1. Work pressure	3.09	1.11	0.55	0.45			
2. State CSE	5.34	0.91	0.77	0.23	0.01		
3. Task performance	5.60	0.76	0.45	0.55	0.26**	0.33**	
4. Trait CSE	5.05	0.81	—	—	0.34*	0.77**	0.37**

** $p < 0.01$ (two-tailed); * $p < 0.05$ (two-tailed); M, mean; SD, standard deviation; ICC, intra-class correlation. The correlations between work pressure, state CSE, and task performance are within-person correlations (i.e., computed on person-centered data; $N = 327$). The correlations with trait CSE are between-person correlations (i.e., to compute them, work pressure, state CSE, and task performance were aggregated to the person-level; $N = 55$).

Analyses

Because of the complexity of the mediation model, we first tested all hypothesized relationships separately using two-level regression analyses with the lme4 package in R (Bates, 2010). All level-1 predictors (i.e., work pressure and state CSE) were person-centered, while the level-2 predictor (i.e., trait CSE) was grand-mean centered. This procedure ensures that the level-1 predictors contain within-person variability only, which is necessary because the hypotheses regarding the relationships between work pressure, state CSE, and task performance pertain to the within-person level. To test whether the effect of the level-1 predictors was consistent across individuals, we tested whether a model with a random slope on the between-person level fitted our data significantly better than a model without random slopes. Both models were compared using a log-likelihood difference test, and when the slope was non-significant ($p > 0.05$), it was trimmed.

Next, the hypotheses were tested simultaneously using Bayesian two-level path modeling in Mplus version 7.3 (Muthén and Muthén, 1998–2012). We used Bayesian estimation because it can flexibly accommodate non-normal distributions (Muthén, 2010; Kruschke et al., 2012; Zyphur and Oswald, 2013), which is important when testing for mediation using the product-of-coefficients approach (i.e., the product of two coefficients is traditionally non-normally distributed). Moreover, it allows testing complicated models. An important difference between Bayesian and the more traditional—frequentist—approach is that Bayesian analysis does not yield p -values and confidence intervals. Instead, for each parameter in the model, Bayesian analysis yields a posterior distribution, which shows the probability distribution of the parameter given the data (Kruschke et al., 2012; Zyphur and Oswald, 2013). Based on these posterior distributions, credibility intervals can be constructed. These credibility intervals include a predefined percentage of the posterior distribution (e.g., 95%), thereby returning the most credible values of the parameter. For our Bayesian analysis, we will draw on these credibility intervals to help deciding which parameter values should be deemed credible or not (Kruschke et al., 2012).

RESULTS

Means, standard deviations, correlations, and intra-class correlations (ICCs) of work pressure, state CSE, momentary task performance, and trait CSE are shown in **Table 1**. These ICCs show, for each level-1 variable, the proportion of variation due to between- and within-person differences. Overall, the ICCs show

that a substantial part of the variability in work pressure, state CSE, and task performance is due to within-person differences.

Next, we tested the hypothesized relationships by means of a series of two-level regression analyses. First, we tested whether within-person fluctuations in work pressure relate in an inverted U-shaped way to within-person fluctuations in task performance (i.e., Hypothesis 1). To do so, we predicted momentary task performance from work pressure and work pressure squared (work pressure was person-centered before computing the squared effect). Moreover, we tested whether these relationships varied across individuals. In line with Hypothesis 1, we found that both the linear ($\gamma = 0.18$; $p = 0.004$) and the quadratic ($\gamma = -0.11$; $p = 0.041$) component of work pressure related to momentary task performance (see **Figure 1**). Furthermore, the impact of both the linear ($\sigma^2 = 0.08$; $p < 0.001$) and the quadratic ($\sigma^2 = 0.02$; $p = 0.003$) component differed across individuals. Next, we tested whether there is an inverted U-shaped within-person relationship between work pressure and state CSE (i.e., Hypothesis 2). This analysis revealed that the quadratic ($\gamma = -0.10$; $p = 0.015$), but not the linear ($\gamma = 0.03$; $p = 0.434$) component of work pressure related to state CSE, thereby supporting Hypothesis 2. Moreover, we found between-person differences in the strength of the relationship between the linear component of work pressure and state CSE ($\sigma^2 = 0.02$; $p = 0.006$), but not in the relationship between the quadratic component of work pressure and state CSE ($\sigma^2 = 0.01$; $p = 0.614$). Thirdly, we tested the moderating effect of trait CSE on the relationship between work pressure and state CSE (i.e., Hypothesis 4). This was done by adding the main effect of trait CSE as well as the interaction between trait CSE and the linear component of work pressure to the previous model. In line with Hypothesis 4, this analysis showed that trait CSE negatively moderated the relationship between work pressure and state CSE ($\gamma = -0.12$; $p = 0.024$). Moreover, there was a positive direct effect of trait CSE on state CSE ($\gamma = 0.80$; $p < 0.001$). A graphical representation of this moderation effect is shown in **Figure 2**, which shows that the level of state CSE of people high on trait CSE is less affected by the level of work pressure these people experience. Finally, we tested a model in which momentary task performance was predicted by state CSE, work pressure, and work pressure squared¹. This analysis showed that state CSE ($\gamma = 0.36$; $p < 0.001$) and work pressure ($\gamma = 0.17$; $p = 0.004$) related positively to momentary

¹Although this test does not directly addresses one of our hypotheses, we performed it to decide whether or not to include random slopes for the direct effects (i.e., the relationships between work pressure and work pressure squared on one hand and momentary task performance on the other hand) in the Bayesian path model.

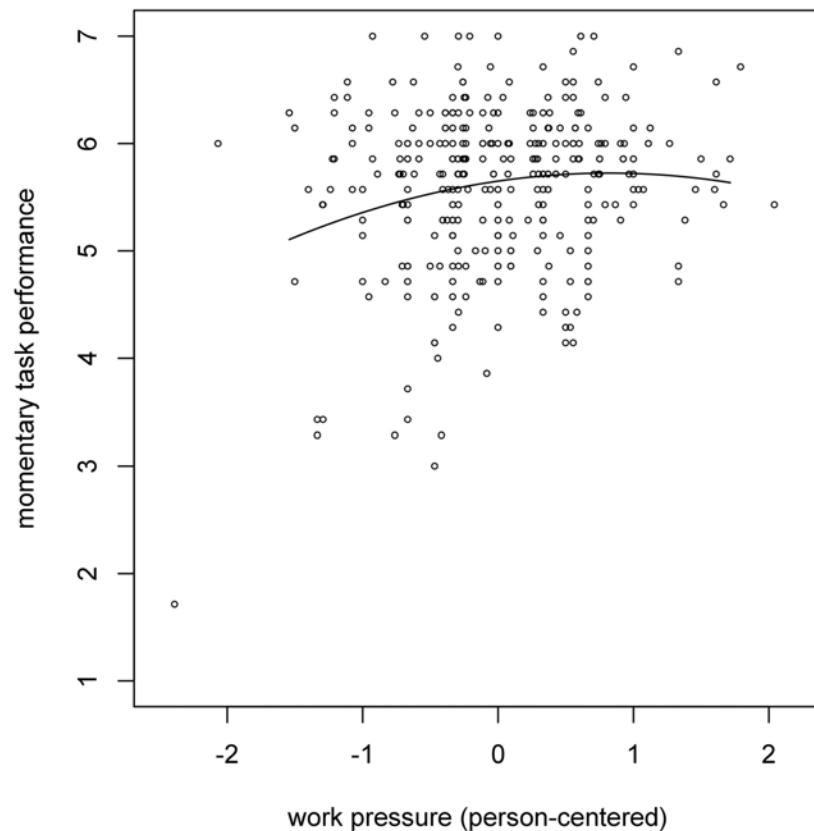


FIGURE 1 | Momentary task performance as a function of work pressure. The work pressure scores are person-centered.

task performance, but work pressure squared did not ($\gamma = -0.06$; $p = 0.210$). Moreover, the impact of work pressure ($\sigma^2 = 0.07$; $p < 0.001$) and work pressure squared ($\sigma^2 = 0.01$; $p = 0.019$) differed across individuals, while this was not the case for state CSE ($\sigma^2 = 0.01$; $p = 0.241$).

Next, we tested the moderated mediation model in its entirety using Bayesian two-level path analysis. To this end, a model was tested in which state CSE was predicted by the linear and squared effect of work pressure, while momentary task performance was predicted from state CSE and the linear and squared effect of work pressure (all these relationships were modeled at the within-person level). Moreover, and in line with the results of the multilevel regression analyses, we included random slopes for the relationship between work pressure and state CSE, the relationship between work pressure and momentary task performance, and the relationship between work pressure squared and momentary task performance. At the between-person level, the random slope between work pressure and state CSE was regressed on trait CSE². To formally test the indirect (mediation) effect of work pressure on momentary task performance via state CSE (i.e., Hypothesis 3), we relied on the approach of Hayes and Preacher (2010), which is specifically developed for testing non-linear mediation. Because the relationship between work pressure

(X) and state CSE (i.e., the *a*-path) is curvilinear, while the relationship between state CSE and momentary task performance (i.e., the *b*-path) is linear, the mediation effect not only depends on the *a*- and *b*-paths, but also on X, which implies that the effect of work pressure on momentary task performance via state CSE is conditional on the level of work pressure. Because of this reason, Hayes and Preacher (2010) refer to the indirect effect as the instantaneous indirect effect, which is the effect of the predictor on the outcome through the mediator(s) at a specific value of the predictor.

A graphical representation of the instantaneous indirect effects, together with the 95% credibility intervals for people low (-1 SD), average, and high ($+1$ SD) on trait CSE is shown in **Figure 3**. From this figure, it can be seen that for low levels of work pressure the instantaneous indirect effect of work pressure on task performance via state CSE is positive [e.g., for people with a low (-1 SD) trait CSE score the instantaneous indirect effect equals 0.23 when the level of work pressure is low (i.e., a score of -2)]. This implies that, when work pressure is low, further increases in work pressure promote task performance via their effect on state CSE. Moreover, because the curves—describing the instantaneous indirect effect—decrease, the motivational effect of increases in work pressure weakens with increased levels of initial work pressure. On the contrary, for high initial levels of work pressure, the instantaneous indirect effect of work pressure on task performance via state CSE is negative [e.g., for people with

²The results from the Bayesian path analysis fully replicated the findings of the separate regression analyses.

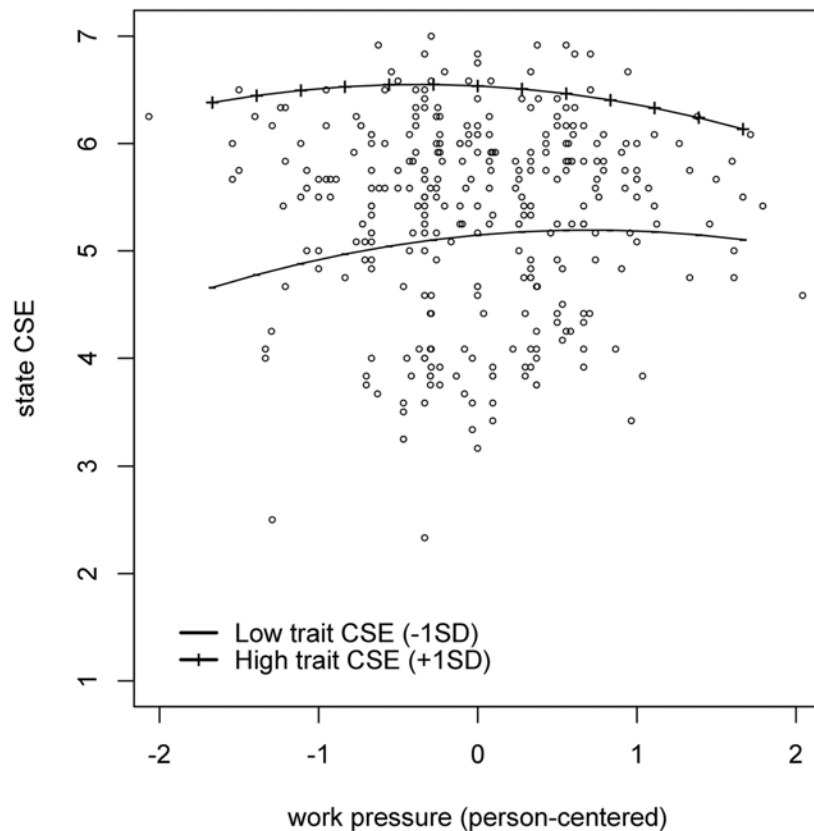


FIGURE 2 | State Core Self-Evaluations as a function of work pressure. The work pressure scores are person-centered.

a low (-1 SD) trait CSE score the instantaneous indirect effect equals -0.13 when the level of work pressure is high (i.e., a score of 2)]. This means that further increases in work pressure deplete task performance via their negative effect on state CSE. Moreover, this depleting effect becomes stronger when the initial level of work pressure is higher (which can be seen from the fact that the curves decrease). Combined, **Figure 3** thus provides support for a curvilinear mediation effect (i.e., Hypothesis 3) as increases in work pressure are promoting task performance via state CSE when the level of work pressure is low, while they deplete task performance via state CSE when the level of work pressure is high. Regarding the moderation effect of trait CSE, **Figure 3** shows that for people low in trait CSE the depleting effect of work pressure via state CSE especially holds for low levels of work pressure, while for people high in trait CSE the depleting effect is especially located at high levels of work pressure. This can be seen from the fact that the curves shift downward when going from low to high trait CSE, and from the fact that the 95% credibility intervals contain 0 at high (respective low) values of work pressure for people low (respective high) in trait CSE.

DISCUSSION

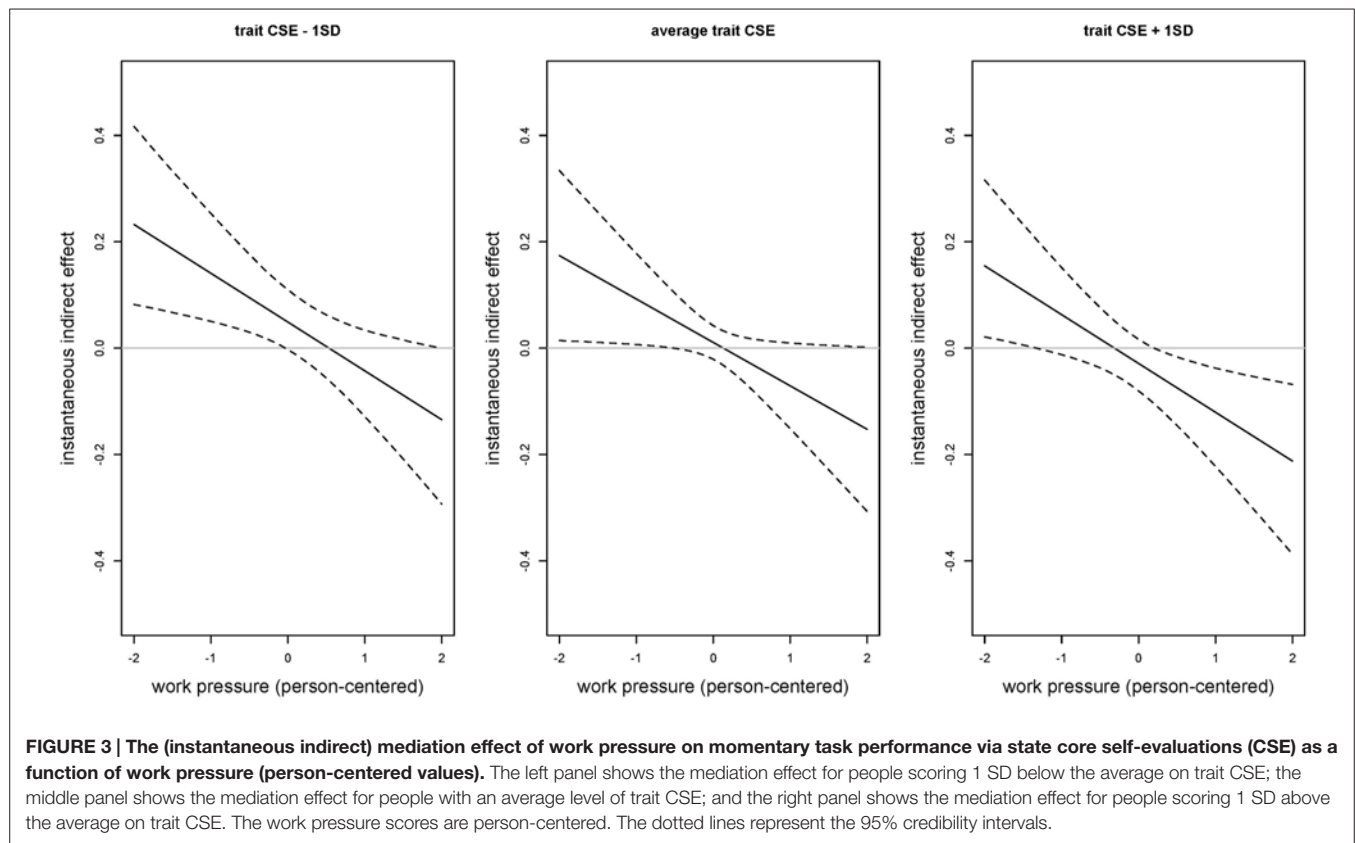
With the present paper, we contributed to a better understanding of the role of CSE at the workplace. This was done by (a) shedding light on a work-related trigger (i.e., perceived work

pressure) and consequence (i.e., task performance) of state CSE and (b) by revealing the unique way in which state and trait CSE interact. This is a major contribution to the literature on CSE, as it uncovers the mechanisms through which CSE relates to work outcomes in everyday working life. In what follows, we will discuss the theoretical and practical implications of our findings.

Theoretical Implications

In line with the CSEJAM model (Judge et al., 2012) and person-situation interactionism models (Tett and Guterman, 2000; Marshall and Brown, 2006), we found that trait CSE can be conceived of as individual differences in the extent to which appraisals about one's sense of self-worth, capabilities, and competence depend on environmental stimulation. This showed from the fact that the relationship between work pressure and state CSE differed as a function of the individual's level of trait CSE.

Importantly, our findings not only support, but go well beyond the mechanisms proposed by person-situation interactionist models such as Trait Activation Theory (Tett and Guterman, 2000) and the Traits as Situational Sensitivities Model (Marshall and Brown, 2006) by showing that the mediation effect of work pressure on task performance via state CSE is not only quantitatively, but also qualitatively different for people with different levels of trait CSE. That is, for people low in trait CSE,



the depleting effect of work pressure via state CSE operates for low but not for high levels of work pressure, while for people high in trait CSE the depleting effect is located at high but not at low levels of work pressure. Altogether, this suggests that, depending on one's trait CSE level, qualitatively different mechanisms might be at play.

We suggest that this dual mechanism can be explained by goal setting (Locke and Latham, 1990) and self-discrepancy theory (Higgins, 1987). In particular, low levels of work pressure might not pose a problem for people high in trait CSE because these individuals have a higher level of goal setting motivation (Erez and Judge, 2001). An important reason for this might be that goal commitment—which is an element of goal setting motivation—is a function of expected goal attainment, and this is per definition higher in people who are high in trait CSE. Because people high in trait CSE have higher levels of goal commitment, they do not require external pressure to perform well. People low in trait CSE, in contrast, do not have this strong base of resources, and therefore rely more on external pressures to regulate their behavior. Indeed, because they are less likely to believe that they can achieve what they want to achieve, their level of goal commitment is generally lower. Therefore, their level of state CSE is more strongly influenced by external pressures when the level of work pressure is low. The result of all of this is that under conditions of low work pressure, the level of state CSE of high trait CSE people is virtually unaffected when work pressure decreases, while the level of state CSE of low trait CSE people decreases because of the combination of under-stimulation and a lack of

goal setting motivation. Turning to high levels of work pressure, we believe that the reason for the detrimental effect of increased levels of work pressure on the state CSE of individuals high on trait CSE, may be that their self-image strongly relies on the idea that they succeed in whatever they undertake. However, when they come across a situation in which the level of work pressure is (too) high, this high sense of achievement gets threatened, which, according to self-discrepancy theory (Higgins, 1987), leads to a flow of negative emotions such as disappointment, dissatisfaction, sadness, and depression. People with a low trait CSE level, in turn, should experience these feelings of self-discrepancy to a lesser extent because for them not being able to cope with the demands at hand is nothing new, and is more congruent with their self-image. As a result, under high work pressure, the level of state CSE of people high on trait CSE decreases when high work pressure increases further due to increasing feelings of self-discrepancy, while the state CSE level of people low on trait CSE does not decrease substantially because being unable to meet demands is not perceived as a shock for their self-image. It should be noted that, to formally test this dual mechanisms account, future research is needed in which goal commitment and self-discrepancy are measured along with work pressure, state CSE, trait CSE and task performance.

A possible alternative explanation for the finding that there are qualitatively different mediation effects for people high and low on trait CSE is that the levels of perceived work pressure might not be comparable. Because we person-centered the perceived work pressure scores, all between-person differences in work pressure

were removed from the data. Yet, it might be that the baseline of work pressure is higher for trait CSE people, as they seek and create jobs that offer challenges; an idea that aligns with the finding that people select situations that are congruent with their personality (Emmons et al., 1986; Côté and Moskowitz, 1998; Frederickx and Hofmans, 2014). Because of this (which is by the way supported by the positive correlation between the person's average level of work pressure and his/her trait CSE level), people high on trait CSE might experience generally higher levels of work pressure than people low on trait CSE. As a result, for people high on trait CSE, levels of work pressure that are lower than usual can still be relatively high, and therefore they might still be challenging and not be associated with apathy. Conversely, levels of work pressure higher than usual might be extremely high for people high in trait CSE, which would then lead to overload and depletion of their state CSE level. For people low in trait CSE, levels of work pressure lower than usual may be very low and therefore offer no stimulation at all, hence depleting their state CSE level. When experiencing more work pressure than usual, the level of work pressure might be high, but still manageable for those low in trait CSE; and therefore it should not relate to decreased levels of state CSE. We tested this alternative explanation by regressing state CSE on the grand-mean centered work pressure scores (which contain both between- and within-person variability). Although the effects are weaker (i.e., the effects of work pressure squared and the interaction between trait CSE and work pressure are only significant at the $p < 0.10$ level), the pattern of findings was similar to that found with person-centered scores. This implies that between-person differences in work pressure cannot fully explain the qualitatively different mechanisms. However, to find a definite answer to the question whether individual differences in the average level of work pressure might explain why people with different trait CSE levels react differently to work pressure, future research is needed. One way to do so would be to manipulate work pressure rather than to measure it.

Practical Implications

In line with previous findings on challenge demands, our study shows that, up to some point, work pressure might stimulate state CSE and task performance. This implies that managers should not always try to decrease the level of work pressure. Instead, they might try to keep work pressure at a moderate level as this seems to work best with all employees. Additionally, our findings also revealed that the mechanism relating work pressure to task performance is different for people with different trait CSE levels. While increasing low levels of work pressure can activate people low on trait CSE because it increases their state CSE level, it has little effect on people high on trait CSE. This implies that

managing the level of work pressure is especially relevant when the employee is low in trait CSE, as for these people increasing challenge demands can trigger resources. Finally, very high levels of work pressure should always be avoided as they strongly deplete the state CSE of people high, and do no longer activate the state CSE of people low in trait CSE.

Limitations and Future Research

Despite its strong points, our study is also subject to some limitations. First, all data were self-reported and came from a single source. Whereas self-reports are needed to measure CSE, they might be problematic for work pressure and task performance because of self-serving biases. Yet, because of the way we centered the data (i.e., relative to the individual's own baseline), consistent over- or underestimations of the level of work pressure and task performance are absorbed by the individual's average and are therefore removed from the data. As a result, stable, between-person differences in self-serving biases cannot account for our findings. However, when the degree of over- or underestimation varies as a function of one's level of state CSE, this cannot be resolved with person-centering the data. To solve this issue, one should rely on other-rated work pressure and task performance and/or on objective measures of these variables. Note, however, that collecting other-ratings might be challenging in a daily diary study as peers or supervisors typically do not monitor one's task performance on a day-to-day basis. Objective task performance, on the other hand, may resolve the issue of self-serving bias, but introduces external validity issues as objective task performance can only be collected for a very limited number of occupational groups.

A second limitation is that the data are correlational in nature. This implies that we were able to show that work pressure, state CSE, and task performance were related at the within-person level, but not that work pressure caused state CSE, and that state CSE in turn led to task performance. To test such causal relationships, experimental research is needed.

Conclusion

Our findings suggest that the impact of work pressure on task performance is driven by a complex interplay of between- and within-person differences in CSE. Regarding this interplay, we supported and extended the idea of traits as individual differences in the susceptibility to situational provocation by (a) showing that trait CSE predicts how people react to within-person fluctuations in work pressure, and (b) that this differential reactivity is qualitatively different for people low and high in trait CSE. These findings have important implications for future research and practice because they suggest that different mechanisms are at play.

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Aesthetic Emotions and Aesthetic People: Openness Predicts Sensitivity to Novelty in the Experiences of Interest and Pleasure

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There is a stable relationship between the Openness/Intellect domain of personality and aesthetic engagement. However, neither of these are simple constructs and while the relationship exists, process based evidence explaining the relationship is still lacking. This research sought to clarify the relationship by evaluating the influence of the Openness and Intellect aspects on several different aesthetic emotions. Two studies looked at the between- and within-person differences in arousal and the emotions of interest, pleasure and confusion in response to visual art. The results suggest that Openness, as opposed to Intellect, was predictive of greater arousal, interest and pleasure, while both aspects explained less confusion. Differences in Openness were associated with within-person emotion appraisal contingencies, particularly greater novelty-interest and novelty-pleasure relationships. Those higher in Openness were particularly influenced by novelty in artworks. For pleasure this relationship suggested a different qualitative structure of appraisals. The appraisal of novelty is part of the experience of pleasure for those high in Openness, but not those low in Openness. This research supports the utility of studying Openness and Intellect as separate aspects of the broad domain and clarifies the relationship between Openness and aesthetic states in terms of within-person appraisal processes.

Keywords: Openness/Intellect, interest, knowledge emotions, aesthetics, personality processes, appraisals, multi-level modeling

INTRODUCTION

"It is art that makes life, makes interest, makes importance... and I know of no substitute whatever for the force and beauty of its process."

-Henry James

Making and appreciating art is a quintessentially human behavior, but not everyone would agree with the sentiment expressed by Henry James above. Divergent opinions about the importance of art and experiences with art make the study of individual differences a crucial part of aesthetic science—after all, it is said that beauty is in the eye of the beholder. However, in psychological aesthetics there are still gaps in what is known about both the beauty and the beholder. Psychological aesthetics has primarily focused on one aspect of the aesthetic experience in the form of liking, pleasure and preference. Aesthetics associations with personality—primarily

Openness/Intellect—have focused almost exclusively on individual differences in liking different types of art. Further, little work has gone into understanding the processes underlying the relationship between aesthetics and Openness/Intellect. This is problematic because the nature of the personality/art appreciation relationship could seem circular, given that personality items directly mention aesthetic engagement when measuring Openness/Intellect.

In the current study, we extend previous research investigating the relationship between Openness/Intellect and aesthetic appreciation in three ways. First, we model the appraisal processes underlying the emotions of interest, pleasure, and confusion. This extends previous research by considering three distinct emotions rather than pleasure only. Second, we test whether the aspects of Openness and Intellect differentially predict these three emotional states. This extends previous research by considering the two different aspects of Openness/Intellect, rather than the broad domain only. Third, we test whether the aspects of Openness and Intellect differentially predict within-person appraisal processes underlying these three emotional states. This extends previous research by considering within-person processes, rather than between-person associations only. By integrating these various elements we intended to answer the question: *Why* are those higher in Openness/Intellect more aesthetically engaged?

Aesthetic People

Openness/Intellect is the personality domain of the aesthetically sensitive, according to many areas of research. It is the best predictor of positive aesthetic attitudes and participation in aesthetic activities such as visiting museums, reading literature, and creating art (McManus and Furnham, 2006). Previous findings have demonstrated Openness/Intellect to be the best personality predictor of artistic creativity (Feist, 1998; Silvia et al., 2009b) and vocational interests related to the arts (Barrick et al., 2003). Most importantly, Openness/Intellect is a consistent predictor of aesthetic appreciation, which has been shown to be highly variable (Vessel and Rubin, 2010). Several studies indicate that Openness/Intellect is associated with liking a broad range of artistic types including abstract, representational, pop, renaissance, cubism, Japanese, and unpleasant art (Furnham and Walker, 2001; Rawlings, 2003; Chamorro-Premuzic et al., 2009, 2010). Openness/Intellect therefore is a domain of personality that explains individual differences in creating, seeking, and appreciating art.

Openness/Intellect is an unusually heterogeneous personality domain, and recent work suggests that it can be represented with two major aspects: *Openness* and *Intellect* (DeYoung et al., 2007, 2012; Woo et al., 2014). Johnson (1994) poetically described Openness as interest in beauty and Intellect as interest in truth, suggesting that they are both information-seeking traits diverging in the types of situations that elicit interest.

Intellect is associated with fluid and crystallized intelligence and with scientific creativity, while Openness is associated with artistic creativity, implicit learning ability, and crystallized intelligence (Kaufman et al., 2010; Nusbaum and Silvia, 2011; Kaufman, 2013). DeYoung (2014) distinguishes the aspects

on the basis of different styles of cognitive exploration, with Openness reflecting individual differences in exploration through perceptual or sensory information, and Intellect reflecting individual differences in learning and exploration of abstract information. Johnson's (1994) and DeYoung's (2014) distinctions suggest that Openness, as opposed to Intellect, is the aspect primarily associated with appreciation of visual art. Further distinctions based on emotional experiences have also emerged. Silvia and Nusbaum (2011) showed that Openness, and not Intellect, is associated with unusual aesthetic experiences such as chills, feeling touched, and absorption, suggesting differences between the aspects in the propensity to experience states that have been linked to broad definitions of aesthetic experiences. Given the distinction between Openness and Intellect we aimed to test their differential roles in aesthetic experiences.

Aesthetic Emotions

Nearly all research on the link between personality and aesthetic appreciation, like aesthetics research more generally, has focused on how much participants liked or disliked an artwork (e.g., Furnham and Walker, 2001; Rawlings, 2003; Chamorro-Premuzic et al., 2009). Since the pioneering work of Berlyne (1971), most models of aesthetics concern themselves with states of pleasure, liking, or preference. Silvia (2009) argued that, while important, such evaluations do not take into account the breadth of emotions felt in response to art. A similar trend exists within the research in the emerging field of *neuroaesthetics*, which has almost exclusively focused on the evaluation of something as pleasing or beautiful (Fayn and Silvia, 2015). Such a reductionist approach runs the risk of missing meaningful individual differences in aesthetic experiences and in understanding the ways in which personality traits manifest in such experiences. Emotions felt in response to aesthetic objects—categorized within this paper as aesthetic emotions—are varied and include interest, confusion, pleasure, anger, and even disgust (Silvia, 2012). The term aesthetic emotions is not used to suggest a separate group of emotions only felt in response to aesthetic objects. Rather, it is used to group the states that have been observed to occur in response to aesthetic objects.

The distinction between liking versus disliking something may be a valid indicator of pleasure, but it does not represent the depth and complexity of aesthetic emotions. A group of emotions frequently felt in response to art, yet distinct from pleasure, are the *knowledge emotions*. The knowledge emotions—interest, awe, beauty, confusion, and surprise—associated with beliefs about thoughts and knowledge, they stem from epistemic goals, and arise from metacognitive processes (Silvia, 2010, 2012). Several emotional states may fit this categorization, and all are distinct from pleasure. The emotion of interest has been distinguished from pleasure on the basis of cognitive appraisal processes—interest is positively associated with complex stimuli, but pleasure is negatively related to complexity (Turner and Silvia, 2006). Two other states that are distinct from pleasure and involve epistemic goals are *awe* and *beauty*. The emotion of awe is felt as one tries to accommodate vast novelty, the success of which leads to a powerful emotional state (Shiota et al., 2007). Awe can be and is frequently experienced as a

negative and fear-like state when accommodation is unsuccessful. Beauty is defined as “the exhilarating feeling that something complex, perhaps to the point of being profound, might yield an understanding” (Armstrong and Detweiler-Bedell, 2008, p. 312). Beauty is distinguished from the pleasant on the basis of effort: pleasure is associated with fluent processing (Reber, 2012), but beauty relies on effortful processing that drives arousal and results in an exhilarating experience. Therefore, several aesthetic states are distinguished from simple pleasure. All are elicited by complex and novel situations where understanding is required but is effortful. Pleasure, on the other hand, is facilitated by ease of understanding.

From the individual differences perspective, two studies have distinguished pleasure and other aesthetic experiences through factor analysis techniques. Eysenck (1941) attempted to explain the presence of two factors in aesthetic preference. The first factor was easily attributable to valance, while the second was generally associated with preferences for the abstract. A core feature of abstract art is novelty and complexity, suggesting interest driven rather than pleasure driven preferences. More recently, Marković (2010) found that two factors describe aesthetic appreciation. These factors were labeled affective tone and aesthetic experiences. Descriptors “lovely” and “charming” loaded highest on affective tone, while aesthetic experience was associated with adjectives such as “exceptional” and “profound.” Thus, converging evidence and theory suggest that some aesthetic experiences are distinct from mild positive states of pleasure and that at the core of these states is the resolution of novelty and complexity, rather than fluent processing associated with pleasure.

Aesthetic states, like other emotions, are generated by appraisal process patterns (Ellsworth and Scherer, 2003). Interest occurs when a stimulus is appraised as novel yet understandable (Silvia, 2005). Novelty orientates and highjacks our attention, while the resolution of the novelty toward understanding leads to the positive experience of interest. This appraisal structure has been supported in response to art, poetry, and film (Silvia, 2005, 2008; Silvia et al., 2009a; Silvia and Berg, 2011). Pleasure and confusion are also predicted by the same appraisals but in different ways. Confusion is associated with appraisals of novelty and lack of understanding (Silvia, 2010). Pleasure is elicited by appraised understanding and negatively related to novelty (Turner and Silvia, 2006). The appraisal approach is therefore particularly useful in distinguishing differing aesthetic emotions and studying the underlying processes that facilitate them.

Between Aesthetic Emotions and Aesthetic People

Appraisal theories of emotions have been used to further understanding of processes that underlie personality traits associated with emotional experiences. There are two ways in which personality is involved in the appraisal-emotion system: (1) appraisal strength—the tendency to appraise situations in a particular way—varies as a function of personality; and (2) appraisal-emotion relationships vary as a function of personality (Kuppens, 2009; Kuppens and Tong, 2010).

Openness/Intellect has been implicated in both of the aforementioned ways. Curiosity—a trait associated with Openness/Intellect (Mussel, 2010)—is associated with greater appraised understanding, which fully mediates the curiosity-interest relationship (Silvia, 2008). That is, curious people feel greater interest because they are better able to understand epistemic situations, which in turn predicts greater interest. This finding is consistent with the theoretical framework proposed by Mussel (2013) for Intellect traits. Within this framework, Intellect traits are associated with processes of seeking and conquering intellectually stimulating events, which map onto interest and understanding.

Further, within the experience of interest, novelty and understanding have been found to form two clusters with Openness/Intellect predicting membership in only one (Silvia et al., 2009a). Openness/Intellect was associated with the cluster in which novelty was a much stronger predictor of interest while understanding was less important, compared to the other cluster. This suggests that Openness/Intellect may moderate the interest-appraisal relationships predisposing those higher on Openness/Intellect to be more sensitive to novelty and less sensitive to understanding appraisals. One study has looked at the unique influence of the Openness and Intellect aspects on the processes and appraisal structure of interest in response to quotations. Openness was related to greater interest overall and a lessened reliance on understanding, while Intellect related to greater understanding (Fayn et al., 2015). This suggests that Openness and Intellect may relate to interest in different ways and that appraisal processes are useful for explaining these differences.

The influence of Openness/Intellect on the appraisal structure of pleasure and confusion, and the distinct influence of Openness and Intellect on the appraisal structure of interest, have not previously been tested. Taken together, previous findings indicate that appraisals can explain the mechanisms that underlie Openness/Intellect and its relationship with interest. Therefore, we aimed to evaluate the underlying processes associated with the Openness and Intellect aspects in order to understand whether those higher in either aspect are more aesthetically engaged and how the aspects manifest differently in aesthetic experiences.

The Present Research

In summary, positive aesthetic experience is broader than liking and may be divided into two families of experiences: pleasure and the knowledge emotions. Openness/Intellect may influence both these states and the processes that underlie these traits. Therefore, we moved away from the predominant practice of evaluating *liking* artworks, in lieu of measuring distinct emotional states that have previously been implicated in the aesthetic experience. Additionally, by studying variability in appraisal-emotion relationships across multiple stimuli we were able to evaluate the way personality manifests in aesthetic experiences. Thus, the aims of the current research are to explore the relationship between Openness/Intellect and aesthetic appreciation by: (1) extending the states studied within personality-aesthetics relationships to pleasure, interest, and confusion; (2) evaluating the unique influences of the Openness

and Intellect aspects; and (3) testing whether the Openness and Intellect aspects moderate the within-person appraisal processes that underlie these aesthetic emotional states.

Study 1 evaluated the differential influence of Openness and Intellect on different aesthetic states in response to visual art. In Study 2 we tested whether the appraisal processes associated with interest, pleasure and confusion can explain the relationships between Openness/Intellect and aesthetic appreciation, and whether the Openness and Intellect influence appraisal processes.

STUDY 1

The purpose of this study was to test whether Openness and Intellect differentially predict states of interest, pleasure, and arousal. Based on past work on Openness and Intellect, we predicted that Openness would be a stronger predictor of aesthetic experience than Intellect.

Method

Ethics Statement

This study was approved by the Human Ethics Committee of the University of Sydney. Written consent was obtained from all the participants before the experiment according to the established guidelines of the committee.

Participants

A total of 53 psychology students (74% female) participated in the study for course credit. Participants were aged between 17 and 42 years ($M = 19.15$ years, $SD = 3.01$ years). All participants were proficient in English ensuring comprehension of instructions.

Procedure

The study was conducted on computers over two 1-h sessions to minimize the influence of a long session of psychometric assessments on aesthetic appreciation. In the first session participants completed the Openness and Intellect scales, as well as other individual difference measures not relevant to the current study. In the second session—at least 1 h apart from the first—participants reported their thoughts and feelings in response to seven color images taken from published art books. The images were all in color and could broadly be described as modern art, comprising of both abstract and representational examples. The artists were: Dorosheva, Kadel, Kiefer, Magritte, Moki, Pollock, and Ryden.

Measures

Openness and Intellect

Openness and Intellect were assessed using the Big Five Aspect Scales (DeYoung et al., 2007). Each scale included 10 Likert style items on a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*) such as “I enjoy the beauty of nature” (Openness) and “I like to solve complex problems” (Intellect). The Openness scale is made up of items that reflect the Openness to Aesthetics, Feelings and Fantasy scales, while Intellect items include self-reported ability and Openness to Ideas items. The scale yields a full-scale Openness/Intellect score along with scores

for the Openness and Intellect aspects. The internal consistencies for Openness ($\alpha = 0.86$) and Intellect ($\alpha = 0.79$) were good within the current sample.

Ratings of interest, pleasure, and arousal

After viewing each picture, people rated it on a series of seven-point semantic differential scales. The scales assessed feelings of *interest* (interesting-uninteresting, engaging-boring), *pleasure* (pleasing-displeasing, enjoyable-unenjoyable), and *arousal* (calm-aroused, sluggish-excited). Most of the items have been used in past research in research on emotions (e.g., Day, 1967, 1968; Silvia, 2005; Turner and Silvia, 2006). The items were reverse-scored and averaged; high scores indicate high levels of interest, pleasure, and arousal.

Results and Discussion

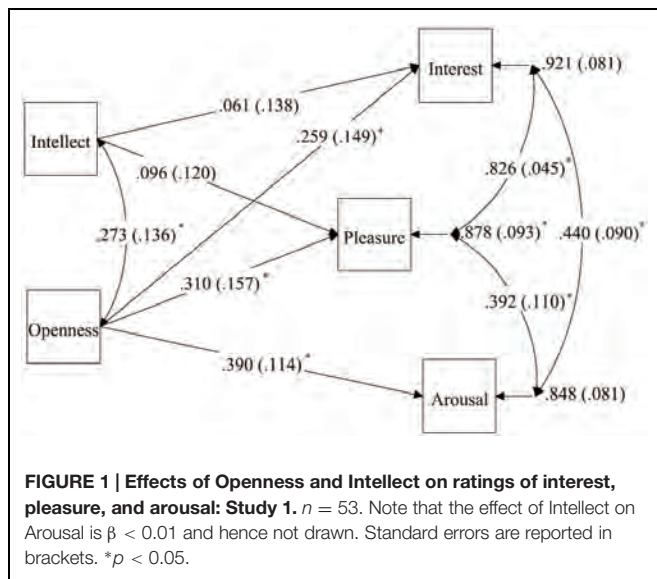
The analyses were conducted with Mplus 7.2 (Muthén and Muthén, 1998–2012) using maximum likelihood with robust standard errors. For interpreting effect sizes, we use the common guidelines (Cumming, 2012) of $r = 0.10/0.30/0.50$ as small/medium/large. **Table 1** reports descriptive statistics and correlations for the measures of personality and aesthetic experience.

The zero-order correlations suggest, as expected, that Openness was associated with stronger aesthetic engagement than Intellect: Openness had stronger relationships, medium in size, with all three outcomes. To examine their differences more formally, we conducted a multivariate regression model in which Openness and Intellect were the two predictors and interest, pleasure, and arousal were the outcomes. **Figure 1** displays the model and results. The effects of Openness on interest, pleasure, and arousal were medium in size, and most were statistically significant; the effects of Intellect on interest, pleasure, and arousal, in contrast, were all near-zero or small in size. The results lend support to the utility of separating Openness and Intellect when evaluating individual differences in aesthetic states. Openness had notable relationships with the three types of aesthetic experience, whereas Intellect did not. Limitations of this study are the small sample size which we addressed in study 2, and a limited range on the Openness scale. Both of these limitations have a bearing on the strength of the results found in this study. Small sample sizes are an indication of underpowered studies, while range restrictions usually underestimate effect sizes.

TABLE 1 | Descriptive statistics and Pearson correlations of personality variables with between-person aggregated ratings.

	<i>M</i>	<i>SD</i>	1	2	3	4	5
(1) Intellect	35.08	6.43	1	0.27	0.13	0.18	0.10
(2) Openness	40.23	5.39		1	0.28	0.34	0.39
(3) Interest	5.83	0.67			1	0.84	0.50
(4) Pleasure	5.52	0.74				1	0.47
(5) Arousal	4.67	0.72					1

$n = 53$. All relationships above 0.18 are significant at 0.05 level, all those above 0.38 are significant at the 0.01 level, and all those above 0.49 are significant at the 0.001 level.



STUDY 2

Study 2 sought to extend these findings in several important ways. First, we shifted the range of emotional states that we assessed by focusing on *interest*, *pleasure*, and *confusion*. Whereas interest and pleasure have a long history in aesthetics research, confusion has only recently attracted attention among emotion researchers as a response to events that are unfamiliar and hard to understand (Silvia, 2010).

Second, to understand the processes underlying the Openness/Intellect-emotion relationships, appraisal processes were evaluated. The inclusion of appraisal processes can help determine why those higher in Openness/Intellect are more aesthetically sensitive—whether they are more or less emotionally responsive to appraisals. That is, we seek to determine whether Openness/Intellect can explain individual differences in appraisal-emotion relationships. As previously mentioned, Openness/Intellect moderates the appraisal structure of interest and relates to greater appraisals of understanding (Silvia, 2008; Silvia et al., 2009a). The current study extends this finding in several ways. First, we examine the two aspects of Openness/Intellect for their unique influence on aesthetic experience. Second, we test whether Openness and Intellect similarly moderate the appraisal structure of pleasure and confusion. We expect, as in Study 1, that Openness but not Intellect will be the aesthetically relevant aspect. Third, we included an additional individual difference measure to help clarify the roles of Openness and Intellect. A possible explanation for the relationship between Openness/Intellect and aesthetic appreciation is that those higher in Openness/Intellect have greater knowledge of the arts (Silvia, 2007a), which in turn predicts interest in art (Silvia, 2006). Art expertise has been shown to moderate the interest-appraisal relationships—experts are less reliant on understanding and more sensitive to novelty (Silvia, 2013)—a finding also associated with Openness/Intellect (Silvia et al., 2009a). This may indicate that the effects of

Openness/Intellect on aesthetic appreciation are a function of expertise in the arts rather than a differences in personality. These variables have not been studied together in the context of aesthetic appreciation, therefore, we controlled for art expertise in the current study.

Method

Ethics Statement

This study was approved by the Human Ethics Committees of the University of Sydney and the University of North Carolina at Greensboro. Written consent was obtained from all the participants before the experiment according to the established guidelines of the committees.

Participants

A total of 225 students from various degrees and majors (69% female) participated in the study for either course credit or \$10 USD compensation. The students majors were 25.3% Physical Sciences, 21.8% Arts, 14.7% Psychology, 12% Health Sciences, 10% Business/Economics, 6.7% Social Sciences, 4.4% were undecided, and 4.9% had majors that did not fit into the categories presented as they were mixtures of more than one category. Participants' age was between 18 and 56 years ($M = 20.56$ years, $SD = 4.91$ years). All participants were proficient in English ensuring comprehension of instructions.

Procedure

The data were collected during a 1-h session in groups ranging from 1 to 8 participants at a time. The study involved completion of self-report personality scales and ratings of 18 visual art images. We sought to include a broad scope of pieces ranging from traditional to contemporary art. The images were all in color and included both abstract and representational works. The artists were: Bacon, Blake, Goya, Hayuk, Kato, Kiefer, Magritte, Marc, Monroe, Pollock, Repin, Ryden, Schiele, Siqueiros, and Turner. The self-report scales came before and after the visual art ratings to avoid fatigue. All data was collected using Medialab (Jarvis, 2004) on computers. Images were presented in a random order, as were questions relating to the images; both controlled by the randomization algorithm within Medialab.

Measures

Openness and Intellect

As in Study 1, Openness and Intellect were assessed using the Big Five Aspect Scales (DeYoung et al., 2007). Each scale has 10 items on a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

Art expertise

Art expertise was measured using the *aesthetic fluency scale* (Smith and Smith, 2006), which assesses expertise by asking people how familiar they are with different figures and ideas from art history. The scale got participants to report their familiarity in response to 10 people and concepts (*Mary Cassatt*, *Isamu Noguchi*, *John Singer Sargent*, *Alessandro Boticelli*, *Gian Lorenzo Bernini*, *Fauvism*, *Egyptian Funerary Stelae*, *Impressionism*, *Chinese Scrolls*, *Abstract Expressionism*). The scale ranged from

0 (*I have never heard of this artist or term*) to 4 (*I can talk intelligently about this artist or idea in art*). It should be noted that the fluency scale assesses self-reported expertise in the arts and may be subject to overclaiming. However, the aesthetic fluency scale has been widely used to assess expertise and has displayed good internal and external validity (e.g., Silvia, 2007a; Silvia and Barona, 2009; DeWall et al., 2011; Silvia and Nusbaum, 2011; Smith, 2014).

Emotions and cognitions in response to visual art

Participants viewed 18 images of various valence and style taken from various art books, previous studies, and the google images database. Participants could observe the image for as long as they wanted, but for a minimum of 5 s. A smaller version of the image was also visible while reporting on their thoughts and feelings.

For each image participants completed items assessing various emotions and cognitions. For emotional evaluations participants were asked: “Did you find this picture...” followed by items for *interesting*, *pleasing*, and *confusing*. Appraisal processes of novelty (*complex-simple*, *unusual-common*) and understanding (*hard to understand-easy to understand*, *comprehensible-incomprehensible*) were assessed using seven-point semantic differential scales. All scales had been previously used in assessments of aesthetic states (Silvia, 2005, 2010, 2013). In addition to the emotion items, we asked some behavior-like preference items, which are common in aesthetics research (e.g., Cooper and Silvia, 2009). For each image, participants were asked *I would like more information on this image*, *On Facebook I would “like” this image*, *On Facebook I would share this image on my wall*, and *I would like to own a copy of this*. Each item was answered with a binary NO/YES scale. The time taken to view each image was also recorded to evaluate whether Openness or Intellect were associated with longer viewing times.

Results and Discussion

Data Reduction and Analysis

The items for the personality and aesthetic fluency scales were averaged to form overall scores. Internal consistencies for the BFAS Openness and Intellect scales, and the aesthetic fluency scale were good (see Table 2).

The large number of images viewed by each person allowed us to use multilevel models, which can estimate between-person effects, within-person effects, and their interactions (Silvia, 2007b; Nezlek, 2011). For the multilevel models, between-person predictors (Openness, Intellect, and Aesthetic Fluency) were

centered at the sample's grand mean and were rescaled by dividing the full scale score by the number of items in the scale. Within-person predictors (appraisals of novelty-complexity and understanding) were centered at each person's own mean (Enders and Tofghi, 2007). The null model was used to evaluate intraclass correlation coefficients (ICCs). The ICCs indicated a significant amount of variance for interest (19%), pleasure (11%), and confusion (13%) at the between-person level.

The random slope and intercept models were tested separately for each emotion and are graphically depicted in Figure 2. The analyses were conducted with Mplus 7.2, using maximum likelihood with robust standard errors. All coefficients are unstandardized regression weights; some, where noted, are logistic effects. Estimation of power is a contentious topic within multilevel modeling due to the complexity of the parameters being estimated (Nezlek, 2011); by most standards the number of level 1 and level 2 units of measurement in our sample is sufficient to assume accurate estimations of the parameters of interest (Maas and Hox, 2005).

Descriptive Statistics and Bivariate Relationships

Openness and Intellect were both related to greater Aesthetic Fluency, pleasure, and lower confusion. Openness, but not Intellect, was related to greater interest (Table 2). The states of interest and pleasure had a strong overlap at the between and within person levels, and were unrelated to confusion at the between person level. Pleasure and interest differed from each other in their within-person relationship with confusion, interest was independent of confusion, but pleasure had a small negative relationship with confusion.

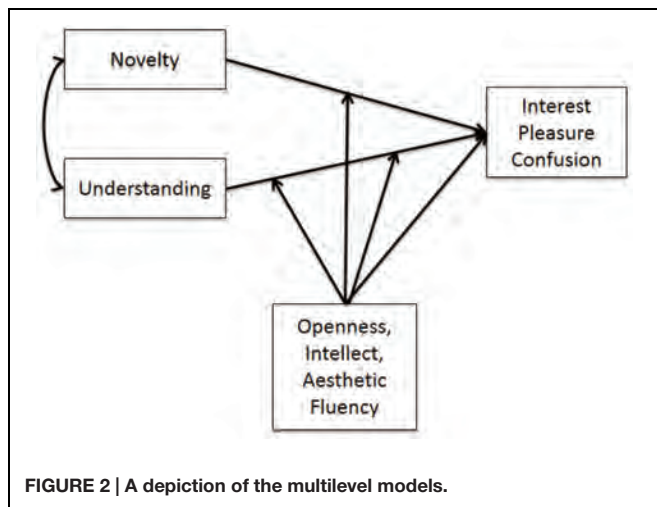
Overall Between-person Effects of Openness and Intellect on Emotions and Preference Ratings

Our first models examined the overall effects of Openness and Intellect on emotion ratings (interest, pleasure, and confusion) and on preference ratings (e.g., whether people indicated wanting to own a copy of the image). As expected, Openness and Intellect showed diverging relationships with these outcomes. Openness predicted finding the images significantly more interesting ($b = 0.61$, $SE = 0.11$, $p < 0.001$), more pleasing ($b = 0.77$, $SE = 0.09$, $p < 0.001$), and less confusing ($b = -0.31$, $SE = 0.10$, $p = 0.003$). Intellect, in contrast, predicted finding the images less confusing ($b = -0.29$, $SE = 0.11$, $p = 0.008$), but it didn't significantly predict either interest ($b = -0.06$, $SE = 0.10$, $p = 0.573$) or pleasure ($b = 0.09$, $SE = 0.09$, $p = 0.287$).

TABLE 2 | Descriptive statistics and correlations between personality traits, aesthetic fluency and emotions.

	<i>N</i>	<i>M</i>	<i>SD</i>	1	2	3	4	5	6
(1) Openness	225	39.16	5.59	(0.76)	0.39	0.53	0.39	0.56	−0.28
(2) Intellect	225	36.23	5.51		(0.80)	0.39	0.11	0.27	−0.28
(3) Aesthetic Fluency	224	22.21	7.41			(0.83)	0.36	0.52	−0.26
(4) Interest	224	5.21	0.84				1	0.67	0.06
(5) Pleasure	224	3.51	0.83				0.52	1	−0.13
(6) Confusion	224	3.98	0.80				0.02	−0.20	1

All relationships above 0.13 are significant at 0.001 level, and all those below 0.13 are not significant; correlation below the diagonal are within-person relationships; Cronbach's alphas in parentheses.



For the preference ratings, a logistic model found that Openness significantly predicted the likelihood of wanting more information about the image ($b = 1.65$, $SE = 0.32$, $p < 0.001$), the likelihood of liking ($b = 0.93$, $SE = 0.16$, $p < 0.001$) and sharing ($b = 1.09$, $SE = 0.25$, $p < 0.001$) the image on Facebook, and the likelihood of wanting to own it ($b = 1.14$, $SE = 0.18$, $p < 0.001$). Intellect, in contrast, did not significantly predict wanting to learn more ($b = -0.49$, $SE = 0.30$, $p = 0.101$), liking ($b = -0.08$, $SE = 0.16$, $p = 0.619$) or sharing ($b = 0.14$, $SE = 0.18$, $p = 0.402$) the image on Facebook, or wanting to own it ($b = 0.02$, $SE = 0.22$, $p = 0.942$).

For view times—averaged across all stimuli—a regression model found that Openness significantly predicted greater viewing times ($b = 206.29$, $SE = 62.85$, $p = 0.001$). Intellect did not predict variance in view times ($b = -0.39.06$, $SE = 63.89$, $p = 0.542$).

In short, Openness and Intellect diverged in their relationships with aesthetic experience, preference ratings, and viewing times. Openness significantly predicted all of them, but Intellect predicted only feeling less confused.

Overall Within-person Effects of Appraisals on Emotions

The results for all multilevel models are presented in **Table 3**. These models evaluated the within-person main effects of appraisals on emotions. As in past work, interest was significantly predicted by appraisals of high novelty and high comprehensibility, and confusion was predicted by high novelty and low comprehensibility. Pleasure, in contrast, was more weakly predicted by novelty but predicted by comprehensibility, consistent with models that emphasize ease of understanding (Reber, 2012) and achieving insight and knowledge (Leder et al., 2012) as a source of liking.

Personality as Predictors of Emotion Intercepts and Moderators of Appraisal-emotion Relationships

Openness and Intellect had different main effects on aesthetic experience, but do they moderate how appraisals influence aesthetic experience? These models included Openness and

Intellect as between-person predictors of emotions and appraisal-emotion slopes. If a between-person trait significantly predicts a slope, then the relationship between an appraisal and an emotion shifts across levels of the trait. Prediction of intercepts implies that the overall mean of the emotion shifts according to trait regardless of appraisals. Both intercepts and slopes were modeled as random in these models.

Openness predicted larger intercepts for interest, pleasure, and smaller intercepts for confusion. Intellect predicted lower intercepts for confusion, but was not significantly related to interest and pleasure intercepts.

For *interest* (Model 1), the effect of novelty was moderated by both Openness and Intellect. For people high in Openness and Intellect, novelty was more strongly coupled to interest. No significant moderation effects appeared for understanding. For *pleasure* (Model 2), the effect of novelty was moderated by Openness but not Intellect. For people high in Openness, novelty was more strongly linked to pleasure. Follow up analysis on the difference between the novelty-pleasure slopes for Openness and Intellect indicated that they were not significantly different from each other (Wald test = 1.00, $df = 1$, $p = 0.32$). No significant moderation effects appeared for understanding. And for *confusion* (Model 3), in contrast, neither Openness nor Intellect moderated either appraisal. Neither the effect of novelty nor the effect of understanding on confusion varied across levels of Openness and Intellect.

Considered together, these results suggest that both Openness and Intellect are associated with greater sensitivity to novelty in the experience of interest, but only the Openness aspect is associated with greater sensitivity to novelty in the experience of pleasure. While the slope moderations by Openness and Intellect were not found to differ from each other, the moderating influence of Openness was significant, while the influence of Intellect was not. Finally, Openness, but not Intellect, was associated with greater pleasure and interest overall.

Exploring Art Expertise

Our final models explored the roles of art expertise (measured with the aesthetic fluency scale). To examine art expertise, we included it alongside Openness and Intellect to see if it reduced their effects. As we discussed earlier, such a result would suggest that the effects of personality are largely carried by acquired expertise about the arts.

The inclusion of art expertise didn't change any of the Openness and Intellect findings with respect to interest, confusion and pleasure. This suggests that the effects of Openness and Intellect are not driven by greater expertise in the arts. For *interest* (Model 4), neither the effect of novelty nor the effect of understanding was moderated by art expertise, but expertise was related to greater intercepts in the model. For *pleasure* (Model 5), neither the effect of novelty nor the effect of understanding was moderated by art expertise, but expertise was related to greater intercepts in the model. And for *confusion* (Model 6), art expertise moderated the effect of novelty, but not understanding; in contrast, neither Openness nor Intellect moderated either appraisal. This suggests that novelty is less related to confusion for those with greater art expertise. These results suggest that

TABLE 3 | Multilevel models of within and between person predictors of aesthetic experiences.

Within-person predictors										
	Interest (DV)				Pleasure (DV)				Confusion (DV)	
Novelty	0.39***	(0.03)			0.08**	(0.03)			0.20***	(0.02)
Understanding	0.28***	(0.02)			0.28***	(0.03)			−0.56***	(0.03)
Between-person predictors										
	Slopes				Slopes				Slopes	
	Intercept	N	U	Intercept	N	U	Intercept	N	U	
Models 1–3										
Openness	0.61*** (0.11)	0.12** (0.04)	−0.06 (0.05)	0.77*** (0.10)	0.16** (0.05)	0.02 (0.05)	−0.31** (0.10)	−0.01 (0.04)	−0.03 (0.04)	
Intellect	−0.06 (0.10)	0.12* (0.05)	0.05 (0.04)	0.09 (0.09)	0.07 (0.06)	−0.04 (0.05)	−0.29** (0.11)	−0.06 (0.04)	0.01 (0.05)	
Models 4–6										
Openness	0.45*** (0.12)	0.11* (0.05)	−0.04 (0.05)	0.57*** (0.09)	0.13* (0.06)	0.03 (0.05)	−0.23* (0.15)	0.03 (0.04)	<0.01 (0.05)	
Intellect	−0.09 (0.10)	0.11* (0.05)	0.07 (0.04)	−0.01 (0.09)	0.05 (0.06)	−0.03 (0.04)	−0.27* (0.11)	−0.04 (0.04)	0.03 (0.05)	
Aesthetic fluency	0.28** (0.08)	0.02 (0.04)	−0.05 (0.03)	0.34*** (0.07)	0.04 (0.04)	−0.03 (0.04)	−0.13 (0.09)	−0.06* (0.03)	−0.06 (0.04)	

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; N = Novelty-Interest slope; U = Understanding-Interest slope; Standard errors are reported in brackets.

the novelty-interest and novelty-pleasure moderation are not influenced by art expertise but are rather driven by Openness.

GENERAL DISCUSSION

Openness/Intellect is the personality domain that best explains individual differences in aesthetic appreciation. However, the research linking actual art appreciation to the domain has several issues. First, as discussed in the introduction the focus on *liking* artworks is limited, as aesthetic experience is much broader and richer than mild feelings of pleasure (Silvia, 2009). Second, there's a risk of circularity in the relationship, given that items about aesthetic engagement appear on all major Openness to Experience scales. Without examining why this relationship exists, not much is added to our understanding of Openness/Intellect and aesthetics. In this research, we broadened the range of aesthetic emotions and examined appraisal mechanisms that could explain differences in aesthetic experience as a function of Openness/Intellect. Art expertise was evaluated alongside personality to test whether the influence of Openness and Intellect on aesthetic appreciation can be explained by greater art knowledge.

As predicted, Openness/Intellect reflected individual differences in aesthetic experiences—both pleasure and the knowledge emotions. The strength of the relationship was particularly driven by Openness as opposed to Intellect, supporting the distinction in the aspects based on perceptual versus abstract engagement (DeYoung, 2014). Mechanisms for these relationships were also discovered through differences in appraisal-emotion relationships. The Openness/Intellect aspects predicted reactivity to novelty appraisals in experiences of interest. While the novelty seeking core of Openness/Intellect has previously been suggested (Woo et al., 2014), our study provides within-person process evidence for this special relationship with novelty and demonstrates that those

higher in Openness/Intellect are *reactive* to novelty in their experiences with interest. Openness diverged from Intellect in the experience of pleasure. Intellect did not predict individual differences in the processes associated with pleasure, but novelty was a stronger predictor of pleasure for people high in Openness. Further, Openness predicted greater interest and pleasure regardless of how artworks were appraised, further distinguishing it from Intellect. Openness and Intellect were related to lower levels of confusion, but variance in appraisal-emotion relationships was not associated with either aspect.

Finally, the possible confound of art expertise was evaluated as an explanation for the Openness-aesthetic emotions relationship. The inclusion of art expertise did not influence any of the Openness-aesthetic emotion relationships, suggesting that the effects were particular to the personality variables rather than greater expertise. Expertise did predict greater interest and less confusion overall, and it was related to a smaller relationship between novelty and confusion.

Together these findings provide an important update for our understanding of the relationship between the Openness/Intellect and aesthetic emotions. Particularly, our findings show that Openness, as opposed to Intellect, is the aspect of the aesthetically engaged, and provide a process based understanding for *why* those higher in Openness are more aesthetically engaged. Finally, methodological differences between this and previous research on personality and aesthetics highlight the advantages of the current approach.

Within this paper we assume rather than test a causal flow from personality to emotion states. That is, we assume that personality reflects biologically driven consistencies in emotions, cognitions, and behavior. Therefore, personality is treated as an antecedent of states. Similarly, appraisals are considered to be antecedents of emotions. For interest, both appraisals, when experimentally manipulated, have been shown to influence interest (Silvia, 2005). Thus, within this paper, we treat appraisals as causing emotions.

Advantages of the Current Method

There are two methodological differences between the current method and most of the research on personality and aesthetics. First, we moved away from the predominant practice of evaluating *liking* artworks and shifted toward measuring distinct emotional states that have previously been implicated in the aesthetic experience. Liking is a common and important aesthetic response—mild feelings of pleasure might be the most common everyday aesthetic experience—but it is only one of many important experiences people have in response to the arts (Silvia, 2009). Second, we explored both within- and between-person effects. The integration of dispositional and situational variables has long been advocated (Cronbach, 1957; Underwood, 1975), but it is uncommon for aesthetics research to examine effects at the within-person level of analysis, which is the natural level for examining how appraisals influence emotional responses (see Silvia, 2007b; Nezlek, 2011).

The How and Why of Openness/Intellect and Esthetics

Previous research has demonstrated that Openness/Intellect is related to differences in appraisal processes for the emotion of interest (Silvia, 2008; Silvia et al., 2009a). The current research builds on these findings in two important ways by: (a) evaluating the independent roles of Openness and Intellect in interest-appraisal processes; and (b) evaluating differences in pleasure-appraisal and confusion-appraisal processes.

Openness and Intellect were both associated with reactivity to novelty in the experience of interest suggesting that novelty sensitivity is at the core of the domain. However, Intellect, as opposed to Openness, did not reflect greater interest overall. This suggests that being higher on Intellect is reflective of lower than average levels of interest when novelty is not found in an artwork, yet higher than average interest for novel artworks. Conversely, Openness was related to greater interest regardless of appraised novelty suggesting that while novelty is preferred, greater interest is experienced even in the absence of it. The sensitivity to novelty in the experience of interest for both Openness and Intellect provides a possible process explanation for part of the Openness-Fluid-Crystallized-Intelligence (OFCI) model which proposes a developmental link between Openness/Intellect and fluid intelligence (Ziegler et al., 2012). Ziegler et al. (2012) propose that being open increases learning opportunities, thereby increasing fluid intelligence. Our findings suggest that Openness/Intellect is associated with a sensitivity, through interest, to stimuli and situations that are appraised as novel and complex. This preferential engagement with challenging information could support the pathway from Openness/Intellect to gains in fluid and crystallized intelligence.

While the Openness and Intellect aspects reflect quantitative differences in the appraisal structure of interest, qualitative differences are present in the experience of pleasure. Openness, but not Intellect, was associated with the presence or absence of

a pleasure-novelty relationship. Studies have shown quantitative differences in appraisal structures—the appraisal structure remains constant yet the predictive *strength* of an appraisal varies as a function of a trait (Kuppens and Tong, 2010). However, few studies have found qualitative differences in appraisal structures. Our findings indicate that those higher in Openness experience pleasure as a function of novelty and understanding, while those lower on the aspect are only influenced by understanding. The idea that understandable things are pleasant is congruent with fluency based aesthetic theories where things that are easily understood are pleasant to the beholder (Reber, 2012). Our findings suggest that this may primarily be the case for people lower on Openness. For those higher on Openness, pleasure is also influenced by the novelty of an artwork.

This finding has important implications for aesthetic theories. Fluency based accounts are at odds with interest based accounts. Interest requires novelty, whereas fluency-based aesthetic experiences are a function of easy processing. This distinction maps nicely onto interest and pleasure. Interest is experienced in the face of novelty and pleasure is experienced when processing requires little effort. Our research suggests that individual differences both complicate and clarify this distinction. It seems that the influence of fluent processing in the experience of aesthetic pleasure is dependent on trait standing. Those higher in Openness are sensitive to novelty and complexity in their experience of pleasure. Conversely, pleasurable experiences for those lower on Openness are not predicted by stimulus novelty.

Openness/Intellect Model

These findings add to the growing empirical consensus for the utility of studying Openness and Intellect as separate aspects of the broader domain. The distinction previously proposed—Openness as exploration through perception, and Intellect through learning and abstract information (DeYoung, 2014)—is supported with Openness reflecting greater pleasure and interest and less confusion in response to visual art. While Intellect was also found to play a role in the processes that facilitate interest, this role does not predict greater aesthetic reactions but rather reflects a preference for the novel, and a lesser tendency to feel confusion in response to visual art. The relationship between Intellect and interest in art, when controlling for Openness, is not evident at the between-person level, but is apparent when within-person processes are considered. Future studies are encouraged to explore the differential influence of Openness and Intellect on interest in non-perceptual stimuli such as science and philosophy to gain further insights into this useful separation of the Openness/Intellect domain.

CONCLUSION

Henry James saw art as central to life and beauty, and this attitude, like that of many other creative people, was likely a function of his Openness. We aimed to extend our understanding of the

role personality plays in common aesthetic experiences: pleasure, interest, and confusion. Our findings suggest that Openness, as opposed to Intellect, is the personality core of aesthetic experiences, and that the relationship persists because those higher in Openness are more sensitive to novelty in artworks and experience greater engagement overall, predisposing them to feel more interest and pleasure in response to the arts.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Cross-cultural adjustment to the United States: the role of contextualized extraversion change

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Personality traits can predict how well-sojourners and expatriates adjust to new cultures, but the adjustment process remains largely unexamined. Based on recent findings that reveal personality traits predict as well as respond to life events and experiences, this research focuses on within-person change in contextualized extraversion and its predictive validity for cross-cultural adjustment in international students who newly arrived in US colleges. We proposed that the initial level as well as the rate of change in school extraversion (i.e., contextualized extraversion that reflects behavioral tendency in school settings) will predict cross-cultural adjustment, withdrawal cognitions, and school satisfaction. Latent growth modeling of three-wave longitudinal surveys of 215 new international students (54% female, $M_{\text{age}} = 24$ years) revealed that the initial level of school extraversion significantly predicted cross-cultural adjustment, (lower) withdrawal cognitions, and satisfaction, while the rate of change (increase) in school extraversion predicted cross-cultural adjustment and (lower) withdrawal cognitions. We further modeled global extraversion and cross-cultural motivation as antecedents and explored within-person change in school extraversion as a proximal factor that affects adjustment outcomes. The findings highlight the malleability of contextualized personality, and more importantly, the importance of understanding within-person change in contextualized personality in a cross-cultural adjustment context. The study points to more research that explicate the process of personality change in other contexts.

Keywords: extraversion, personality change, contextualized personality, cross-cultural adjustment, international students, United States, cross-cultural motivation, latent growth model

INTRODUCTION

In today's global economy, adapting and adjusting to new cultures as sojourners and expatriates have become increasingly important. International corporations frequently send individuals to work in foreign countries for an extended period of time, and the success of such foreign assignment is anything but guaranteed (Brookfield Global Relocation Services, 2012). Among the factors that lead to expatriate outcomes, cross-cultural adjustment is a crucial contributor to expatriate success, while inability to adjust is linked to expatriate's early return and inadequate performance (Naumann, 1992; Shaffer et al., 1999; Anderson, 2005).

Given the importance of understanding the antecedents of cross-cultural adjustment, there has been a growing interest in identifying individual characteristics to predict cross-cultural

adjustment (Arthur and Bennett, 1995; Ones and Viswesvaran, 1999). In particular, personality (e.g., Swagler and Jome, 2005; Sri Ramalu et al., 2010) and cross-cultural motivation (e.g., Templer et al., 2006) have been shown as antecedents of successful adjustment. However, following research on personality change (e.g., Vaidya et al., 2002; Lüdtke et al., 2011), it is likely that sojourners experience personality change in response to the changes they encounter in a new cultural environment. More importantly, it remains to be seen whether such change can predict cross-cultural adjustment.

The goal of the current research is to study contextualized extraversion change in the cross-cultural adjustment process. We situate our investigation in a particular population: newly arrived international students in US colleges and universities, given the unique dual challenge faced by this population. On the one hand, international students, like all sojourners, undergo the process of adjusting to a foreign culture. On the other hand, international students need to manage the academic (e.g., Credé and Niehorster, 2012) and social demands (Ross et al., 1999) that can have a substantial impact on their long-term career outcomes.

This study makes several theoretical contributions to the personality and work adjustment literature, accompanied by practical implications for organizations. First, by recognizing the malleable aspect of personality, organizational researchers can better understand how personality changes and the impact of these changes on vocational and career adjustment. Second, examining personality changes in the cross-cultural context will lay the ground work for illuminating personality changes in other important, specific contexts pertaining to work-related transitions and adaptation.

Cross-cultural Adjustment

In the past few decades, there has been a growing interest in studying personality to predict cross-cultural adjustment. For instance, Swagler and Jome (2005) showed that high levels of agreeableness and conscientiousness, as well as low levels of neuroticism, were linked to better psychological adjustment among American Sojourners in Taiwan. In addition, sociocultural adjustment was predicted by high levels of extraversion. Similar results were found by Sri Ramalu et al. (2010), where high levels of agreeableness and extraversion were associated with better general cross-cultural adjustment among a diverse sample of expatriates in Malaysia, while greater conscientiousness and openness to experience were linked to better work adjustment. In addition, Peltokorpi (2008) revealed that emotional stability was related to better adjustment in both non-work related (interaction and general living) and work related adjustment among expatriates from 21 countries in Japan.

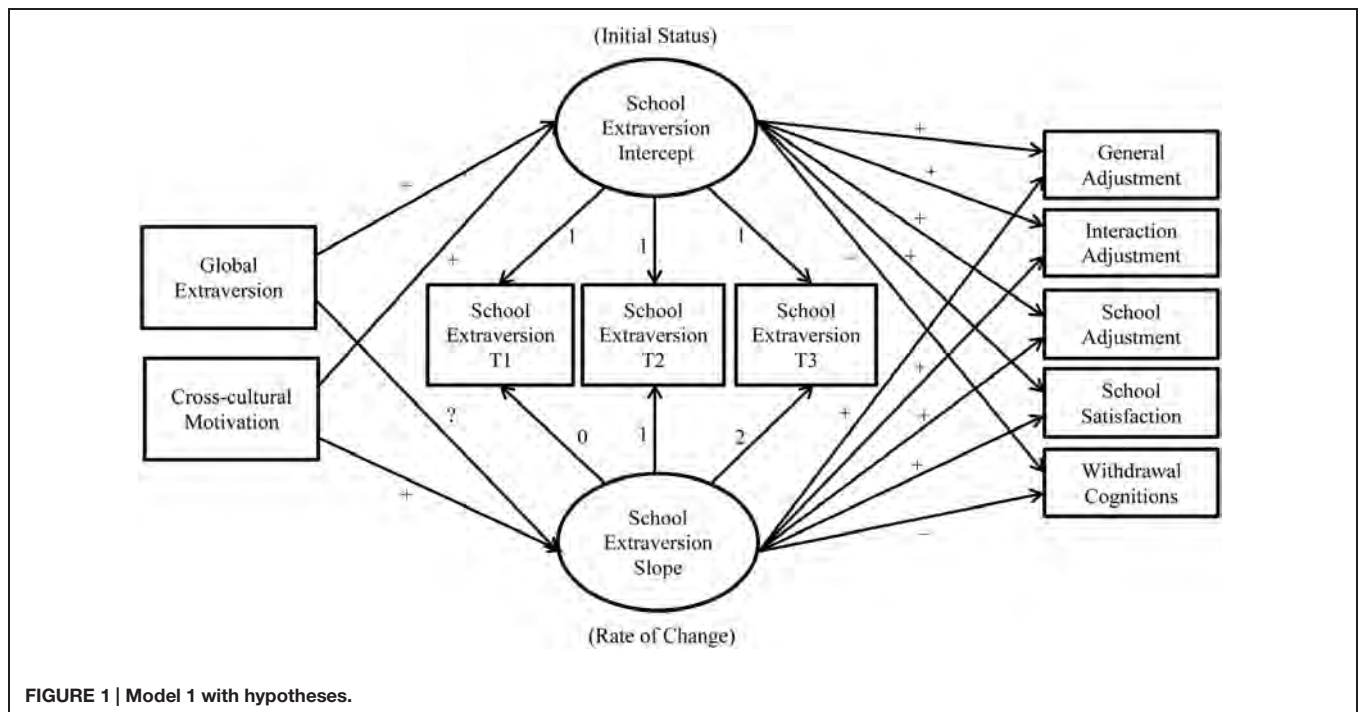
Although researchers have examined various personality traits that predict cross-cultural adjustment, we focus on extraversion and cross-cultural motivation in our current research model (see **Figure 1**) as distal antecedents. We briefly review the influence of extraversion and cross-cultural motivation on adjustment outcomes below.

In the current study, we focus on the personality domain of extraversion as a lens to understanding the process of cross-cultural adjustment. Extraversion describes the extent to which

a person is assertive, warm, excitement-seeking, and people-oriented (Costa and McCrae, 1992). Research has shown that extraverts tend to seek out more social activities (e.g., Argyle and Lu, 1990; Asendorpf and Wilpers, 1998), grow a bigger social network (e.g., Asendorpf and Wilpers, 1998), and create a more positive social environment (e.g., Eaton and Funder, 2003). Not only are extraverts more sociable, they also enjoy social activities to a greater extent. Studies have shown that extraverted individuals tend to report higher intimacy, higher satisfaction, and less conflict in social interactions (e.g., Barrett and Pietromonaco, 1997; White et al., 2004). Given its relevance in social interactions, extraversion in a cross-cultural setting may drive sojourners to seek out more interpersonal relationships, receive more social support, and gain satisfaction via interacting with others. In addition, extraverts also tend to be happier than introverts, owing to the positive relationship between extraversion and positive affect (Costa and McCrae, 1992; Lucas and Baird, 2004). In line with this reasoning, extraversion has been shown to significantly predict sojourner (Swagler and Jome, 2005) and expatriate (Sri Ramalu et al., 2010) adjustment and satisfaction.

Yet another reason to highlight the role of extraversion in cross-cultural adjustment lies in America's overall "extraverted culture." Data has suggested that America has one of the highest average scores on extraversion in the world (McCrae and Terracciano, 2005). According to the person-environment fit literature that emphasizes the congruence between individual characteristics and the environment (Kristof-Brown and Guay, 2011), extraversion should be especially relevant and predictive of adjustment in the US.

Cross-cultural adjustment can be challenging. Thus, successful cross-cultural adjustment requires motivation that drives one's continuous effort in learning and engaging in the new environment. Cross-cultural motivation is defined as "the capability to direct attention and energy toward learning about and functioning in situations characterized by cultural differences" (Ang et al., 2007). It is one of the three dimensions in the Cultural Intelligence framework that captures two related aspects, namely cross-cultural self-efficacy and cross-cultural intrinsic motivation (Ang et al., 2007; Chen et al., 2010). First, individuals with high cross-cultural motivation tend to be more self-efficacious in their adaptive capability. According to the theory of self-efficacy, individuals who believe in their capability tend direct more attention and effort in gathering information and developing strategies to meet the challenges (Bandura, 2002). Thus, in a cross-cultural setting, high motivation can enable sojourners to better channel their effort and knowledge into understanding the local culture and behave accordingly. Second, cross-cultural motivation reflects higher intrinsic interests in being part of the cross-cultural experiences. Compared to those with little or no motivation, highly motivated individuals enjoy social interactions with people from other cultures, and are more likely to adjust behaviors to achieve smooth and successful encounters (Chen et al., 2010). Research evidence suggests that cross-cultural motivation can enable better adjustment and adaptation in a foreign culture (Templer et al., 2006; Ang et al., 2007; Chen et al., 2010). Therefore, we posit that individuals with



higher levels of cross-cultural motivation will also have better cross-cultural adjustment outcomes.

Personality Change

Cross-cultural adjustment is a process where a person interacts with and adapts to a foreign environment. Although the existing literature has shed light on the impact of personality on cross-cultural adjustment, the focus on traits as static dispositions ignores the potential *process* by which one experiences changes in personality during cross-cultural adaptation. Given the malleable aspect of personality that has been demonstrated in recent research (Caspi and Roberts, 2001), we argue that change in personality can be used as an appropriate lens to investigate the process of cross-cultural adjustment.

The person-environment interactional approach of personality development recognizes the active role people take in their environment, and emphasizes the interactive dynamics between the traits and environmental contexts in shaping personality changes (Fraleigh and Roberts, 2005). On the one hand, *selection effects* posit that personality traits predict life events, such that people with different personality traits would select themselves into different events or be selected by others into different situations (Headey and Wearing, 1989; Roberts and Wood, 2006). On the other hand, *socialization effects* refer to the influence of life events on personality traits, such that personality changes are reactions to these events (Roberts and Mroczek, 2008; Roberts et al., 2008). Longitudinal studies have supported both effects (e.g., Vaidya et al., 2002; Specht et al., 2011; Boyce et al., 2015). For instance, in a two-wave longitudinal study, Vaidya et al. (2002) demonstrated support for selection effects, such that college students who scored higher on initial levels of extraversion, agreeableness, and conscientiousness were more

likely to experience positive events later on, whereas negative events were predicted by lower initial levels of agreeableness and conscientiousness, as well as higher initial levels of neuroticism. Socialization effects were also supported, linking positive events (Time 1) with increases in extraversion and negative events (Time 1) with increases in neuroticism over time. Similar patterns of results were shown in a 4-year longitudinal study (Lüdtke et al., 2011). Comparing samples of young adults who followed different career paths, initial levels of personality traits had a significant impact on career choices (i.e., attending college or vocational training), while experiences and events in different careers also predicted changes in personality traits among these individuals. Socialization effects were also evident when linking work and social experiences to personality changes. For instance, individuals with higher work participation or advances in status also reported increases in domains of conscientiousness (agency and norm adherence; Roberts, 1997; Roberts et al., 2001) and in the social dominance facet of extraversion (self-confidence and assertiveness; Clausen and Gilens, 1990). In a sample of German adults, Boyce et al. (2015) also showed support for the socialization effects in the context of unemployment, such that individuals who had undergone unemployment experienced significant patterns of change in agreeableness, conscientiousness, and openness to experience. Experiences from social relationships can also contribute to change in personality traits, such that first time in a romantic relationship was associated with increases in extraversion and conscientiousness, as well as decreases in neuroticism (e.g., Neyer and Lehnart, 2007; Lehnart et al., 2010; however, see Asendorpf and Wilpers, 1998). Therefore, it can be concluded that personality traits predict as well as respond to life events and experiences.

Building upon the empirical findings on personality and its predictive value, researchers have started to use personality change to aid the prediction of various outcomes. For instance, Mroczek and Spiro (2007) found that mortality among aging men was predicted by both high initial levels and increases in neuroticism ($N = 1,663$). In addition, Siegler et al. (2003) showed that gains in hostility from college to midlife were linked to a wide range of negative outcomes, such as social isolation, obesity, as well as negative changes in economic and work life.

In sum, the literature suggests that personality can change throughout the life course, and such changes can provide valuable information in understanding and predicting important life outcomes. In the current study, we focus on change in contextualized personality, namely school extraversion, and its impact on cross-cultural adjustment. Compared to global traits, which cannot fully account for situational variations (Mischel, 1968, 1973; Wright and Mischel, 1987), contextualized personality captures one's behavioral expressions of trait personality within a particular context (e.g., at work; Heller et al., 2009). For example, work contextualized personality captures one's behavioral expressions of trait personality at work (Heller et al., 2009). In a similar vein, school extraversion represents the summary of a student's extraverted behavior in the school context. Contextualized personality has been shown to outperform global traits in predicting context-specific outcomes (Schmit et al., 1995; Hunthausen et al., 2003; Bing et al., 2004). For instance, in a sample of 89 middle-aged women, Roberts and Donahue (1994) showed that contextualized personality varied across different roles (e.g., as a mother or as a worker) and role-specific personality had a significant advantage in predicting role-specific criteria in the corresponding context, whereas general personality yielded better prediction on general life outcomes. In a meta-analysis, Shaffer and Postlethwaite (2012) concluded that contextualized personality measures had higher validity in predicting job performance than global (i.e., non-contextualized) personality measures, such that the increases in validity exceeded at least 100% for four of the Big Five dimensions (openness to experience, extraversion, agreeableness, and emotional stability).

Given the proximity of contextualized personality, we intend to bridge the two areas of research (i.e., personality change and contextualized personality) and examine contextualized extraversion change and its relationship to cross-cultural adjustment outcomes. There are two major reasons for the use of this particular approach. First, personality change may be better captured in particular contexts, such that contextualized extraversion would experience more change than global extraversion. From a personality development perspective, evidence has supported the interaction between traits and contexts in shaping personality changes (Fraley and Roberts, 2005). Given the dynamics between the person and the environment, it is important to consider the corresponding context in which personality change may take place. From another point of view, life experiences and events can also lead to subsequent personality changes. For instance, Lüdtke et al. (2011) found that different life paths predicted different changes in personality, such that individuals on a vocational career path

had higher increases in conscientiousness and lower increases in agreeableness than their counterparts who chose to pursue college degrees. In such cases, differences in contexts (vocation vs. school) may provide different cues that facilitate changes in personality. Therefore, as Lewis (1999) argued, the best way to study personality change is to examine behavior in context.

Second, contextualized personality change may provide better prediction than global personality change in the corresponding context. Bing et al. (2004) argued that the specificity of the reference point may account for the incremental validities of contextualized personality over global traits. Similarly, the validity of personality changes in predicting outcomes (in a particular context) may be improved by applying a specific context that responds with the criteria. Namely, specification of the context (e.g., school) may yield better and more accurate predictions in context-related outcomes (e.g., school satisfaction) due to the proximity of the predictors (e.g., school extraversion). Therefore, we focused on school extraversion and linked its initial level and change to cross-cultural adjustment outcomes.

Hypothesis 1: The initial levels of school extraversion will positively predict cross-cultural adjustment, such that students with higher initial school extraversion will have (a) better cross-cultural adjustment; (b) greater school satisfaction; and (c) lower withdrawal cognitions.

Hypotheses 2: Change in school extraversion will positively predict cross-cultural adjustment outcomes, such that increases in school extraversion will predict (a) better cross-cultural adjustment; (b) greater school satisfaction; and (c) lower withdrawal cognitions.

In an attempt to identify antecedents for personality change, we discuss the potential influence of global extraversion and cross-cultural motivation on the initial level and change in school extraversion. As the initial status of school extraversion represents how extraverted an individual is upon first assessment, we expect that global extraversion will likely be positively related to the initial level in school extraversion (see Bing et al., 2004; Heller et al., 2009). The impact of global extraversion on the change in school extraversion, however, is less clear. On the one hand, individuals who are already extraverted in general may be more prone to engage in and enjoy social interactions at school, and the positive feedback and experience in the overall "extraverted" environment may in turn prompt them to further elevate their extraversion in a school setting. On the other hand, introverts may have a greater potential than extraverts to increase their school extraversion in the process of cross-cultural adjustment because they have more room to grow.

Hypothesis 3: Global extraversion (Time 1) will positively predict the initial levels of school extraversion.

Research Question 1: How will global extraversion influence the slope of change in school extraversion?

Individuals with high cross-cultural motivation will have higher capacity and motives in learning and monitoring behaviors in a foreign context, which may result in them acting more extraverted in the US society. As described earlier, the US is among the most extraverted societies in the world, and sojourners coming from other cultures may encounter individuals who are more extraverted than those they are accustomed to interacting with. When these differences emerge, high cross-cultural motivation can trigger self-efficacy and help channel attention and effort in learning and adapting to the differences. As a result, when interacting with a group of extraverts, sojourners with high cross-cultural motivation may be more likely to develop strategies, such as acting more extraverted, in order to ensure smooth interactions and effective communication. In addition to being more self-efficacious, sojourners with high cross-cultural motivation also tend to show more intrinsic interests in learning and engaging in the cross-cultural experiences. Compared to people with low cross-cultural motivation, highly motivated individuals may be more likely to initiate interactions with the local people, learning more about the American culture, and be more motivated in adjusting behaviors (e.g., act more extraverted) in order to tackle the barriers in social interactions.

Hypothesis 4: Cross-cultural motivation (Time 1) will positively predict the initial levels of school extraversion.

Hypothesis 5: Cross-cultural motivation (Time 1) will positively predict the slope of change in school extraversion.

Thus far, our hypotheses are focused on extraversion as a higher-order factor of personality. According to DeYoung et al. (2007), extraversion encompasses two aspects, namely enthusiasm (positive emotion and sociability) and assertiveness (social dominance and the enjoyment of exhibitionism and leadership roles). In an exploratory fashion, we examined whether the pattern of results differ across these two aspects of extraversion.

MATERIALS AND METHODS

This research was approved by the Institutional Review Board at Wayne State University. Online informed consent was obtained from all participants in this research.

Participants

The current sample consisted of first-year undergraduate and graduate international students from sixteen universities who had recently arrived at the United States at the time of the first survey. To maximize the representativeness of the current sample, two methods were utilized for recruitment: (1) An e-mail advertisement about the study was sent to the Office of International Students and Scholars of 157 universities across the United States to solicit eligible international students. In order to reach out to universities across the United States with relatively large international student bodies, the names of the universities were obtained from (1) the list of National Universities with Most International Students on USNews

(USNews, 2012), and (2) the list of Accredited Programs in Clinical Psychology on the official website of American Psychological Association (American Psychological Association [APA], 2012). Thirteen universities (response rate = 8.28%) agreed to advertise the current survey via Listserv or Newsletter; and (3) a Facebook message was sent to 27 universities who had a Facebook page and did not respond to the e-mail inquiry. Two universities (response rate = 7.40%) agreed to post a study advertisement on their official Facebook page. To ensure that the current sample consists of only newly arrived international students, we screened out students who were not from a foreign country or had been in the US for 3 months or longer.

Two hundred and eighty-nine individuals provided sufficient data (i.e., no missing values on global extraversion or cross-cultural motivation) to be included in the analysis (57% males; average age = 23, $SD = 5$). Participants were asked to complete three questionnaires over 4 months after arriving in the United States. Participants in the current study reported coming from a diverse range of countries, with the top five countries being China (22%), Canada (13%), Australia (8%), Japan (7%), and India (6%).

Procedure

Acknowledging the limitation of cross-sectional designs in making predictive inferences, the present study adopted a longitudinal design to better capture the changes in personality and to make a stronger test for predictive values of such changes (Funder, 2008). Pinpointing the timeframe for longitudinal changes to occur can be challenging, as the patterns of change can depend on a multitude of environmental and personal factors in the transition process. However, it has been shown that most issues related to adaptation occur in the early stage of a cross-cultural experience (Ward et al., 1998; Ying, 2005). Therefore, in the current study, cross-cultural adjustment was captured in the first 4 months (approximately one academic semester) after international students' arrival in the states. Specifically, participants were asked to complete measures of school extraversion, global extraversion, and cross-cultural motivation within the first month after arriving in the US (Time 1), followed by the second assessment of school extraversion 2 months after the first wave (Time 2) and the third assessment of school extraversion together with cross-cultural adjustment outcomes (i.e., cross-cultural adjustment, withdrawal cognitions, and school satisfaction) 4 months after the first wave (Time 3). Participants who completed the study were compensated a \$10 gift card and a chance to win a \$50 gift card based on random drawing.

Screening for Insufficient Effort Responding

To ensure data quality, we utilized two measures of insufficient effort responding (IER; Huang et al., 2012) to screen participants who did not fully attend to the survey instructions and items (see DeSimone et al., 2015). Removing IER prior to data analysis is important because IER can have potential deleterious impact on survey results (Huang et al., 2014b). First, we used three

items from a validated infrequency scale (Huang et al., 2014a) designed to detect IER in a low-stakes survey context. The three items presented counterfactual statements (i.e., “I have never used a computer”; “Eat cement occasionally”; and “Can teleport across time and space.”) where deviation from choosing the “correct” answers would indicate possible IER behavior. The three items were scattered in the first survey. Any response option indicating disagreement to the counterfactual statements was coded as attentive responding (0), whereas the other response options were coded as IER (1). The IER scale score was computed as the average of the three dichotomized item scores ($\alpha = 0.75$).

The second operationalization of IER used the response time approach, where an unrealistically short survey completion time was used to indicate IER. We adopted Huang et al.’s (2012) 2 s per item criterion and flagged individuals who responded faster than this on each survey. Participants were coded as IER (1) based on survey completion time if they sped through at least one of the three surveys and attentive responding (0) if otherwise.

To maximally retain the sample and avoid misclassifying attentive respondents, we followed Huang et al.’s (2012) recommendation to remove respondents who clearly engaged in IER behavior. Specifically, we excluded responses that (a) scored 1 on the IER scale (i.e., failing all three IER items); and (b) sped through at least one of the surveys. This *post hoc* decision rule was made after the data collection but before testing the current research model. Out of the 289 participants, 74 (25.61%) individuals were flagged and removed from subsequent analyses, leaving the final sample of 215 participants (54% male; $M_{\text{age}} = 24$ years, $SD = 4$).

Measures

Global Extraversion

Global extraversion ($\alpha = 0.77$) was measured with the 20-item extraversion scale from DeYoung et al. (2007), which measures two aspects of extraversion, namely enthusiasm ($\alpha = 0.73$) and assertiveness ($\alpha = 0.65$). Participants were asked to rate how well each item accurately described themselves. Sample items include: “Make friends easily” (enthusiasm) and “Take charge” (assertiveness). All items were administered on a seven-point Likert scale, ranging from 1 (very inaccurate) to 7 (very accurate).

School Extraversion

To assess School extraversion, we adapted the global extraversion measure by asking participants to reflect only on their behavior at school settings (see Schmit et al., 1995; Bing et al., 2004). All items were administered on a seven-point Likert scale, ranging from 1 (very inaccurate) to 7 (very accurate). Cronbach’s alphas were 0.84, 0.77, and 0.72 across the three waves, respectively. For the two aspects of school extraversion, the Cronbach’s alphas were 0.79, 0.76, and 0.71 for school enthusiasm and 0.71, 0.68, and 0.63 for school assertiveness, respectively.

Cross-cultural Motivation

Ang et al.’s (2007) five-item motivational cultural intelligence (CQ) scale was used to assess cross-cultural motivation (see

Chen et al., 2010). This measure captures both cross-cultural self-efficacy (a sample item is: “I am confident that I can socialize with locals in a culture that is unfamiliar to me.”) and cross-cultural intrinsic motivation (a sample item is: “I enjoy interacting with people from different cultures.”). All items were administered on a seven-point Likert scale, ranging from 1 (strong disagree) to 7 (strongly agree). Cronbach’s alpha of the scale was 0.82.

Cross-cultural Adjustment

We used a 14-item scale from Black (1988) to assess three facets of cross-cultural adjustment: general (seven items; $\alpha = 0.83$), interaction (four items; $\alpha = 0.86$), and work (three items; $\alpha = 0.80$). Items pertaining to work adjustment were adapted to the school context. Participants were asked the extent to which they feel adjusted (or unadjusted) to the various aspects of their life in the US. All items were administered on a seven-point Likert scale, ranging from 1 (very unadjusted) to 7 (very adjusted).

Withdrawal Cognitions

Withdrawal cognitions were measured based on Shaffer et al.’s (2006) six-item scale (adapted from Hom and Griffeth, 1991). A sample item is: “I plan to leave this school.” All items were administered on a five-point Likert scale, ranging from 1 (strong disagree) to 5 (strongly agree). The measure had a Cronbach’s alpha of 0.97.

School Satisfaction

Satisfaction was assessed in the school context using a seven-item scale from Lounsbury et al. (2005). A sample questions is “How satisfied are you with how much you are leaning in school?” All items were administered on a seven-point Likert scale, ranging from 1 (very dissatisfied) to 7 (very satisfied). Cronbach’s alpha was 0.83 for the scale.

RESULTS

Descriptive statistics and zero-order correlations are presented in **Table 1**. Global extraversion positively correlated with school extraversion assessed at each time point ($r_s = 0.77, 0.55$, and 0.54 , respectively, $p < 0.001$), and the estimates were in line with the correlations previously reported between global and contextualized personality (e.g., Bing et al., 2004; Heller et al., 2009). Global extraversion (Time 1) and school extraversion at each time point was positively associated with the three aspects of cross-cultural adjustment and school satisfaction but was unrelated to withdrawal cognitions.

Prior to hypothesis testing, we examined whether school extraversion at the initial time point added incremental validity above and beyond global extraversion in predicting cross-cultural adjustment outcomes. Without controlling for school extraversion, global extraversion predicted the three aspects of cross-cultural adjustment (general adjustment, $\beta = 0.31$, $p < 0.001$; interaction adjustment, $\beta = 0.31$, $p < 0.001$; school adjustment, $\beta = 0.25$, $p < 0.001$) and school satisfaction ($\beta = 0.39$, $p < 0.001$), but not withdrawal cognitions ($\beta = 0.03$, $p = 0.68$). To test the incremental validity of school extraversion above and beyond global extraversion, we used hierarchical

multiple regression and regressed the cross-cultural adjustment outcome variables separately onto global extraversion (step 1) and school extraversion (step 2). Results revealed that school extraversion significantly predicted school adjustment when controlling for global extraversion, $\beta = 0.22$, $p = 0.04$, explaining 2% additional variance. However, school extraversion did not add any significant incremental prediction for any of the other outcomes.

We employed latent growth modeling (LGM; Chan, 2002) to test the hypotheses. Based on structural equation modeling, LGM allows for modeling and estimating different parameters of change in a longitudinal dataset (Lance et al., 2000; Chan, 2002). Specifically, we used two latent factors (Kline, 2005; Kaplan, 2009; e.g., Chan and Schmitt, 2000) to model the change trajectory for school extraversion: (a) the latent intercept factor that represents the initial status of school extraversion (i.e., how extraverted an individual is upon first assessment); and (b) the latent slope factor that represents the rate of change in school extraversion (i.e., how an individual's extraversion has changed across the span of the study). In light of the present sample size, we used observed scale scores as indicators in the LGM analysis.

We tested two nested models to assess whether there was non-linear change in school extraversion. For the intercept term, both models fixed factor loadings to one for each of the three school extraversion measures. In contrast, for the slope term, the initial constrained model (Model 1, see **Figure 1**) fixed factor loadings to 0, 1, and 2 for T1–T3 school extraversion, respectively, whereas the unconstrained model (Model 2, see **Figure 2**) fixed factor loadings for T1 and T2 school extraversion but freely estimated the loading for T3 school extraversion. Thus, the intercept term indicates the initial level of school extraversion, while the slope term indicates the rate of change in school extraversion. In both models, we included global extraversion and cross-cultural motivation as predictors for the intercept and slope of school extraversion.

Initial model testing revealed that Models 1 and 2 did not converge because a correlation estimate went outside of the reasonable bounds. Specifically, the correlation between cross-cultural motivation and the slope of school extraversion change was estimated to be -1.01 for Model 1 and -1.15 for Model 2, respectively. Given this error, we started diagnosing the cause of this issue by removing the adjustment outcomes from Models 1 and 2 to focus on the effects of the predictors (i.e., global extraversion and cross-cultural motivation) on school extraversion change (intercept and slope). These simplified models converged reasonably well: modified Model 1 (see **Figure 3**): $\chi^2(3) = 12.52$, CFI = 0.98, RMSEA = 0.12, SRMR = 0.16; modified Model 2 (see **Figure 4**): $\chi^2(2) = 1.44$, CFI = 1.00, RMSEA = 0.00, SRMR = 0.01. Importantly, cross-cultural motivation did not predict either the intercept or the slope of school extraversion change (Model 1: $\beta_s = 0.10$ and 0.04 , respectively; Model 2: $\beta_s = 0.11$ and -0.02 , respectively). These non-significant paths were incongruent with the observed strength of relationships between cross-cultural motivation and adjustment outcomes (see **Table 1**), suggesting that the erroneous estimates were caused by the fact that the influence of cross-cultural motivation

TABLE 1 | Descriptive statistics and intercorrelations for study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 T1 global extraversion																
2 T1 school extraversion	0.77***															
3 T1 school enthusiasm	0.73***	0.89***														
4 T1 school assertiveness	0.61***	0.86***	0.54***													
5 T1 cross-cultural motivation	0.51***	0.46***	0.41***	0.39***												
6 T2 school extraversion	0.52***	0.55***	0.48***	0.45***	0.32***											
7 T2 school enthusiasm	0.50***	0.49***	0.53***	0.30***	0.39***	0.79***										
8 T2 school assertiveness	0.32***	0.36***	0.22**	0.41***	0.11	0.78***	0.23**									
9 T3 school extraversion	0.51***	0.54***	0.44***	0.50***	0.35***	0.69***	0.54***	0.54***								
10 T3 school enthusiasm	0.45***	0.43***	0.45***	0.30***	0.33**	0.62***	0.61***	0.36***	0.81***							
11 T3 school assertiveness	0.35***	0.41***	0.23**	0.50***	0.22	0.47***	0.23**	0.51***	0.77***	0.25***						
12 T3 general adjustment	0.27***	0.31***	0.32***	0.21**	0.51***	0.37***	0.47***	0.10	0.31***	0.29***	0.19**					
13 T3 interaction adjustment	0.28***	0.28***	0.30***	0.17*	0.55***	0.25***	0.35***	0.04	0.25***	0.24***	0.14*	0.69***				
14 T3 school adjustment	0.22***	0.28***	0.32***	0.16*	0.39***	0.26***	0.34***	0.06	0.27***	0.26***	0.15*	0.78***	0.62***			
15 T3 school satisfaction	0.39***	0.31***	0.32***	0.22**	0.61***	0.39***	0.45***	0.16*	0.24***	0.24***	0.13	0.52***	0.50***	0.46***		
16 T3 withdrawal cognitions	0.03	0.03	-0.01	0.07	0.35***	-0.11	0.01	-0.18*	-0.08	-0.07	-0.07	0.30***	0.31***	0.27***	0.24***	
M	4.43	4.33	4.31	4.34	5.56	4.37	4.49	4.26	4.35	4.40	4.29	5.26	5.12	5.38	5.34	3.90
SD	0.66	0.75	0.91	0.79	0.89	0.62	0.80	0.78	0.60	0.78	0.73	0.87	1.08	0.99	0.83	2.05

$N = 211-215$. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

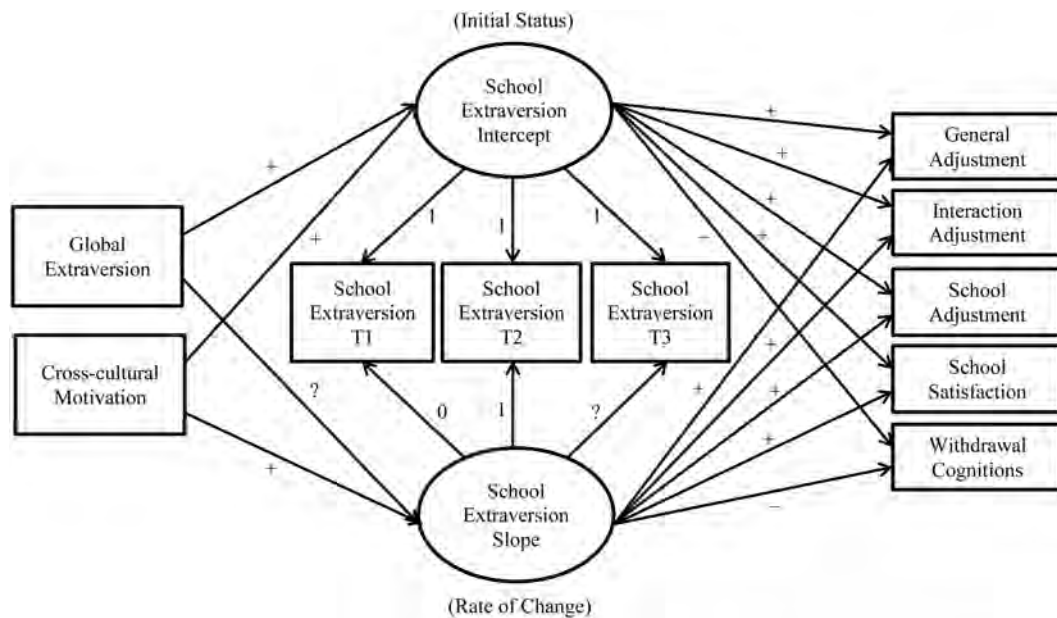


FIGURE 2 | Model 2 with hypotheses.

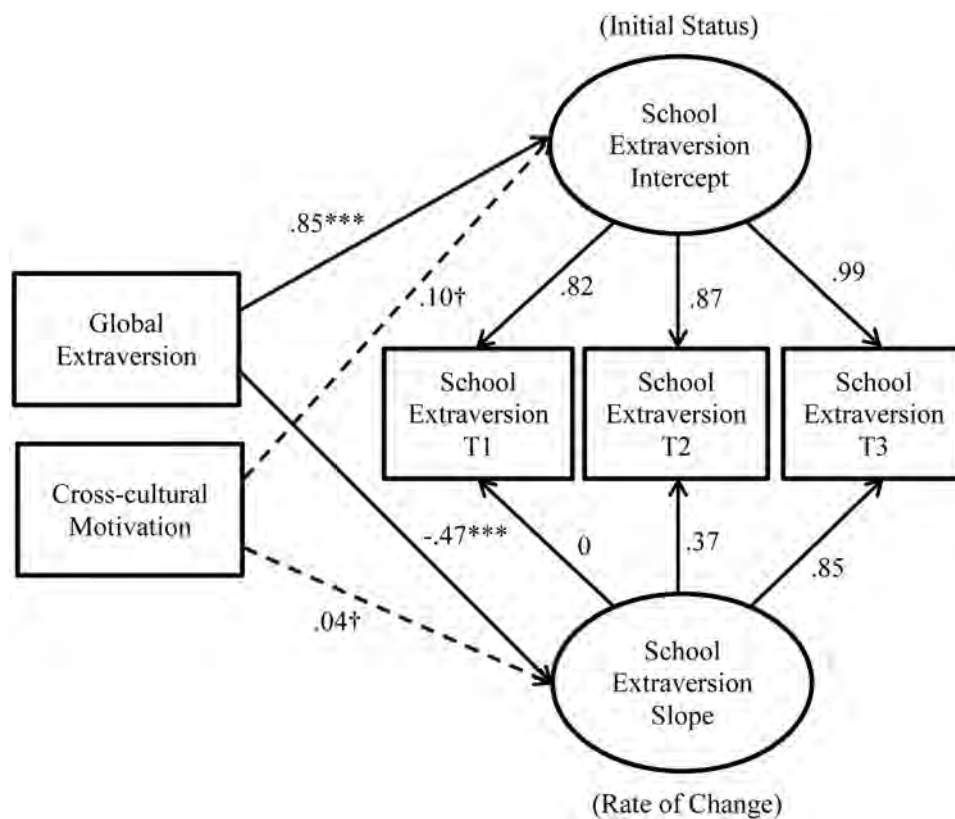


FIGURE 3 | Results from the modified Model 1 with the predictors and school extraversion change. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; † $p \geq 0.05$; $N = 215$. Estimates are standardized estimates from the modified Model 1 (i.e., the constrained model). Solid lines represent significant paths, whereas dotted lines represent insignificant paths.

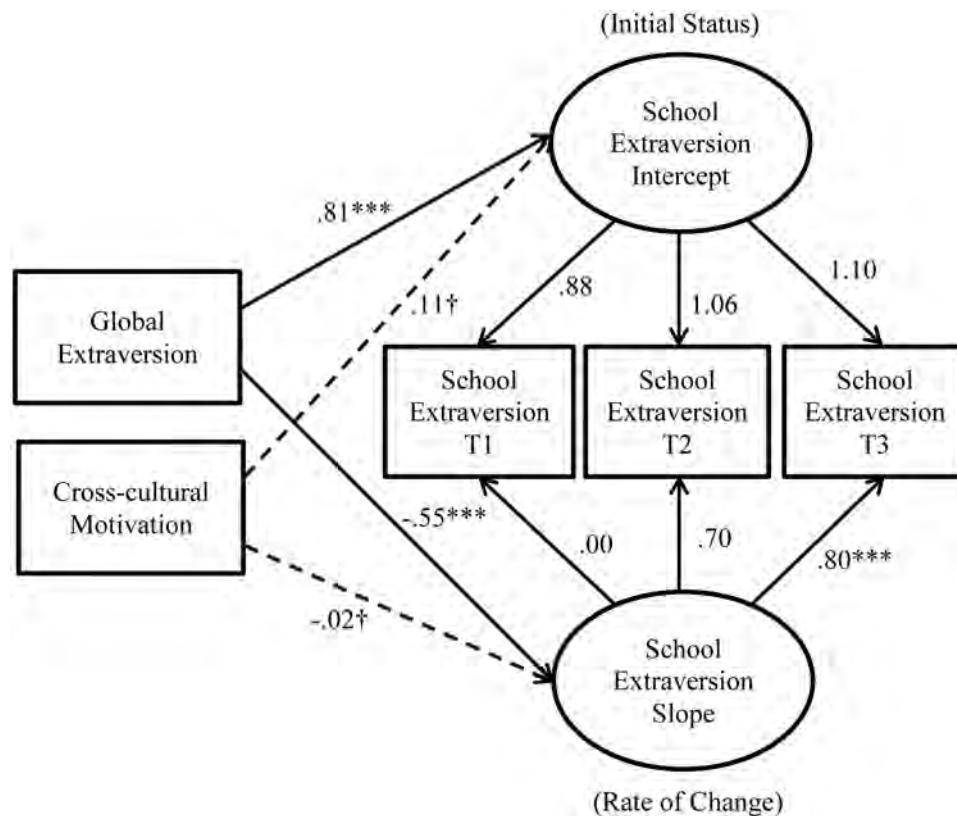


FIGURE 4 | Results from the modified Model 2 with the predictors and school extraversion change. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; † $p \geq 0.05$; $N = 215$. Estimates are standardized estimates from the modified Model 2 (i.e., the unconstrained model). Solid lines represent significant paths, whereas dotted lines represent insignificant paths.

on adjustment outcomes could not be accounted for in Models 1 and 2. In addition, a chi-square difference test revealed that relaxing the constraint on the slope significantly improved the model fit, $\Delta\chi^2(1) = 11.08$, $p < 0.001$, suggesting that the change was non-linear (thus retaining Model 2).

Given past research that suggests a positive influence of cross-cultural motivation on cross-cultural adjustment and adaptation (e.g., Templer et al., 2006; Ang et al., 2007; Chen et al., 2010), we reestimated Model 2 with direct paths from cross-cultural motivation to cross-cultural adjustment outcomes. In other words, in these reestimated models, cross-cultural motivation served the role of a covariate such that its influence on adjustment outcomes could be controlled for. The model had reasonably good fit to the data (see Figure 5): $\chi^2(13) = 26.32$, CFI = 0.99, RMSEA = 0.07, SRMR = 0.03. The loading for the slope on T3 school extraversion was 0.98, indicating a nearly flat rate of change from T2 to T3 on school extraversion.

We proceeded to examine the hypotheses with the estimates from Model 2 (see Figure 5). The initial status of school extraversion predicted two aspects of cross-cultural adjustment (general adjustment, $\beta = 0.23$, $p = 0.01$; school adjustment, $\beta = 0.20$, $p = 0.03$), school satisfaction ($\beta = 0.20$, $p = 0.03$), and withdrawal cognitions ($\beta = -0.36$, $p < 0.001$), but not interaction

adjustment ($\beta = 0.09$, $p = 0.27$). Therefore, *Hypotheses 1a* was partially supported, while *Hypotheses 1b* and *1c* were fully supported. Meanwhile, the slope of change in school extraversion predicted two aspects of cross-cultural adjustment (general adjustment, $\beta = 0.29$, $p = 0.002$; school adjustment, $\beta = 0.22$, $p = 0.02$) and withdrawal cognitions ($\beta = -0.20$, $p = 0.04$), but not interaction adjustment ($\beta = 0.13$, $p = 0.13$) or school satisfaction ($\beta = 0.12$, $p = 0.18$). Thus, *Hypothesis 2a* was partially supported, *Hypothesis 2b* was not supported, and *Hypothesis 2c* was fully supported.

Supporting *Hypothesis 3*, global extraversion ($\beta = 0.86$, $p < 0.001$) significantly and positively predicted the intercept of school extraversion. Interestingly, global extraversion negatively predicted the slope of change in school extraversion ($\beta = -0.62$, $p < 0.001$). Furthermore, cross-cultural motivation did not predict the intercept ($\beta = 0.11$, $p = 0.06$) or the slope of change in school extraversion ($\beta = -0.03$, $p = 0.79$), thus failing to support *Hypotheses 4* and *5*. For a comparison purpose, we tested Model 2 (i.e., the unconstrained model) with the full sample ($N = 289$) without excluding any cases marked as IER. The model had good fit: $\chi^2(13) = 25.46$, CFI = 0.99, RMSEA = 0.06, SRMR = 0.02. The directions and the significance of the paths were similar to those in the IER-excluded sample ($N = 215$), except that the intercept of school extraversion no longer predicted school

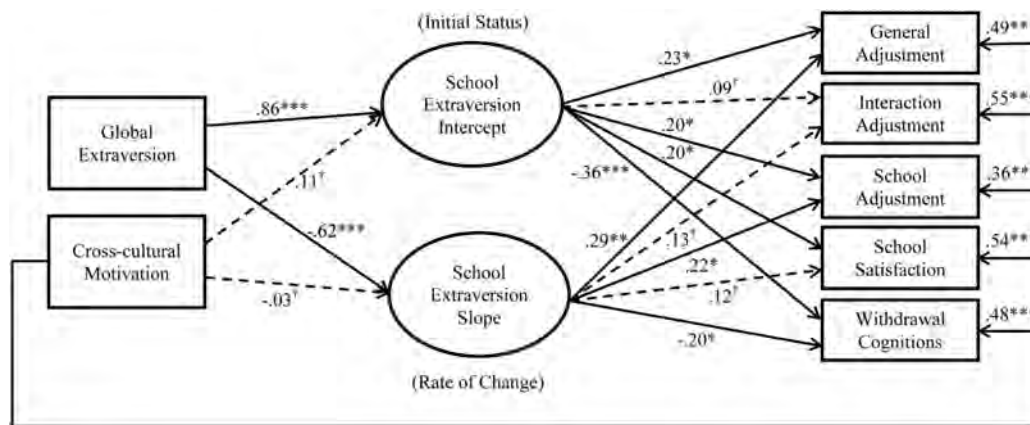


FIGURE 5 | Results from Model 2 with direct paths from cross-cultural motivation to cross-cultural adjustment outcomes. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; † $p \geq 0.05$; $N = 215$. Estimates are standardized estimates from Model 2 (i.e., the unconstrained model). Observed measures of school extraversion were included in the model but not presented here. Solid lines represent significant paths, whereas dotted lines represent insignificant paths.

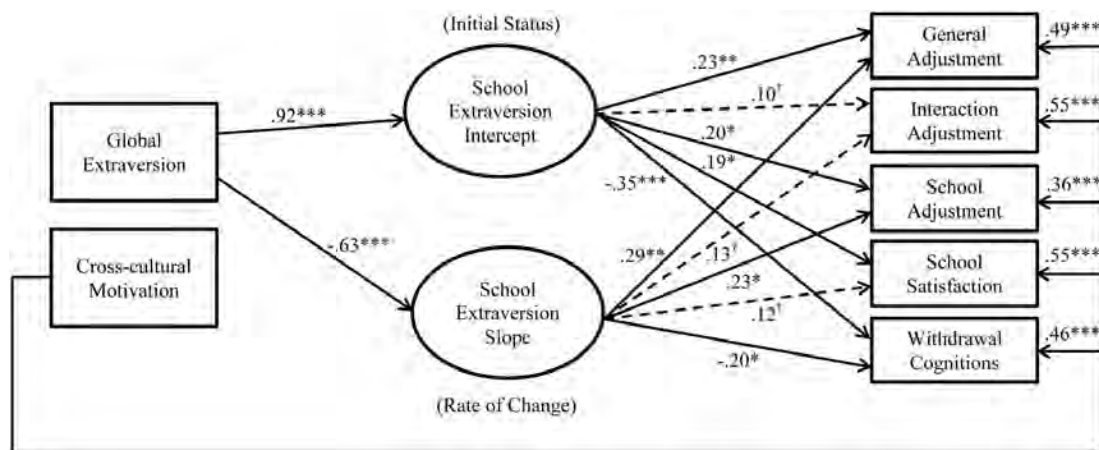


FIGURE 6 | Results from the final Model 2 omitting the paths from cross-cultural motivation to change in school extraversion. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; † $p \geq 0.05$; $N = 215$. Estimates are standardized estimates from Model 2 (i.e., the unconstrained model). Observed measures of school extraversion were included in the model but not presented here. Solid lines represent significant paths, whereas dotted lines represent insignificant paths.

adjustment, $\beta = 0.14$, $p = 0.06$. Based on these results, we retained a more simplified model excluding the non-significant paths from cross-cultural motivation to change in school extraversion (see **Figure 6**). It should be noted that the model trimming at this stage did not affect the conclusions regarding the substantive effects hypothesized above.

Given that our model suggests a potential mediating effect of school extraversion (both in terms of initial status and rate of change) on the relationship between global extraversion and cross-cultural adjustment outcomes, we tested a partial mediation model by allowing the direct paths from global extraversion to the cross-cultural adjustment outcomes [model fit: $\chi^2(8) = 18.95$, CFI = 0.99, RMSEA = 0.08, SRMR = 0.05], and compared it with Model 2. A chi-square difference test revealed that adding the direct paths did not significantly improve the model fit, $\Delta\chi^2(5) = 7.37$, $p = 0.19$, indicating that the more parsimonious Model 2 should be retained. In addition, results from the

partial mediation model showed that none of the paths from global extraversion to cross-cultural adjustment outcomes was significant, while the paths from global extraversion to change in school extraversion and from change in school extraversion to adjustment outcomes all remained similar to those in Model 2. This pattern of results indicates that global extraversion does not directly impact cross-cultural adjustment outcomes, but rather influences them through the initial level and rate of change in school extraversion.

In an exploratory fashion, we examined the two aspects of school extraversion (i.e., enthusiasm and assertiveness) separately to see if either of them was driving the results. Specifically, we retested Model 2 using school enthusiasm (Model 3) and school assertiveness (Model 4) separately. Results from Model 3 showed that there was a significant mean level increase in school enthusiasm ($M_s = 0.17$, $p = 0.004$). The initial status of school enthusiasm predicted all three aspects of cross-cultural

adjustment (general adjustment, $\beta = 0.31$, $p = 0.001$; interaction adjustment, $\beta = 0.17$, $p = 0.04$; school adjustment, $\beta = 0.28$, $p = 0.03$), school satisfaction ($\beta = 0.26$, $p = 0.001$), and withdrawal cognitions ($\beta = -0.29$, $p = 0.002$). Meanwhile, the slope of change in school enthusiasm also predicted the three aspects of cross-cultural adjustment (general adjustment, $\beta = 0.38$, $p < 0.001$; interaction adjustment, $\beta = 0.22$, $p = 0.02$; school adjustment, $\beta = 0.29$, $p = 0.006$) and school satisfaction ($\beta = 0.21$, $p = 0.01$), but not withdrawal cognitions ($\beta = -0.08$, $p = 0.42$).

In terms of school assertiveness, results from Model 4 showed that there was not a significant mean level change in school assertiveness ($M_s = -0.08$, $p = 0.18$). In addition, the initial status of change in school assertiveness negatively predicted withdrawal cognitions ($\beta = -0.27$, $p = 0.002$) but did not predict any of the three aspects of cross-cultural adjustment (general adjustment, $\beta = 0.07$, $p = 0.43$; interaction adjustment, $\beta = -0.02$, $p = 0.79$; school adjustment, $\beta = 0.05$, $p = 0.03$) or school satisfaction ($\beta = 0.06$, $p = 0.45$). Likewise, the slope of change in school assertiveness did not predict the three aspects of cross-cultural adjustment (general adjustment, $\beta = 0.11$, $p = 0.34$; interaction adjustment, $\beta = 0.02$, $p = 0.89$; school adjustment, $\beta = 0.07$, $p = 0.59$), school satisfaction ($\beta = -0.03$, $p = 0.81$), or withdrawal cognitions ($\beta = -0.12$, $p = 0.42$). Therefore, we conclude that school enthusiasm, but not school assertiveness, was the driving force behind school extraversion change and cross-cultural adjustment.

DISCUSSION

Recognizing the malleable aspect of personality and its potential beneficial effect on cross-cultural adjustment in the US, the current study marks a first attempt to capture the *process* by which sojourners experience changes in personality during cross-cultural adaptation, while positioning the changes as proximal antecedents to cross-cultural adjustment outcomes. As expected, students with higher initial school extraversion also had better cross-cultural adjustment in general and at school, greater school satisfaction, and lower withdrawal cognitions. More importantly, increases in school extraversion were shown to positively predict general and school-specific adjustment and negatively predict withdrawal cognitions. In addition, global extraversion positively predicted the initial level of school extraversion yet negatively predicted the rate of change in school extraversion. Findings from the current study lay the ground work for investigating personality changes in specific contexts pertaining to work-related transitions and adaptation. Taken together, this study makes a number of notable contributions to the literatures of cross-cultural adjustment and personality and sheds light on practices in sojourners and expatriate assessment and selection.

Theoretical and Practical Implications

In line with the cross-cultural adjustment literature (e.g., Swagler and Jome, 2005; Sri Ramalu et al., 2010), the current study highlights the important role of contextualized extraversion in facilitating sojourners' adjustment in a new cultural environment.

Our findings demonstrate that school extraversion and its change predicted both general cross-cultural adjustment and academic related adjustment (i.e., school adjustment, withdrawal cognitions). The positive effects of school extraversion and its change on general and school adjustment in the US might be attributed in part to the overall high level of extraversion in the US society (see McCrae and Terracciano, 2005), such that sojourners who are more extraverted or becoming more extraverted in the school context may find their own characteristics increasingly congruent with those of the cultural environment, which in turn lead to better adjustment outcomes. Although in the expected directions, neither the initial status nor the change in school extraversion predicted interaction adjustment, suggesting that extraversion in the school context may not have a direct impact on international students' socialization and interaction with the host nationals in general. That is, as interaction with host nationals can occur beyond the school context, extraversion and its changes contextualized within the school context may not be particularly fitting to predict interaction adjustment outside of the school context. In addition, exploratory analyses on the two aspects of school extraversion (i.e., enthusiasm and assertiveness) showed that school enthusiasm, but not school assertiveness, was the driving force behind school extraversion change and cross-cultural adjustment.

Our findings imply that entering and living in a new culture can lead to changes in one's contextualized personality, a notion that is in line with the socialization effects (Roberts and Mroczek, 2008; Roberts et al., 2008). On the other hand, one should consider the potential selection effects (Headey and Wearing, 1989; Roberts and Wood, 2006) simultaneously. For instance, individuals who choose to study or work abroad may tend to be more extraverted than those who do not. Likewise, international students who are more extraverted or becoming more extraverted in the school context may also select themselves or be selected into more desirable and acceptable events (e.g., study groups, social activities) that may facilitate their adaptation. Future research should test these factors as potential mechanisms via which personality and its change exert effects on cross-cultural adjustment.

Building upon the previous research that has demonstrated the proximity of contextualized personality, we posit that personality change may be better captured in particular contexts, and that contextualized personality change may provide better prediction than global personality change in the corresponding context. Therefore, we examined extraversion changes in a specific context, the school context, and linked these changes to cross-cultural adjustment outcomes. In doing so, the current study advances the existing literature that has been mainly focused on the contextualization of stable personality traits and shows promising results of using contextualized personality changes to predict context specific and general outcomes.

In an attempt to find out what drives contextualized personality change, we examined the relations of two individual differences (i.e., global extraversion and cross-cultural motivation) with school extraversion change. We found that global extraversion, although positively related to the initial

status of school extraversion, negatively predicted the rate of change in school extraversion. In other words, international students who had higher global extraversion also tended to behave more extraverted at school in the beginning but were also more likely to experience a decrease in school extraversion, whereas individuals who had lower global extraversion also behaved more introverted at school in the beginning but may experience an increase in school extraversion. This suggests that introverts may have a greater potential and more room than extraverts to increase their contextualized extraversion while adjusting to a new culture. Although global extraversion was inversely related to the slope of change in school extraversion, descriptive statistics indicate that individuals who were high on global extraversion remained more extraverted in school (5.21 at T1 to 4.74 at T3) compared to those who were low on global extraversion (3.56 at T1 to 3.90 at T3), despite the changes.

Proposing that individuals with high cross-cultural motivation will have high capacity and motivation to behave extraverted in the US, we examined cross-cultural motivation as an antecedent for the initial status and change in school extraversion. Failing to support our hypothesis, we did not find any evidence linking cross-cultural motivation to either the initial status or change in school extraversion. Therefore, the current study's findings suggest that school extraversion and its change may be more driven by one's standing on global extraversion than by cross-cultural motivation.

Despite the growing interest in studying cross-cultural adjustment, the current study is the first to integrate the recent developments in personality research in a cross-cultural context. Based on the findings, the current research echoes past studies (e.g., Caligiuri, 2000) that suggest organizations in the US might incorporate extraversion as a selection tool for sojourners and expatriate workers. Meanwhile, practitioners should recognize the potential malleability of contextualized personality, especially under the influence of other individual characteristics (e.g., global personality), and how personality change may predict adjustment and withdrawal. By identifying changes in contextualized extraversion and their impact on cross-cultural adjustment, the current study broadens our understanding of the role of personality in adaptation and adjustment. Particularly, stable personality traits have been examined to understand how individuals adapt to changes in their work environment (Huang et al., 2014c). On the other end of the continuum, individuals respond to changes in their task context with varying personality states (Minbashian et al., 2010; Huang and Ryan, 2011). The current study identified contextualized extraversion change as an additional mechanism, beyond stable traits and momentary states, that may contribute to one's acceptance of environmental and organizational change, as well as psychological and work adjustment (e.g., adaptive performance, see Jundt et al., 2015).

Limitations

Despite the contributions, this study has a few limitations. First, international students in the current study were facing dual challenges of adapting to a new culture and adjusting to college. Therefore, it is unclear to what extent personality change was

driven by cultural influence or school experience. Future studies may further tease apart the cultural and school influences on personality change by measuring them separately or using a non-student sample.

Second, the current findings, based on international students, may not be readily applied to foreign workers adjusting to the US culture. Although international students may share similar encounters and experiences with organizational sojourners and expatriates in a foreign culture (e.g., cultural shock and adaptation), and that personality traits (e.g., conscientiousness) have been shown to predict similar outcomes in work and school contexts (e.g., job performance and school performance; Barrick and Mount, 1991; Bing et al., 2004), it is unknown whether findings from the current research can be fully replicated in organizational settings. Therefore, researchers are encouraged to replicate this study using organizational sojourners and expatriates.

Third, while we focused on extraversion in the current study given the cultural context, the other four Big Five traits (i.e., agreeableness, conscientiousness, openness to experience, and neuroticism) have also been linked to cross-cultural adjustment in other cultures (e.g., Swagler and Jome, 2005; Peltokorpi, 2008; Sri Ramalu et al., 2010). Although we attempted to explore changes in the other four personality dimensions by tracking them via the mini-IPIP scales (Donnellan et al., 2006), we were unable to obtain reliable measures with four items on each personality dimension. Therefore, a venue for future research is to extend the current study and further examine the relationship between changes of other personality dimensions and cross-cultural adjustment.

Future Directions

As the first study to examine contextualized personality change in the cross-cultural adjustment context, the current study points to a few interesting venues for future research. The first direction for future research pertains to individual factors that may contribute to personality changes in a cross-cultural context. In the current study, we examined global extraversion and cross-cultural motivation as two individual characteristics that may drive changes in school extraversion. Meanwhile, other individual differences may also lead one's contextualized personality to change in a cross-cultural context. For instance, openness to experience may influence the extent to which one is susceptible to cultural influences and subsequently how he or she behaves in a cross-cultural context. Self-monitoring, the extent to which an individual observes and controls his or her behavior according to situational cues (Snyder, 1974), may shape how this person adjusts behaviors when encountered with a new cultural environment. Demographic variables, such as age, may also play a role in whether and how much personality changes during cross-cultural adaptation.

Second, future research should investigate personality changes in other important, specific contexts pertaining to work-related transitions and adaptation. Studying personality changes in different contexts (e.g., cultural, work, and family) is important because not only can it provide insight on the potential varying degrees of personality changes associated with particular contexts

(e.g., personality changes may be more pronounced in a cross-cultural context than in an organizational socialization context), but it can also improve the predictive validity of the individual characteristics for the outcomes of interest. For instance, the model of attraction–selection–attrition (ASA; Schneider, 1987) indicates that organizational newcomers who share similar characteristics with the existing employees should be more likely to stay in the organization and less likely to withdraw. Considering the malleable aspect of contextualized personality, it is possible that some newcomers may experience changes in work contextualized personality that can enable them to fit better with the work group. Therefore, newcomer contextualized personality changes may predict newcomer adjustment and turnover during organizational socialization.

Third, despite the fact that personality and life experiences are interactive in nature, limited research has been conducted to study the two aspects in conjunction. As discussed earlier, the interplay of personality and life events can be referred to as selection effects and socialization effects. The current findings regarding changes in contextualized personality show support for the socialization effects (Roberts and Mroczek, 2008; Roberts et al., 2008). Extending the previous longitudinal studies that have demonstrated both the selection effects and the socialization effects (e.g., Vaidya et al., 2002; Specht et al., 2011), future research on personality changes in a cross-cultural context should examine the potential impact of cross-cultural adjustment outcomes on personality. For instance, a sojourner who is successfully adjusting to the American culture may also become more interested in reaching out to the local nationals, attending activities and events, and staying an active part of his or her surroundings, all of which indicate an increasing level of extraversion. In contrast, a sojourner who experiences difficulty in adapting to a new cultural environment may further withdraw from social interactions and activities, leading to a decrease in extraversion. Therefore, future research should explore the reciprocal relationship between personality and adaptation outcomes.

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- Fourth, provided the growing literature that suggests change in trait personality (e.g., Roberts et al., 2001; Vaidya et al., 2002; Lüdtke et al., 2011; Boyce et al., 2015), it would be an interesting research question to examine the potential change in trait extraversion in a cross-cultural context. It is likely that, given the prolonged influence of cross-cultural events and experiences, some individuals might eventually experience significant changes in their trait personality (e.g., become more extraverted in general). Although we did not examine change in trait extraversion in our study, the current findings regarding change in contextualized extraversion and its predictive validity lay the groundwork for studying trait changes in the future.
- Fifth, based on the findings that contextualized personality may be malleable, organizational researchers and practitioners may explore the feasibility of developing training interventions that aim to elevate certain contextualized personality characteristics (cf. Huang and Ford, 2012) among sojourners and expatriates based on the cultural context.

CONCLUSION

The current captures the *process* by which sojourners experience changes in personality during cross-cultural adaptation and examine how these changes relate to cross-cultural adjustment outcomes. By demonstrating that the initial status and change in school extraversion predict cross-cultural adjustment outcomes, our findings lay the ground work for investigating personality changes in specific contexts pertaining to work-related adaptation and shed light on practices in sojourner and expatriate assessment and selection.

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Determinants of Prosocial Behavior in Included Versus Excluded Contexts

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Prosocial behavior (PSB) is increasingly becoming necessary as more and more individuals experience exclusion. In this context it is important to understand the motivational determinants of PSB. Here we report two experiments which analyzed the influence of dispositional (prosocialness; rejection sensitivity) and motivational variables (prosocial self-efficacy; prosocial collective efficacy; trust; anger; social affiliation motivation) on PSB under neutral contexts (Study 1), and once under inclusion or exclusion conditions (Study 2). Both studies provided evidence for the predicted mediation of PSB. Results in both neutral and inclusion and exclusion conditions supported our predictive model of PSB. In the model dispositional variables predicted motivational variables, which in turn predicted PSB. We showed that the investigated variables predicted PSB; this suggests that to promote PSB one could (1) foster prosocialness, prosocial self and collective efficacy, trust in others and affiliation motivation and (2) try to reduce negative feelings and the tendency to dread rejection in an attempt to reduce the negative impact that these variables have on PSB. Moreover, the few differences that emerged in the model between the inclusion and exclusion contexts suggested that in interventions with excluded individuals special care emphasis should be placed on addressing rejection sensitivity and lack of trust.

Keywords: prosocial behavior, exclusion, psychosocial variables, predictive model, mediation

INTRODUCTION

Civic cooperation, assistance, and solidarity are increasingly becoming necessary. More and more individuals are experiencing social exclusion resulting, for example, in job loss, eviction from one's home or complete marginalization. Promotion of prosocial behavior (PSB) — defined as an broad range of acts, including helping behavior, altruism, cooperation and solidarity intended to benefit other people (Weinstein and Ryan, 2010) — in individuals, groups and communities encourages the development of networks that facilitate coexistence, well-being and healthier social and environmental contexts. It therefore seems important to analyze the motivational determinants of PSB. In this research we analyzed the influence of psychosocial variables — some dispositional and some motivational — on PSB, first in a neutral context (Study 1), and then in the context of included versus excluded groups (Study 2).

Based on the Cognitive Affective Personality System Theory (CAPS; Mischel and Shoda, 1995; Mendoza-Denton et al., 2001), we analyzed the role of some dispositional and psychosocial variables in predicting PSB in both a neutral and an inclusion versus inclusion contexts, as well as

the potential relations between those predictors themselves. The CAPS conceives of the individual as a complex processing system, and suggests that the situation and the cognitive, affective, and personality components interact together, leading individuals to behave in a specific way. Thus, as state in the CAPS (Cervone, 2005), we proposed that some knowledge structures (the dispositional variables proposed in both studies) causally influence appraisal processes (as the psychosocial variables explored in both studies); that both kinds of variables interact together; and that this interaction leads individuals to behave in a specific way, i.e., in a prosocial specific way, as we are interested in explored in this study.

Shoda and Mischel (2006) claimed that the selection of the plausible mediators and determinants of a specific behavior depends on the behavior one is interested in predicting and on the situation within which this behavior is expected to occur. Thus, some variables widely studied in the past in relation to PSB (such as the dispositional and psychosocial variable of this study) seem to be potentially interconnected mediators that can be explored to predict this behavior by following the CAPS approach. Previous studies have shown that dispositional prosocialness (Eisenberg et al., 2002; Carlo et al., 2003), self-efficacy (Bandura, 2001; Caprara and Steca, 2005), and trust (Rotenberg et al., 2005; Welch et al., 2005; Derfler-Rozin et al., 2010; Berigan and Irwin, 2011) are potential predictors of PSB. Moreover, the relations between most of those variables have also been demonstrated, and therefore led us to theorize some meditational hypotheses not yet explored to our knowledge. Thus, it will be interested to explore the validity of a determinant model of PSB involving all those variables, by exploring how they interact together to explain PSB, what to our knowledge has not been explored to the date. Moreover, the exploration of some variables—as rejection sensitivity, anger and affiliation motivation—seems to be particularly relevant in order to explain PSB in the context of social inclusion. Thus, it may be relevant to explore the validity of the model explored in a context of social exclusion by adding those variables explicitly relevant in this context, and once more by exploring the relations those variables maintain between themselves and their potential mediating role in explaining PSB in such contexts.

In brief, the global aim of our two studies was to analyze the role of some dispositional and psychosocial variables in predicting PSB, and to analyze the relation between those predictors themselves by testing the potential mediating effects of self and collective efficacy, trust, anger and affiliation motivation, in accordance with the CAPS (Mischel and Shoda, 1995; Mendoza-Denton et al., 2001). The variables studied were chosen in line with the CAPS (Mischel and Shoda, 1995; Mendoza-Denton et al., 2001) that discuss interconnected mediators, which predict individual behavior. In line with the premise of Shoda and Mischel (2006), the relevance of one or other mediator depends in part on the behavior theorists are interested in predicting and on the context in which this behavior occurs. As such, the dispositional and psychosocial variables chosen for this study have been commonly related to PSB in previous literature and/or to social exclusion situations.

The potential of this study lies in the fact that it explores a potential model of PSB, including the potential relations between different dispositional and psychosocial variables, exploring not only the effect of those variables on PSB, but also the potential interactions between themselves; interactions that finally led to explain PSB. Moreover, we then apply this model to the context of social exclusion versus social inclusion by adding some variables especially relevant in those contexts. In this sense, the analysis of such variables as predictors of PSB, and the testing of the potential relations between them, may be pertinent from a theoretical perspective. Additionally, from an applied perspective, because social exclusion is a common result of the crisis, and because social assistance and PSB promote healthier social and environmental contexts and thus are increasingly necessary, it seems relevant to study which variables can be predictors of PSB, not only in neutral contexts, but also in the contexts of inclusion versus exclusion situations; and then propose some practical interventions based on the results to promote this kinds of beneficial behaviors.

Psychosocial Variables Related to Prosocial Behavior

Many variables have been related to PSB. Dispositional prosocialness, i.e., the disposition or tendency to help, share, cooperate, empathize and take care of other people (Caprara et al., 2000) might be a predictor of PSB. It has been demonstrated that (1) prosocial tendencies correlate positively with global PSB and negatively with aggression (Carlo et al., 2003), (2) prosocial disposition in childhood is related to PSB in young adulthood (Eisenberg et al., 2002) and (3) that individuals with prosocial orientation engage in more PSB, e.g., donating than individuals with individualistic and competitive orientations (Van Lange et al., 2007). Additionally, it is assumed that individuals' behavior tends to be congruent with their disposition (Heider, 1958) and that attitudes drive behavior (Helper and Albarracín, 2014) i.e., a positive attitude to some object or objective will result in behavior designed to increase or promote it. We therefore argue that prosocialness will predict PSB.

H1: Individuals with higher levels of prosocialness engage in higher levels of PSB.

Prosocial Self-Efficacy and Prosocial Collective Efficacy and Related Variables

Self-efficacy can be responsible for unity and directness in terms of the individual's actions (Caprara and Steca, 2005). The relationship between behavior and perceived efficacy — at both individual and collective level — has been widely debated (for a review see Bandura, 2001). Without confidence in their ability or the ability of their group to do something, it is unlikely that individuals will engage in a related behavior (Bandura, 2001). There is also evidence that empathic self-efficacy directly predicts PSB across ages (Caprara and Steca, 2005). From this evidence it follows that higher prosocial self-efficacy — confidence in one's own ability to act prosocially — and higher collective prosocial efficacy — confidence in the ability of one's group to

act prosocially — will predict higher levels of PSB (Cuadrado and Taberero, 2015).

Prosocialness has been associated with self-efficacy. Highly prosocial individuals probably tend to have high levels of confidence in their ability to behave in a prosocial way. Bandura et al. (1999) confirmed the relationship between prosocialness and both self-efficacy and social efficacy. The relationship between empathic self-efficacy beliefs and prosocialness is dynamic (Alessandri et al., 2009). Hence, it seems that the greater the prosocialness levels individuals possess, the more their prosocial self-efficacy will be elevated.

Prosocial self-efficacy and collective prosocial efficacy are also related. Self-efficacy influences beliefs about the effectiveness of one's group (Fernández-Ballesteros et al., 2002). In other words individuals who doubt their own efficacy probably have little confidence in the efficacy of their group, and vice versa (Bandura, 2000; Fernández-Ballesteros et al., 2002).

H2: Prosocial self-efficacy mediates the relationship between (a) prosocialness and prosocial collective efficacy, and (b) prosocialness and PSB.

Trust and Related Variables

Previous research has shown that trust, which “represents confidence in the strength of a partner's commitment” (Rusbult and Agnew, 2010, p. 339), promotes PSB (Rotenberg et al., 2005; Welch et al., 2005; Derfler-Rozin et al., 2010; Berigan and Irwin, 2011).

It is easy to understand the relationship between prosocialness and trust: prosocial individuals expect that PSB will be reciprocated and therefore tend to trust others. The more empathetic an individual is — empathy is an important component of prosocialness (Caprara et al., 2005) — the more likely it is that he or she will feel something in common with others and therefore the more likely he or she is to trust others (Levenson and Ruef, 1992) and be willing to approach them. Empathy and prosocialness promote good interpersonal relationships (Davis and Oathout, 1992) and it has been claimed

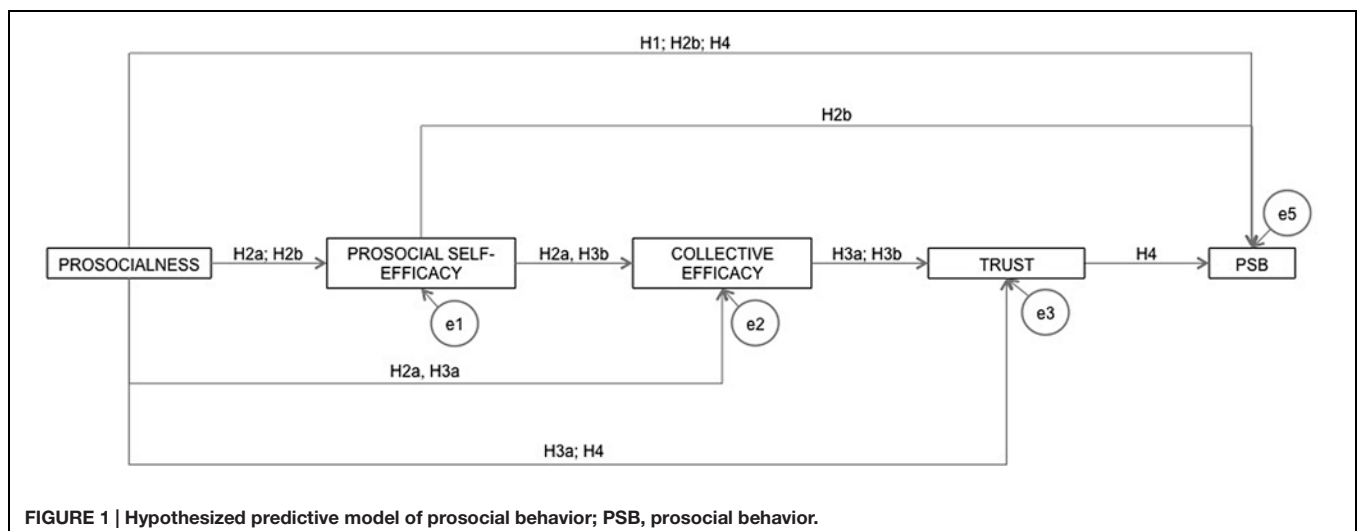
that empathy and trust are closely related (Ickes et al., 1990). Feng et al. (2004) showed that in an online context empathic communication increases trust. Altruism, benevolence, and generosity — which are strongly associated with prosocialness — have also been found to predict trust (Nooteboom and Six, 2003; Klapwijk and Van Lange, 2009; De Dreu et al., 2010). For example, Klapwijk and Van Lange (2009) found that generosity has an important role in building and maintaining trust; and De Dreu et al. (2010) found that parochial altruism promoted in-group trust. We anticipated that more prosocial individuals would show more trust.

It also seems likely that individuals who believe strongly in the prosocialness of their group are confident that group members will treat them with goodwill and benevolence. Sapouna (2010) defined collective efficacy — which is strongly related to, and intertwined with trust (McKenzie et al., 2002) — as “a mutual trust (among the members of a group) combined with their willingness to intervene to achieve common goals” (p. 1920). This suggests that collective efficacy may play a critical role in decisions about the trustworthiness of group members (Kramer et al., 1996). De Cremer (1999) showed that high perceived collective efficacy reduced fear and thus enhanced individuals' trust in the cooperative intentions of others. We anticipated that individuals with high collective prosocial efficacy would trust in the goodwill of their partners.

H3: Collective prosocial efficacy mediates the relationship between (a) prosocialness and trust, and (b) prosocial self-efficacy and trust.

H4: Trust mediates the relationship between prosocialness and PSB.

In short, as **Figure 1** shows, we proposed a predictive model of PSB in which prosocialness and trust were direct predictors of PSB; prosocial self-efficacy mediated the relationships between (1) prosocialness and prosocial collective efficacy and (2) prosocialness and PSB; collective efficacy mediated the relationships between (1) prosocialness and trust and (2) prosocial self-efficacy and trust; and trust mediated the relationship between prosocialness and PSB.



In Study 1 we tested this model in a neutral context. But what happens when individuals are suffering exclusion? Would the variables tested in this model still predict PSB? Would inclusion/exclusion moderate how predictive variables influenced PSB? Previous studies have shown that exclusion and inclusion can influence the extent to which an individual behaves prosocially (e.g., DeWall and Richman, 2011; Lee and Shrum, 2012), so in Study 2 we tested our model in two different conditions — inclusion and exclusion — adding some variables — rejection sensitivity, anger, and affiliation motivation—which seemed relevant to the context conditions.

STUDY 1

The objective of this study was to analyze the relationships between the various motivational determinants of PSB and devise a predictive model of PSB in a neutral context.

Materials and Methods

Participants, Measures and Procedure

The participants were 93 students (86% women, 14% men; age range: 21–43 years, $M = 23.46$, $SD = 2.94$) randomly selected from the University of Cordoba (Spain).

Students completed in our laboratory an online questionnaire created with the Global Park survey program. Then participants were informed that they would have to do some online group tasks in which they would have the opportunity to earn points, which would be exchanged for cash at the end of the experiment (this was part of the manipulation; there were no online participants). Before the group task, dispositional prosocialness was assessed. Then, to ensure the reliability of the online group tasks, the program asked participants to introduce themselves to the other online contestants. Then, in order to know the other participants who may comprise their group, they read the description of six participants (all the participants read the same descriptions of fictitious online participants. Descriptions gave information on sex, age, career choice, academic course, leisure interests etc.). At this point they were informed that the computer had randomly allocated them to a three-person online group. Next prosocial self-efficacy, collective prosocial efficacy, and trust were assessed. After this the participants played three rounds of the public good dilemma game; this allowed them to earn points that could be exchanged for cash (all participants were informed that they had earned 10 euros). Finally, participants were fully debriefed and probed for suspicion.

The Spanish Ministry of Economy and Competitiveness only requires revision and approval by an institutional review board (ethics committee) when the studies imply (a) clinical human experimentation; (b) use of human embryonic stem cells, or derived therefrom, from pre-embryos remaining lines; (c) Use of tissues or biological samples of human origin; (d) Use of personal data, genetic information, etc.; (e) Animal Experimentation; (f) Use of biological agents of risk to human health, animal or plant; (g) Use of genetically modified organisms (GMOs); or (h) Release of GMOs. Thus, the study was not reviewed nor approved by any

institutional ethics committee before the study began because it was exempt from ethical approval procedures.

Dispositional prosocialness

Prosocialness was measured with the short version of the Prosocialness scale (Caprara et al., 2005). This consists of 12 items, e.g., ‘I try to console people who are sad’ with responses given on a seven-point Likert scale.

Prosocial self-efficacy [$\alpha = 0.88$, $M = 6.10$, $SD = 0.80$, range (4.00–7.00)]. Self-efficacy with respect to PSB was assessed using a short (five-items; ‘I can behave cooperatively,’ ‘I can distribute resources equitably,’ ‘I can make an equal division of a common monetary fund,’ ‘I can adopt behavior oriented to help others,’ and ‘I can share resources’) scale with responses given on a 7-point Likert scale, in accordance with Bandura’s (2006) guide to constructing self-efficacy scales. Because this was not a validated scale, we performed Exploratory Factorial Analysis (EFA) with Varimax rotation; this confirmed that the scale had a one-factor structure that explained 68.31% of the variance in scores.

Prosocial collective efficacy [$\alpha = 0.94$, $M = 5.88$, $SD = 1.05$, range (1.00–7.00)]. Participants’ perceptions of the prosocial efficacy of their group were assessed with a short scale designed in accordance with Bandura’s (2006) guide to constructing self-efficacy scales. The scale consisted of the same five items as the individual prosocial self-efficacy scale and responses were given on the same 7-point Likert scale, but all the items were preceded by the phrase ‘My group can’ (e.g., ‘My group can behave cooperatively’). EFA with Varimax rotation confirmed that the scale had a one-factor structure that explained 83.16% of the variance in scores.

Trust [$\alpha = 0.72$, $M = 5.22$, $SD = 1.44$, range (1.00–7.00)]. Trust was assessed using an adaptation of Greenhalgh and Chapman’s (1998) scale. The scale included three items (e.g., ‘I feel that those two people can be counted on to help me’) to which participants responded using a 7-point Likert scale to indicate their trust in the participants with whom they were to perform the online group tasks. Participants completed the scale before solving the online group tasks. EFA with Varimax rotation confirmed that the scale had a one-factor structure that explained 77.43% of the variance in scores.

Prosocial behavior [$\alpha = 0.88$, $M = 5.14$, $SD = 1.74$, range (0.00–6.67)]. PSB was assessed using the public good dilemma game; this in an N -person prisoner’s dilemma game which is usually used to assess tendency to cooperation. An explanation of the game by Santos et al. (2008, p. 213) states that “cooperators (C) contribute an amount c (‘cost’) to the public good; defectors (D) do not contribute. The total contribution is multiplied by an enhancement factor r and the result is equally distributed between all N members of the group.” In our experiment we used a three-person prisoner’s dilemma and three rounds were played. In each round players were given a certain number of points and had to decide how many points to keep and how many to donate. Donated points were doubled and distributed among the group. The mean number of points a participant donated over the three

rounds of the game was used as a measure of PSB, donating more points indicated greater prosocialness.

Treatment of the Data

Sex and age were not the principal aim of our study and did not show any significant influence on the other variables of the study, and were thus omitted from all further analyses.

Preliminary analyses

In order to test the means and standard deviations of the variables of the study, as well as the interactions between them some descriptive analyses and correlation tests including all the variables were performed.

Multicollinearity tests

To detect multicollinearity we examined the correlation matrix for the independent variables, the variance inflation factor (VIF) and tolerance values for all the constructs (Kline, 2005).

Mediation analyses

In order to confirm hypotheses 2, 3, and 4 mediation analyses were computed with Amos (version 21) by following the product-of-coefficients strategy with bootstrapping to test the strength and significance of the indirect effect (Shrout and Bolger, 2002). In the present study the 95% confidence interval of the indirect effect was obtained with 2,000 bootstrap resamples.

Structural Equation Modelling (SEM)

In order to confirm a predictive model of PSB a path analysis was performed with Amos 21. To estimate the causal model the following indicators of the goodness of fit were used:

- (a) Root Mean Square Error of Approximation (RMSEA), which is considered as a good fit with values lower than 0.05, as an adequate fit with values between 0.05 and 0.08, as a mediocre fit with values between 0.08 and 0.10, and as a not acceptable fit with values higher than 0.10. (Browne and Cudeck, 1993; Schermelleh-Engel and Moosbrugger, 2003);
- (b) Comparative Fit Index (CFI) which is suitable if you have values above 0.97 (Schermelleh-Engel and Moosbrugger, 2003);
- (c) Goodness of Fit Index (GFI), for which Hoyle (1995) suggests values above 0.9 as appropriate, and Schermelleh-Engel and Moosbrugger (2003) suggest values above 0.95 indicative of good fit.

Results

Preliminary Analyses

Correlation analysis was used to explore the relationships among all investigated variables in the study. As can be seen in **Table 1**, all correlations were in the expected direction.

A Predictive Model of Prosocial Behavior

To detect multicollinearity we first examined the correlation matrix for the independent variables; the absence of high correlations (i.e., 0.85 or greater) suggested that the data were not affected by collinearity (Kline, 2005). As **Table 1** shows, the highest correlation was between prosocialness and prosocial self-efficacy ($r = 0.64$). We next checked the VIF and tolerance values

for all the constructs. All VIF values were less than 5.0 (range: 1.309–1.871) and all tolerance values were between 0.10 and 1.0 (range: 0.535–0.764) so we can be confident that the data were not affected by multicollinearity (Kline, 2005).

Mediation hypotheses (H2, H3, and H4) were tested using bootstrapping analyses in Amos 21. As **Table 2** shows, all the hypotheses were confirmed.

Moreover, in order to confirm the predictive role of the variables, as well as the hypothesized predictive model of PSB, a path analysis was performed with Amos 21. The goodness-of-fit tests revealed that the model was well-fitted [$\chi^2(3, N = 93) = 2.78, p = 0.43$; $RMSEA = 0.01$ (95% CI [0.01, 0.17]); $CFI = 1.00$; $GFI = 0.99$]. Results confirmed Hypotheses 2 (a and b), 3b—but not 3a—and 4, but only partially Hypothesis 1 (see **Figure 2**).

Discussion

All the variables investigated contributed to a predictive model of PSB in which prosocial self-efficacy and trust act as direct predictors. The direct predictive role of prosocialness was not confirmed; it should, however, be noted that correlation and mediation analyses indicated that—in line with H1—prosocialness was correlated with PSB and directly predicted it ($R = 0.29^{**}$; $\beta = 0.29^{**}$); although prosocialness was not a direct predictor of PSB in the model the two variables were related, with prosocialness directly predicting PSB. This result indicates that a prosocial disposition might lead individuals to behave prosocially, i.e., in congruence with their disposition (Eisenberg et al., 2002; Carlo et al., 2003).

Regarding the direct predictors of PSB and in line with previous studies (Rotenberg et al., 2005; Welch et al., 2005) the experiment showed that having confidence in partners' goodwill encouraged individuals to behave in a prosocial way and conversely participants were less generous to partners they perceived as untrustworthy. Additionally, prosocial self-efficacy directly predicted PSB; the more confident individuals were in their ability to behave prosocially, the more likely they were to behave prosocially. This result is consistent with self-efficacy theory (Bandura, 2001), which states that individuals are less likely to attempt behaviors if they do not believe that they are capable of executing them successfully.

The mediating roles hypothesized were confirmed. Prosocial self-efficacy fully mediated the relationships between (1) prosocialness and prosocial collective efficacy and (2) prosocialness and PSB. The more prosocial an individual's disposition the more likely he or she was to feel capable of behaving prosocially (Alessandri et al., 2009) and in turn, (1) the more they felt that their group was efficacious in behaving prosocially (Fernández-Ballesteros et al., 2002), and (2) the more they behaved prosocially (Bandura, 2001).

Prosocial collective efficacy fully mediated the relationships between (1) prosocialness and trust and (2) prosocial self-efficacy and trust. In accordance with previous research we found that (1) the greater individuals' disposition to PSB the more likely they were to feel that their group was capable of behaving prosocially (Alessandri et al., 2009) and (2) the more individuals perceive themselves as highly efficacious in a determined behavior (being

TABLE 1 | Correlations, means, standard deviations, and alpha reliabilities for all the study one variables.

	1	2	3	4	5	Mean	Range	SD	α
(1) Prosocialness	—					5.96	(3.42–7.00)	0.72	0.90
(2) PS self-efficacy	0.64**	—				6.10	(4.00–7.00)	0.80	0.88
(3) Collective PS efficacy	0.48***	0.59***	—			5.88	(1.00–7.00)	1.05	0.94
(4) Trust	0.41***	0.25*	0.48***	—		5.22	(1.00–7.00)	1.44	0.72
(5) PSB	0.29**	0.33***	0.31**	0.30**	—	5.14	(0.00–6.67)	1.74	0.88

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

PS self-efficacy, prosocial self-efficacy; collective PS efficacy, collective prosocial efficacy; PSB, prosocial behavior.

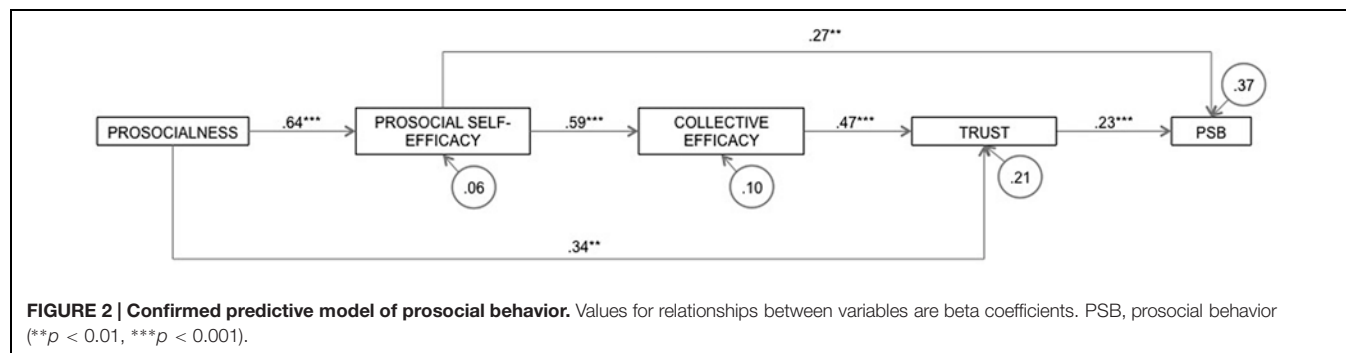
TABLE 2 | Type of Mediation Observed.

Hypothesis	Direct Beta without Mediator	Direct Beta with Mediator	Indirect Beta
H2a: PSness \rightarrow PS self-efficacy \rightarrow collective PS efficacy	0.48***	0.17 (ns)	0.31***
H2b: PSness \rightarrow PS self-efficacy \rightarrow PSB	0.29**	0.13 (ns)	0.16**
H3a: PSness \rightarrow collective PS efficacy \rightarrow trust	0.41***	0.23 (ns)	0.18**
H3b: PS self-efficacy \rightarrow collective PS efficacy \rightarrow trust	0.33***	−0.09 (ns)	0.30***
H4: PSness \rightarrow trust \rightarrow PSB	0.29**	0.20 (ns)	0.09*

Direct and indirect effects calculated with bootstrapping analysis.

PSness, prosocialness; PS self-efficacy, prosocial self-efficacy; collective PS efficacy, collective prosocial efficacy; PSB, prosocial behavior. The first column is a statement of the hypothesis. The second column gives the regression weight for the direct association between the independent variable (IV) and the dependent variable (DV) before controlling for the effects of the putative mediator (M). The third column gives an estimate of the standardized direct effect of the IV on the DV after controlling for the effects of the putative M. The fourth column gives an estimate of the standardized indirect effect of the IV on the DV after controlling for the effects of the putative M in bootstrapping analysis.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.



prosocial), the more they perceive that their group is efficacious in this same behavior (Bandura, 2000; Fernández-Ballesteros et al., 2002). In turn, the more they perceive their partner as having high abilities in being prosocial, the more they trust in those partners (Kramer et al., 1996; De Cremer, 1999).

Trust emerged as a mediator of the relationship between prosocialness and PSB. The more prosocial an individual's disposition the more likely he or she is to trust others (Nooteboom and Six, 2003) and hence to behave prosocially toward them (Welch et al., 2005). This psychological pattern seems intuitively plausible: prosocial and empathic individuals usually see others like them, tend to expect some reciprocity, and consequently trust the others (Levenson and Ruef, 1992). In the expectation that the others will operate with goodwill, trust can produce not only reciprocity but also social orientation by bestowing on individuals the motivation to approximate those others, to engage in activities with them, as well as encouraging closeness as the starting-point for relationships (Welch et al.,

2005); therefore it seems logical that trust may produce PSB (Baumeister and Leary, 1995; Zaskodna et al., 2013).

STUDY 2

Study 1 provided evidence for a predictive model of PSB in which prosocialness, prosocial self-efficacy and trust act as predictors of PSB in a neutral context; however, previous studies have shown that exclusion and inclusion may affect the extent to which an individual behaves prosocially (Maner et al., 2007; Williams, 2007; Smart Richman and Leary, 2009; Romero-Canyas et al., 2010b; DeWall and Richman, 2011; Lee and Shrum, 2012). In our societies, more and more people are experiencing social exclusion, and even complete marginalization. In this context, the promotion of PSB is increasingly relevant. The causes of PSB have generally been attributed to positive experiences and factors; nevertheless PSB may also arise after negative life

events (Vollhardt, 2009), as social exclusion. However, there is controversy about whether exclusion leads to prosocial (Maner et al., 2007; Mead et al., 2010) or antisocial behavior (Ayduk et al., 2008; Coyne et al., 2011). Consequently, it seems pertinent to explore how PSB is affected by inclusion and exclusion and whether the mechanisms that predict PSB in neutral contexts are the same in contexts of inclusion or exclusion. We were therefore interested in exploring potential contextual differences in associations between predictor variables and PSB; in particular we wanted to know whether the predictive variables explored in Study 1 were similarly powerful predictors of PSB in included and excluded individuals.

The objective of Study 2 was to determine if the model developed in Study 1 was valid for excluded and included individuals. We also added some supplementary variables of particular relevance to inclusion/exclusion contexts to the model: rejection sensitivity, anger, and affiliation motivation. In general, we expected that the variables that have shown to be predictors of PSB in Study One in a neutral context will be similarly powerful predictors of PSB in excluded and included contexts. There is no reason to think that prosocialness, prosocial self-efficacy, collective prosocial efficacy nor trust will not predict PSB in excluded and included contexts to the same extent as in a neutral context. Nevertheless, considering a new variables included in Study 2, it is interesting to note that we expected that rejection sensitivity will be predictor of anger and PSB only in contexts of exclusion, but not in contexts of inclusion. This prediction is based in the rejection sensitivity model of Levy et al. (2001) in which it is explained that rejection sensitivity is activated only when rejection cues are detected, triggering in turn negative affective states as anger, which in turn reduce the probability to behave prosocially.

Psychosocial Variables Related to Prosocial Behavior

In Study 2 we used the model found in Study 1 is replicated by adding some variables of particular interest in the context of the exclusion-PSB relationship.

Rejection Sensitivity and Related Variables

Rejection sensitivity — i.e., the tendency to anxiously expect social rejection (Downey and Feldman, 1996) — moderates the link between exclusion and antisocial behavior: exclusion provokes aggression toward the rejecters in individuals who are highly sensitive to rejection but not in those who are less sensitive (Ayduk et al., 2008). Rejection sensitivity therefore seemed relevant to a model intended to predict PSB in the contexts of exclusion and inclusion.

Rejection sensitivity has been related to self-efficacy, which is in turn related to PSB. When rejection-sensitive individuals perceive rejection cues they activate negative self-efficacy beliefs (Ayduk et al., 2000). Rejection sensitivity impairs self-regulation, and — to an even greater extent — self-efficacy and interpersonal self-efficacy (Downey and Feldman, 1996; Levy et al., 2001; Inzlicht et al., 2006). The low interpersonal self-efficacy of high rejection sensitivity individuals produces decreases in confidence

and skill in social interaction, particularly in the event of meeting new people, where there are more chances to be rejected; and as rejection sensitivity increases, interpersonal competence decreases (Butler et al., 2007). One would therefore expect rejection sensitivity to be negatively associated with prosocial self-efficacy and collective prosocial efficacy. We therefore predicted that:

H1: Prosocial self-efficacy mediates the relationship between rejection sensitivity and prosocial collective efficacy.

Anger and Related Variables

Anger increases when individuals feel excluded (Chow et al., 2008; Romero-Canyas et al., 2010b) and it has been shown that anger increases antisocial desires and exacerbates antisocial behavior (Leach et al., 2006) and reduces prosocial behavior in excluded individuals (Cuadrado et al., 2015). We consider that anger is relevant to models of the relationship between exclusion and PSB therefore included it as a motivational determinant in our predictive model of PSB.

There is evidence that anger is related to variables known to be associated with PSB, such as rejection sensitivity, collective efficacy and trust. In line with the rejection sensitivity model (Levy et al., 2001), Downey et al. (2000) offered a model in which—when rejection cues are perceived—high rejection sensitivity heightens cognitive-affective overreactions such as anger, that in turn increment the likelihood of violence occurring. In rejection-sensitive individuals exclusion elicits hostility (Ayduk et al., 1999) and reduces positive affect (Romero-Canyas et al., 2010b). Luterek et al. (2004) have also demonstrated that rejection sensitivity mediates the relationship between childhood sexual abuse and anger. We expected that the more individuals dread rejection, the more they feel angry when excluded.

Efficacy beliefs influence whether individuals think optimistically or pessimistically and their emotional responses (Bandura, 2000). Individuals who perceive that they or their group have low efficacy in a given task feel bad and activate a negative affect—such as anger (Valentino et al., 2009)—and a drop in positive affect (Salanova et al., 2011).

A propos trust, affective states influence the way in which we form an opinion of how trustworthy a person is (Jones and George, 1998). Individuals report more positive perceptions of others and report higher interpersonal trust when experiencing positive affect; conversely when experiencing negative affect, they are more likely to see others in a negative light and to perceive them as less trustworthy (Jones and George, 1998). Individuals experiencing positive affect tend to view human nature as more positive (Veitch and Griffitt, 1976), whilst anger decreases trust (Dunn and Schweitzer, 2005). We expected that angry individuals would trust their partners less.

In line with previous research and the results of Study 1 we hypothesized that:

H2: Anger mediates the relationship between (a) rejection sensitivity and trust, (b) prosocial self-efficacy and trust, and (c) prosocial collective efficacy and trust.

Affiliation Motivation and Related Variables

Affiliation motivation is the desire to maintain social contact or a sense of belonging (Veroff and Veroff, 1980); it motivates individuals to pursue positive interpersonal relationships (Zaskodna et al., 2013). High affiliation motivation reflects a strong sense of social interdependence (Markus and Kitayama, 1991) and so individuals with high affiliation motivation tend to act on behalf of their society or for the benefit of the group, i.e., in a prosocial manner. Individuals with high affiliation motivation will tend to behave in a friendly, prosocial manner in order to create or maintain social contact and avoid breaking bonds (Baumeister and Leary, 1995; Zaskodna et al., 2013). Many authors (Maner et al., 2007; Smart Richman and Leary, 2009; Romero-Canyas et al., 2010b; DeWall and Richman, 2011) have argued that rejected individuals tend to behave prosocially only when they see an opportunity to reconnect with others and have the desire to do so. These data suggested that affiliation motivation was likely to be a predictor of PSB.

There is also evidence that affiliation motivation is associated with several potential predictors of PSB. If we assume that prosocialness includes the tendency to take care of other people (Caprara et al., 2000) then it follows that prosocialness should increase desire for social contact and hence that prosocialness should predict affiliation motivation.

Rejection-sensitive individuals expect to be rejected by others and avoidance of such rejection is one of their primary goals (Downey and Feldman, 1996). Fear of rejection is an important component of affiliation motivation (Shipley and Veroff, 1958). Maner et al. (2010) argued that the increase in progesterone levels which is observed in individuals who dread rejection when they are given an opportunity to re-affiliate is consistent with their desire for compensatory social contact and their affiliation motivation. We anticipated that individuals who anxiously expect rejection would have a greater desire to continue interacting than less rejection-sensitive individuals.

The more capable individuals feel of doing something, the greater their motivation to act accordingly. Individuals who feel themselves to be highly capable of PSB are likely to behave prosocially, in accordance with this perception, and are more likely to be motivated to continue cooperating with partners than individuals with lower prosocial self-efficacy. This suggests that collective efficacy may increase the likelihood of engaging in relationships (Tasa et al., 2011). Social self-efficacy has also been related to the pursuit of social goals, as the more individuals feel socially efficacious, the more they endorse affiliation motivation (Patrick et al., 1997). We hypothesized that both self and collective prosocial efficacy would be positive predictors of affiliation motivation.

Given that trust is an expectation that others will contribute to positive outcomes and that trust tends to be reciprocal, individuals should have a greater desire to affiliate with people they trust. Trust leads to more open communication (Smith and Barclay, 1997) and to cooperation (Parks et al., 1996). Trusting individuals tend to be intrinsically motivated to engage in activities with others whereas less trusting individuals are less likely to want to affiliate (Green and Brock,

1998). Trust fosters closeness and is the starting point for personal relationships (Welch et al., 2005). We hypothesized that:

H3: Trust mediates the relationship between (a) prosocialness and affiliation motivation, and (b) prosocial collective efficacy and affiliation motivation.

H4: Affiliation motivation mediates the relationship between (a) prosocialness and PSB, (b) rejection sensitivity and PSB, (c) prosocial self-efficacy and PSB, (d) prosocial collective efficacy and PSB, and (e) trust and PSB.

In short, our predictive model of PSB was very similar to that in Study 1, but included some supplementary variables. In this new model, in addition to the relationships of Study 1, prosocial self-efficacy also mediated the relationship between rejection sensitivity and prosocial collective efficacy. Anger mediated the relationships between (1) rejection sensitivity and trust, (2) prosocial self-efficacy and trust and (3) collective prosocial efficacy and trust. Trust mediated the relationships between (1) prosocialness and affiliation motivation and (2) collective efficacy and affiliation motivation. Affiliation motivation mediated the relationships between (1) prosocialness and PSB, (2) rejection sensitivity and PSB, (3) prosocial self-efficacy and PSB, (4) prosocial collective efficacy and PSB and (5) anger and PSB (see Figure 3).

Materials and Methods

Participants

The participants were 119 students (71.4% women, 28.6% men; age range: 17–51 years, $M = 19.89$, $SD = 5.18$) randomly selected from the University of Cordoba (Spain). Students who take part in the first study were not able to take part in this second study.

Manipulation and Measures

The procedure was similar to that used in Study 1. Participants completed an online questionnaire in our lab and were then informed that they would have to do some online group tasks in which they would be able to earn points that would be exchanged for cash at the end of the experiment. Before the group tasks, dispositional prosocialness, rejection sensitivity and anger were assessed. Next, to ensure the reliability of the online group tasks, the program asked the participants to introduce themselves to the rest of the online contestants. Then participants read descriptions of six fictitious participants (all the participants read the same descriptions). They were then told that the computer had randomly allocated them to a three-person online group. At this point a sense of exclusion or inclusions was induced by having the participants play a round (30 passes in total) of the fourth version of the Cyberball game (Williams et al., 2012), a program developed for research on exclusion. Participants were randomly assigned to the exclusion condition (in which they received the ball only twice) or the inclusion condition (in which they received the ball ten times).

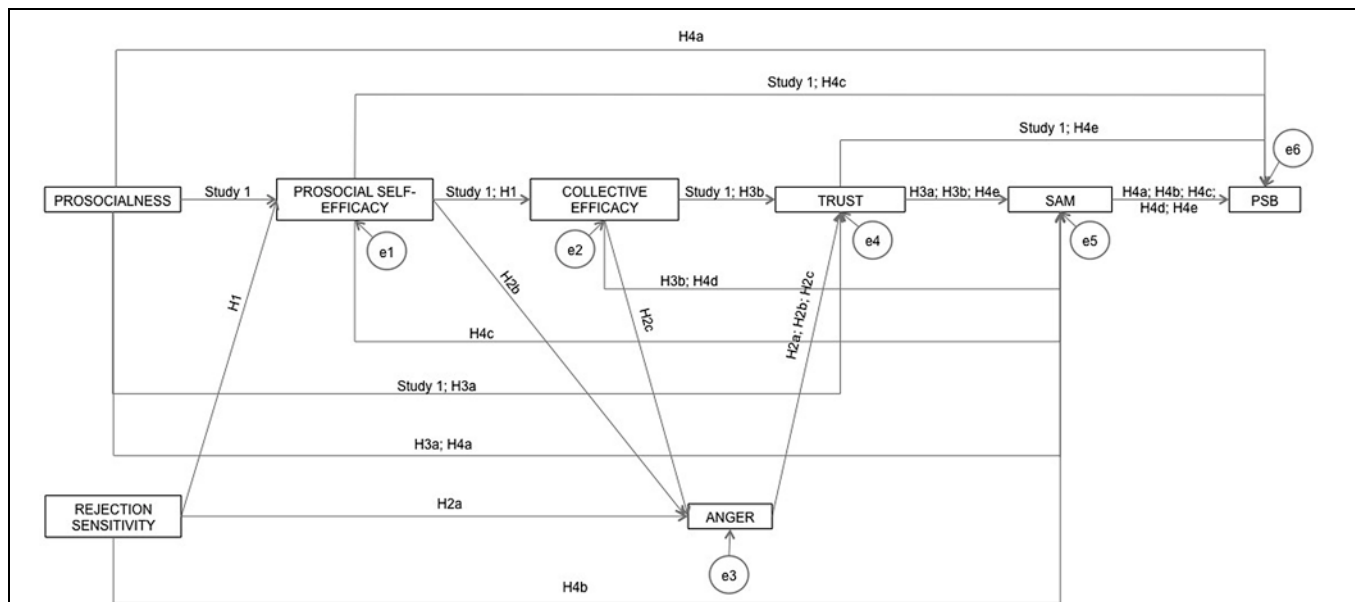


FIGURE 3 | Hypothesized predictive model of sharing resources prosocial behavior; SAM, social affiliation motivation; PSB, prosocial behavior - sharing resources.

At this point a manipulation check was performed. Then, prosocial collective efficacy, anger, social affiliation motivation and trust were assessed. Then participants played two rounds of the *N*-person prisoner's dilemma game [$M = 2.58$, $SD = 0.78$, range (0.00–3.50); $M_{\text{included}} = 2.63$, $SD = 0.79$, range (0.00–3.50); $M_{\text{excluded}} = 2.52$, $SD = 0.77$, range (0.00–3.50)] to assess PSB. After the two rounds, participants were informed that we had obtained enough data and that no further play was required. Finally, participants were fully debriefed and probed for suspicion.

As study one, this study was exempt from ethical approval procedures and thus was not reviewed nor approved by any institutional review board (ethics committee).

The variables were as in Study 1 (Cronbach's alphas for reliability are shown in **Figure 4**), with the addition of three new variables considered relevant to the inclusion/exclusion context.

Rejection sensitivity

[$M = 3.83$, $SD = 1.45$, range (1.00–7.00); $M_{\text{included}} = 3.88$, $SD = 1.44$, range (1.17–7.00); $M_{\text{excluded}} = 3.77$, $SD = 1.46$, range (1.00–6.67)]. Rejection sensitivity was measured with the six-item Hypersensitivity to Social Rejection scale (Ronen and Baldwin, 2010; e.g., 'If someone doesn't seem to like me I think about it for the rest of the day'), with responses given on a 7-point Likert scale.

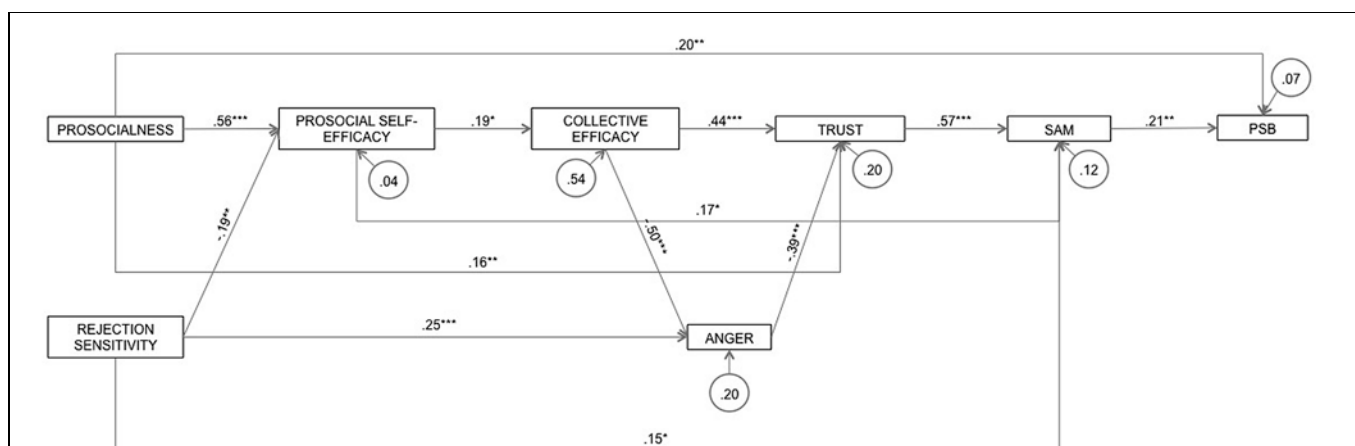


FIGURE 4 | Predictive model of sharing resources prosocial behavior confirmed to be equal across the two samples. SAM, social affiliation motivation; PSB, prosocial behavior - sharing resources (* $p < 0.05$, ** $p < 0.01$, * $p < 0.001$).**

Anger

Anger was assessed before and after the manipulation using a three-item (e.g., 'angry') short version of the anger factor of the Profile of Moods States scale (McNair et al., 1971) with responses given on a 7-point Likert scale. Descriptive statistics for anger before the manipulation were $M = 1.52$, $SD = 0.81$, range (1.00–4.33); $M_{\text{included}} = 1.50$, $SD = 0.84$, range (1.00–4.033); $M_{\text{excluded}} = 1.53$, $SD = 0.79$, range (1.00–4.00). After the manipulation the corresponding statistics were $M = 2.05$, $SD = 1.58$, range (1.00–7.00); $M_{\text{included}} = 1.24$, $SD = 0.54$, range (1.00–4.00); $M_{\text{excluded}} = 2.90$, $SD = 1.84$, range (1.00–7.00).

Affiliation motivation

[$M = 5.51$, $SD = 5.51$, range [1.33–7.00]; $M_{\text{included}} = 6.16$, $SD = .74$, range (3.67–7.00); $M_{\text{excluded}} = 4.84$, $SD = 1.31$, range (1.33–7.00)]. Participants' desire to continue interacting with their group was assessed with a specially developed six-item scale ('I wish to remain part of this group for future group tasks,' 'I would like to remain part of this group,' 'I dislike this group for future group tasks,' 'I would like to be fully accepted by the members of this group in the future,' 'I would like to be fully integrated into this group in the future,' and 'I would like the members of this group to accept me in the future') to which responses were given using a 7-point Likert scale. EFA with Varimax rotation confirmed that a single factor explained 62.9% of the variance in scores.

Manipulation check

A manipulation check was performed after the experimental manipulation. Perceptions of inclusion and exclusion were measured with four items ('My group members have excluded me,' 'My group members have included me,' 'I feel excluded by my group members,' and 'I feel included by my group members').

Treatment of the Data

Sex and age were not the principal aim of our study and did not show any significant influence on the other variables of the study, and were thus omitted from all further analyses.

Preliminary analyses

In order to test the means and standard deviations of the variables of the study, as well as the interactions between them some descriptive analyses and correlation tests including all the variables were performed.

Multicollinearity tests

To detect multicollinearity we examined the correlation matrix for the independent variables, the VIF and tolerance values for all the constructs (Kline, 2005).

Mediation analyses

In order to confirm hypotheses 1, 2, 3, and 4 mediation analyses were computed with Amos (version 21) by following the product-of-coefficients strategy with bootstrapping to test the strength and significance of the indirect effect (Shrout and Bolger, 2002). In the present study the 95% confidence interval of the indirect effect was obtained with 2,000 bootstrap resamples.

Structural Equation Modelling (SEM)

In order to confirm a context-sensitive predictive model of PSB a multi-group SEM analysis (moderated analysis) was conducted with Amos (version 21) to test for the equivalence of the causal structure between the two experimental conditions; this analysis was performed according to the steps prescribed in Byrne (2009) and by using the critical ratio for differences between parameters method. To estimate the causal model the same indicators of the goodness of fit of Study 1 were used.

Results

Manipulation Check

ANOVA showed main effects of experimental condition on perception of exclusion [$F(1,118) = 94.34$, $p < 0.001$] and inclusion [$F(1,118) = 127.31$, $p < 0.001$]. Participants in the exclusion context felt more rejected [$M_{\text{excl}} = 4.05$, $SD_{\text{excl}} = 1.88$, range_{excl} (1.00–7.00); and $M_{\text{incl}} = 1.43$, $SD_{\text{incl}} = 0.92$, range_{incl} (1.00–6.00)] and less included [$M_{\text{excl}} = 2.41$, $SD_{\text{excl}} = 1.83$, range_{excl} (1.00–7.00); and $M_{\text{incl}} = 5.75$, $SD_{\text{incl}} = 1.37$, range_{incl} (2.00–7.00)] than participants in the inclusion context. We therefore concluded that the manipulation was effective.

Preliminary Analyses

Correlation analyses were performed to explore the relationships between all the variables in the study. As can be seen in **Tables 3** and **4**, all correlations were in the expected direction.

A Context-Sensitive Predictive Model of Prosocial Behavior

To detect multicollinearity we examined the correlation matrix for the independent variables; the lack of high correlation coefficients (i.e., 0.85 or greater) indicated that collinearity was not a problem (Kline, 2005). As indicated in **Table 3**, the highest correlation coefficient was between prosocialness and prosocial self-efficacy ($r = 0.65$). Next we checked VIF and tolerance values for all the constructs. All VIF values were less than 5.0 (range: 1.070–2.415) and all tolerance values were between 0.10 and 1.0 (range: 0.414–0.934) so we can be confident that the data were not affected by multicollinearity (Kline, 2005).

Bootstrapping analyses were performed with Amos 21 to test hypotheses about mediation of relationships involving PSB (H1, H2, H3, and H4). Most hypotheses were confirmed; the exception was H4b, that affiliation motivation mediates the relationship between rejection sensitivity and PSB (**Table 5**).

Multi-group structural equation modeling (SEM) was performed to confirm the context-sensitive predictive model of sharing resources PSB. The model was a good fit to the data [$\chi^2(15, N = 119) = 7.46$, $p = 0.94$, $RMSEA = 0.01$, 95% CI [0.01,0.02]; $CFI = 1.00$, $GFI = 0.98$]. Comparison of the well-fitted baseline unconstrained model [$\chi^2(30, N = 119) = 27.36$, $p = 0.60$, $RMSEA = 0.01$, 95% CI [0.01,0.06]; $CFI = 1.00$, $GFI = 0.95$] with the well-fitted fully constrained model [$\chi^2(43, N = 119) = 55.09$, $p = 0.10$, $RMSEA = 0.05$, 95% CI [0.01,0.08]; $CFI = 0.95$, $GFI = 0.90$] using the chi-square comparison test indicated a difference between the inclusion and exclusion groups [$\Delta\chi^2_{(13)} = 27.73$; $p > 0.01$]. The critical ratio for differences between parameters method revealed groups differences in the

TABLE 3 | Correlations, means, standard deviations and alpha reliabilities for all the study two variables of the general sample.

	1	2	3	4	5	6	7	8	Mean	Range	SD	α
(1) Prosocialness	—								6.10	(4.17–7.00)	0.62	0.87
(2) Rejection sensitivity	0.02 (ns)	—							3.83	(1.00–7.00)	1.45	0.88
(3) PS self-efficacy	0.55***	−0.18*	—						6.25	(4.00–7.00)	0.70	0.85
(4) Collective PS efficacy	0.03 (ns)	−0.10 (ns)	0.19*	—					4.85	(1.00–7.00)	2.09	0.98
(5) Anger	−0.07 (ns)	0.29***	−0.16 [#]	−0.52***	—				1.98	(1.00–7.00)	1.51	0.91
(6) Trust	0.20*	−0.10 (ns)	0.22*	0.65***	−0.63***	—			4.42	(1.00–7.00)	1.89	0.97
(7) SAM	0.26**	0.06 (ns)	0.27**	0.42***	−0.36***	0.60***	—		5.51	(1.33–7.00)	1.25	0.87
(8) PSB	0.26**	0.14 (ns)	0.19*	0.06 (ns)	−0.08 (ns)	0.13 (ns)	0.26**	—	2.58	(0.00–3.50)	0.78	$R = 0.77***$

[#] $p < 0.09$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

For PSB' reliability, Pearson correlation analysis was done because it is composed only by two variables. PS self-efficacy, prosocial self-efficacy; collective PS efficacy, collective prosocial efficacy; SAM, Social affiliation motivation; PSB, prosocial behavior.

rejection sensitivity→anger path ($\beta_{\text{exclusion}} = 0.59$, $p > 0.001$; $\beta_{\text{inclusion}} = 0.01$, ns ; $z = 4.05$, $p > 0.01$) and the prosocial collective efficacy efficacy→trust path ($\beta_{\text{exclusion}} = 0.19$, $p > 0.05$; $\beta_{\text{inclusion}} = 0.68$, $p > 0.001$; $z = -2.66$, $p > 0.01$). **Figure 4** represents the general model for the combined sample.

Discussion

All the variables analyzed contribute to a predictive model of PSB — valid for both excluded and included individuals — in which prosocialness and affiliation motivation act as direct predictors of PSB. Most of the paths in the Study 1 model were confirmed. The disappearance of two of the relationships found in Study 1 — between (1) prosocial self-efficacy and PSB and (2) trust and PSB — might be due to the incorporation of affiliation motivation, which acted as a mediator of those relationships, such that there were no longer direct associations between the independent variables and PSB. The model was valid for both included and excluded individuals although there were two path differences. First, rejection sensitivity only predicted anger in the context of exclusion; this is consistent with previous reports that rejection-sensitive individuals only react with anger when they feel rejected (Downey et al., 2000; Levy et al., 2001; Luterek et al., 2004). Second, there was a stronger association between collective prosocial efficacy and trust in the context of inclusion. Individuals who were confident in the ability of their group to act prosocially trusted their partners more, particularly when they felt included in the group. This provides some evidence, albeit weak, that exclusion reduces trust (Twenge et al., 2007).

In line with previous studies (Eisenberg et al., 2002; Carlo et al., 2003) we found that prosocialness was a direct determinant of PSB and that individuals tend to behave in accordance with their dispositions (Heider, 1958). Affiliation motivation was also a direct predictor of PSB. The desire to maintain social contact motivates individuals to behave in a prosocial and friendly way in order to achieve affiliation (Baumeister and Leary, 1995; Zaskodna et al., 2013).

There was evidence for all the hypothesized mediation relationships except for the mediation of the relationship between rejection sensitivity and PSB by affiliation motivation. Nevertheless, the predictive model confirms that, as expected, rejection sensitivity negatively predicted affiliation motivation (Shipley and Veroff, 1958; Maner et al., 2010), which in turn was

a positive predictor of PSB (Baumeister and Leary, 1995; DeWall and Richman, 2011; Zaskodna et al., 2013).

Prosocial self-efficacy mediated the association between rejection sensitivity and collective prosocial efficacy. The more sensitive individuals are to social rejection, the more likely they are to feel rather incapable of PSB (Butler et al., 2007), and also to feel that their group is relatively incapable of PSB (Fernández-Ballesteros et al., 2002).

Anger runs as a mediator between three different links. It mediated the relationship between rejection sensitivity and trust; rejection sensitive individuals tend to report greater anger (Downey et al., 2000; Levy et al., 2001) and in turn to have less trust in others (Jones and George, 1998). Anger also mediated the relationships between self- and collective prosocial efficacy and trust. In other words when individuals feel that they or their group are relatively incapable of PSB they tend to report greater anger (Bandura, 2000; Valentino et al., 2009) and to trust their interaction partners less (Jones and George, 1998).

Trust mediated two relationships. It was a partial mediator of the prosocialness-affiliation motivation association. The more individuals have a prosocial tendency, the more they trust others (Nooteboom and Six, 2003), and in turn the more they wish to affiliate with their group (Patrick et al., 1997), probably because prosocial individuals tend to feel that others resemble them, expect some reciprocity, and consequently trust them (Levenson and Ruef, 1992) and wish to keep in contact with them. Trust implies an expectation that others will operate with goodwill and therefore motivates individuals to engage with others thus producing a social orientation; trust also promotes closeness which is the starting point for friendships (Welch et al., 2005). It therefore seems logical that trust would increase affiliation motivation (Green and Brock, 1998). Second, we found that trust fully mediated the prosocial collective efficacy-affiliation motivation association; individuals who felt their group was capable of PSB were more likely to trust group members (Sapouna, 2010) and in turn more motivated to affiliate with them (Patrick et al., 1997).

Affiliation motivation mediated four different relationships. It was a partial mediator of the prosocialness-PSB relationship. As a personal trait that includes the tendency to take care of others prosocialness (Caprara et al., 2000) obviously increases (1) the desire for positive interaction with the others, i.e., affiliation

TABLE 4 | Correlations, means, standard deviations and alpha reliabilities of the included and excluded samples for all the study two variables.

	Inclusion			Exclusion										
	Mean	Range	SD	1	2	3	4	5	6	7	8	Mean	Range	SD
(1) PSness	6.11	(4.17–7.00)	0.64	–	0.01 (ns)	0.49***	–0.17 (ns)	0.01 (ns)	0.09 (ns)	0.25*	0.28*	6.08	(4.67–7.00)	0.61
(2) RS	3.88	(1.17–7.00)	1.44	0.03 (ns)	–	–0.29*	–0.21 [#]	0.52***	–0.28*	0.05 (ns)	0.07 (ns)	3.77	(1.00–6.67)	1.47
(3) PS S-Eff	6.25	(4.00–7.00)	0.72	0.61***	–0.08 (ns)	–	0.10 (ns)	–0.20 (ns)	0.13 (ns)	0.23 [#]	0.06 (ns)	6.24	(4.60–7.00)	0.68
(4) Coll. PS eff	6.24	(4.60–7.00)	0.70	0.54***	–0.10 (ns)	0.77***	–	–0.27*	0.33**	0.02 (ns)	–0.06 (ns)	3.40	(1.00–7.00)	2.08
(5) Anger	1.22	(1.00–4.00)	0.50	–0.34**	0.07 (ns)	–0.28*	–0.27*	–	–0.47***	–0.06 (ns)	–0.07 (ns)	2.78	(1.00–7.00)	1.78
(6) Trust	5.62	(2.67–7.00)	1.02	0.52***	0.02 (ns)	0.57***	0.63***	–0.45***	–	0.31*	0.03 (ns)	3.16	(1.00–7.00)	1.76
(7) SAM	6.16	(3.67–7.00)	0.74	0.39**	0.05 (ns)	0.51***	0.45***	–0.44***	0.61***	–	0.36**	4.84	(1.33–7.00)	1.31
(8) PSB	2.63	(0.00–3.50)	0.79	0.24 [#]	0.21 (ns)	0.29*	0.22 [#]	–0.03 (ns)	0.24 [#]	0.14 (ns)	–	2.52	(0.00–3.50)	0.77

[#] $p < 0.09$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Upper triangle shows the excluded sample correlations ($N = 61$); lower triangle shows the included sample correlations ($N = 58$).

For PSB reliability, Pearson correlation analysis was done because it is composed only by two variables. PSness, prosocialness; RS, rejection sensitivity; PS S-Eff, prosocial self-efficacy; coll. PS Eff, collective prosocial efficacy; SAM, Social affiliation motivation; PSB, prosocial behavior.

motivation (Hill, 1987) and (2) PSB; this is consistent with Eisenberg et al. (2002), Carlo et al. (2003) and with the theory that individuals tend to behave in a way which is consistent with their thoughts, beliefs and attitudes (Heider, 1958).

Affiliation motivation also mediated the associations between prosocial efficacy—both self and collective—and PSB. Our results showed that individuals who felt that they and their group were highly capable of PSB were more motivated to affiliate with others (Patrick et al., 1997), probably because perceiving oneself or one's group as prosocial motivates individuals to develop positive interpersonal relationships and maintain social contacts. A higher desire to maintain social contact in turn results in more PSB, probably because, as Baumeister and Leary (1995) and Zaskodna et al. (2013) argued, individuals with high affiliation motivation behave in a friendly way in order to maintain social contact and avoid exclusion.

Affiliation motivation also mediated the relationship between trust and PSB. Trusting individuals were more likely to desire social contact (Patrick et al., 1997) and in turn more likely to engage in PSB (Baumeister and Leary, 1995; Zaskodna et al., 2013).

Note that the mediation analyses indicated that two variables, prosocialness and affiliation motivation, were direct predictors of PSB. In addition path analysis confirmed the direct and indirect predictive relationships detected in the mediation analyses.

GENERAL DISCUSSION AND CONCLUDING REMARKS

The validity of our model in the contexts of inclusion and exclusion indicates that psychosocial interventions designed to foster prosocialness, individual and collective prosocial efficacy, trust and affiliation motivation, as well as interventions to decrease negative affect, have the potential to promote PSB in both excluded and included individuals. The differences in relationships in the two contexts suggest, moreover, that psychosocial interventions could be used to (1) mitigate the negative impact of rejection sensitivity, especially in individuals who feel ostracized and (2) increase trust, especially in excluded individuals.

Affiliation motivation is possibly the most interesting of the mediators we identified. In Study 1 we demonstrated that trust tends to engender PSB, whilst in Study 2 we demonstrated that this relationship was mediated by affiliation motivation. It is possible that trust enhances the probability that someone will act prosocially (Rotenberg et al., 2005) precisely because it enhances intrinsic motivation to affiliate (Parks et al., 1996; Green and Brock, 1998). This might explain why Twenge et al. (2007) failed to show that trust mediated the effect on PSB — because affiliation motivation mediates the trust-PSB relationship. We also found that affiliation motivation mediated the relationship between PSB and most of the predictor variables we investigated. This pattern of results suggests that affiliation motivation may be a predictor of PSB in both included and excluded individuals and it follows that practitioners should take special care to enhance individuals' affiliation motivation as a means of fostering PSB. In this context

TABLE 5 | Type of mediation observed.

Hypotheses	Direct Beta without Mediator	Direct Beta with Mediator	Indirect Beta
H1: RS → PS self-efficacy → collective PS efficacy	−0.10 (<i>ns</i>)	−0.07 (<i>ns</i>)	−0.03*
H2a: RS → anger → trust	−0.03 (<i>ns</i>)	0.07 (<i>ns</i>)	−0.10**
H2b: PS self-efficacy → anger → trust	0.10 (<i>ns</i>)	0.08 (<i>ns</i>)	0.14*
H2c: collective PS efficacy → anger → trust	0.64***	0.42***	0.22***
H3a: PSness → trust → SAM	0.25**	0.16*	0.09**
H3b: collective PS efficacy → trust → SAM	0.49***	0.08 (<i>ns</i>)	0.33***
H4a: PSness → SAM → PSB	0.26**	0.20*	0.05**
H4b: RS → SAM → PSB	0.14 (<i>ns</i>)	0.13 (<i>ns</i>)	0.02 (<i>ns</i>)
H4c: PS self-efficacy → SAM → PSB	0.19*	0.12 (<i>ns</i>)	0.06**
H4d: collective PS efficacy → SAM → PSB	0.06 (<i>ns</i>)	−0.06 (<i>ns</i>)	0.12**
H4e: Trust → SAM → PSB	0.13 (<i>ns</i>)	−0.04 (<i>ns</i>)	0.17**

Direct and indirect effects in proposed mediation relationships. PSness, prosocialness; RS, rejection sensitivity; PS self-efficacy, prosocial self-efficacy; collective PS efficacy, collective prosocial efficacy; SAM, social affiliation motivation; PSB, prosocial behavior. The first column is a statement of the mediation hypothesis. The second column presents the regression weight for the direct association between the independent variable (IV) and the dependent variable (DV) before controlling for the effects of the putative mediator (M). The third column presents an estimate of the standardized direct effect of the IV on the DV after controlling for the effects of the putative M. The fourth column presents an estimate of the standardized indirect effect of the IV on the DV after controlling for the effects of the putative M in bootstrapping analysis.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

we suggest that it would be useful to promote broad, strong social networks.

Limitations and Future Directions

Although this study has implications for our understanding of the psychosocial determinants of PSB it is important to highlight its limitations. The data for both studies were from a student sample with a majority of women so care must be exercised in interpreting the findings and they may not generalize to the wider population. There is no reason to believe, however, that relationships investigated in these studies would be different in the student and general populations. It would nevertheless be interesting to replicate this study in a larger sample that was representative of the general population; such a study would allow the investigation of potential sex and age effects.

In these studies the possible interactions were limited; participants were members of a group of (fictitious) strangers and all interactions took place online. We also cannot be sure that the Cyberball task represents a good proxy for real world inclusion and exclusion contexts. For these reasons our results may not generalize to genuine personal relationships and real world social exclusion. In this context it is relevant that humans tend to act for the benefit of close relations (Olson and Spelke, 2008; IJzerman et al., 2015). Iannone et al. (2014) showed that being excluded by two people who were stranger to each other made participants feel worse than being excluded by two people who were friends with each other. We also note that whilst laboratory studies have shown that exclusion at the hands of an out-group is painful (Williams et al., 2000; Smith and Williams, 2004), even if the out-group is despised (Gonsalkorale and Williams, 2007), a study of real life exclusion showed that rejection by people to whom one feels close is more painful than rejection by strangers or acquaintances (Nezlek et al., 2012). Future research should investigate how the relationships we have identified are influenced by the ecological validity of the

exclusion manipulation and the strength of the social relationship between an individual and the group which excludes him or her.

Similarly, we can wonder about the external validity of the PSB measure, and whether the prisoner's dilemma game is useful in thinking about real world situations. Note that different studies have corroborated the external validity of the public good games (Franzen and Pointner, 2013; Stoop, 2014; Goeschl et al., 2015; Rommel et al., 2015). In a recent study, Franzen and Pointner (2013) have demonstrated that in lab behavior is related to PSB in the field—these authors used a measure of PSB with a dilemma game similar to the one we have used in this experiment. Moreover, recently Goeschl et al. (2015) have shown that the prisoner's dilemma game is related to PSB (giving money to reduce CO₂ emissions) in the field. Thus, research is showing some evidences of external validity of the prisoner's dilemma game, and there is no reason to believe that the measure used in this experiment to assess PSB (the prisoner's dilemma game) does not have ecological validity. Nevertheless, it would be interesting in future research to analyze the applicability of the game to the real world.

Another potential limitation is that our outcome variable was related to the winning or sharing of a monetary reward whilst PSB encompasses a wider spectrum of interpersonal interactions and behaviors (Weinstein and Ryan, 2010). In future research it would be interesting to measure a broader range of PSB, including helping behavior, altruism, cooperation, and solidarity as well as the sharing of resources (Weinstein and Ryan, 2010).

CONCLUSION

As all the variables we investigated were related to PSB practical interventions to increase PSB should be designed to (1) promote a more prosocial disposition,

encourage individuals to perceive themselves as capable of PSB, encourage trust in others and increase affiliation motivation and (2) work on negative feelings and on the tendency to dread rejection to reduce their negative impact on PSB. Romero-Canyas et al. (2010a), suggested that the vicious cycle involving rejection sensitivity and exclusion could be interrupted by promoting general self-regulatory skills and experiencing supportive relationships; we suggest that a similar strategy could be used to promote the motivational determinant of PSB.

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