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Measuring Momentary Stress, Affect, and Cognition: Relationships with the Internalizing and Externalizing Spectra

Susan C. South · Michelle L. Miller

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Abstract The Internalizing (INT) and Externalizing (EXT) spectra are an emerging way to conceptualize the structure of psychopathology. Demonstrating relationships with emotional reactions to, and cognitive appraisals of, daily stressful events would be strong evidence of ecological validity. In the current study (N=78), the experience sampling method (ESM, a structured diary technique with Palm Pilots) was used to capture affect and cognition related to current stressor, five times per day, for 1 week. Multilevel random coefficient modeling was used to examine affective and cognitive reactivity to daily stressors as a function of baseline levels of INT and EXT. INT scores were related to higher levels of negative affect (NA), lower levels of positive affect (PA) and more negative cognitive appraisals of the stressful situation. Several cross-level interactions were found between psychopathology scores, cognitive appraisals, and affect. Participants higher in INT psychopathology showed less decrease in NA as level of control increased, compared to participants low in INT. EXT moderated the association between NA and distress, with higher levels of EXT resulting in a stronger association between distress and NA. INT and EXT also moderated the relationships between the cognitive variables (distress and control, coping and control). Findings support both the utility and validity of the INT and EXT dimensions in understanding different forms of stress-related impairment in emotion and cognition.

Keywords INT spectrum · EXT spectrum · Affect reactivity · Daily stressors · Diary study

As a way of advancing the categorization of mental disorders, the INT and EXT spectra of psychopathology provide a model for understanding the relationships among various types of common mental disorders. Instead of viewing each disorder as a distinct entity with clear boundaries and differing etiologies, INT and ENT spectra offer an alternative view that incorporates comorbidity and shared risk factors (Krueger and Markon 2006). Even though much research has sought to validate these dimensions, no studies to date have examined the ecological validity of externalizing or internalizing psychopathology factors as they affect one's daily life. The current study seeks to explore how a person's level of INT or EXT psychopathology is associated with emotional and cognitive reactivity to daily stress.

S. C. South (✉) · M. L. Miller
Department of Psychological Sciences, Purdue University,
703 Third Street, West Lafayette, IN 47907, USA
e-mail: ssouth@purdue.edu

Internalizing and Externalizing Dimensions

Over the last decade, research has coalesced around a model of psychopathology that suggests many of the major mental disorders are best structured according to two, higher order spectra of Internalizing and Externalizing psychopathology (cf., Krueger and Markon 2006). The spectrum model proposes that mental disorders lie within a higher order spectrum that varies continuously as opposed to discretely. Studies examining the underlying structure of common mental disorders consistently find one, higher order INT factor that comprises two, lower order factors of distress (major depression, generalized anxiety) and fear (panic attack, phobias), along with one broad EXT factor encompassing substance use disorders and antisocial behavior (Krueger 1999b; Krueger et al. 1998; Krueger and Markon 2006; Slade and Watson 2006; Vollebergh et al. 2001). Behavior genetic research with twin samples has established that the INT and EXT domains can also account for the structure of genetic and environmental influences on psychopathological syndromes (Hettema et al. 2006; Kendler et al. 2011, 2003; Krueger et al. 2002; Singh and Waldman 2010; South and Krueger 2008; Wolf et al. 2010). Many structural models

include the personality trait of neuroticism within the INT spectrum (Griffith et al. 2010; Hettema et al. 2006; South and Krueger 2008; Watson 2005), whereas both neuroticism (Kotov et al. 2010; Krueger 1999a) and disinhibition (Krueger et al. 2002) have been linked to externalizing psychopathology. Indeed, neuroticism is ubiquitous in almost all forms of psychopathology (Lahey 2009).

Given that nearly all of the common mental disorders regularly included in the INT and EXT spectrum-model are characterized by emotional problems (Kring and Bachorowski 1999), understanding the nature of emotional reactivity at the heart of these higher order dimensions may be key in elucidating causal etiology and refining treatment. Here we distinguish between different forms of affect-related content. Some researchers focus on identifying basic emotions, defined as relatively brief, specifically tied to an eliciting event and associated with a range of adaptive behaviors (Ekman 1992). Others have suggested that a few latent dimensions can capture individual differences in emotionality. For instance, Watson and colleagues have argued for a two-dimen sional system of positive and negative affect (Watson 1988; Watson and Clark 1984; Watson et al. 1988). Negative affectivity (NA), reflects a general tendency to experience aversive emotional states such as sadness, fear, guilt, and irritability; it is posited as a common factor that links mood and anxiety disorders (Clark and Watson 1991; Tellegen 1985), although it appears to be most strongly linked with *distress* disorders (e.g., major depression, generalized anxiety; Watson 2009). Depression and social phobia are also negatively correlated with positive affectivity (PA), the experience of positive emotions such as happiness, satisfaction, and excitement (Watson et al. 2005). NA and PA can be viewed as the trait forms of a predisposition to experience states of negative and positive affect. The NA and PA dimensions have been linked with biologically based motivation systems: NA with behavioral withdrawal, and PA with behavioral approach (Watson et al. 1999). The links between NA and PA and EXT are not as clear as the links between NA, PA, and specific INT syndromes. Externalizing disorders are related to neuroticism (Clark 2005), which is highly correlated with NA (Clark et al. 1994). There is also evidence to suggest that certain forms of externalizing may be associated with deficits in response to positive stimuli (the approach system); for instance, Marini and Stickle (2009) found that youths high in callous-unemotional traits displayed lower levels of responsitivity to reward, as measured by the Balloon Analogue Risk Task (BART-Y; Lejuez et al. 2007).

Despite these proposed links between affective systems and psychopathology, empirical data connecting the INT and EXT spectrum-model to emotional reactivity is lacking. Research in children has shown that emotional reactions are reliably predicted from levels of INT and EXT psychopathology. Children with externalizing problems display undercontrolled emotional reactivity and are high in anger, whereas children with internalizing problems are notable for high levels of sadness (Eisenberg et al. 2001). To date this research has not been extended to the adult literature. We thus have very little information on how INT and EXT problems are related to emotional reactions in an adult's everyday life.

Emotional Reactivity to Momentary Stressors

In the current study, we are interested in momentary affective responses to stressful situations that occur throughout the day. Reactions to daily stress are important to overall well-being, and may be a better predictor of future functioning than major life stressors (Bolger et al. 1989; DeLongis et al. 1982; Wagner et al. 1988). The predominant method for studying this type of dynamic process is the daily diary technique, also variously referred to as the experience sampling method (ESM), ecological momentary assessment (EMA), and ambulatory assessment (Ebner-Priemer and Trull 2009). ESM utilizes within-day, self-assessment data collection methods (e.g., palm pilots) to assess behaviors and related affect and cognition over the course of a participant's daily life. ESM minimizes retrospective recall bias since assessments are conducted in close proximity, chronologically, to the event that is being measured (Piasecki et al. 2007). Additional benefits of utilizing ESM include: ability to examine likelihood of events, the ability to examine whether different affective states can occur together, a way to identify change over time, and the ability to determine whether affective patterns exist (Scollon et al. 2003).

Research using ESM shows that there are transient affective changes following minor negative daily events (Marco et al. 1999; Marco and Suls 1993), with greater stress leading to increases in NA (David et al. 1997; Gable et al. 2000; Marco et al. 1999; Merz and Roesch 2011). There is also a great deal of variability in how people respond to stressful events and situations. Cognitive appraisals of a situation, for instance, the amount of threat and available coping resources, may influence reactions to a stressful event (e.g., Lazarus 1984; Lazarus and Folkman 1984). Research has shown that negative events rated as less pleasant, more stressful, and more disruptive are related to negative mood changes from pre- to post stressful event (Marco et al. 1999; van Eck et al. 1998). Researchers have also investigated several individual difference factors as moderators of the relationship between events and emotional states. Factors such as age (Neupert et al. 2007), self-concept (Hay and Diehl 2010), and neuroticism (Mroczek and Almeida 2004) have all been found to moderate emotional reactivity to stress.

It may be particularly informative to understand the interplay between psychopathology and our reactions to stressful

daily challenges in the environment. We know from past research that emotional dysfunction is a key part of many psychological disorders (Werner and Gross 2010). ESM studies have examined whether psychopathology can predict mean levels of affect, cognitive appraisals, and daily stress. In a diary study of emotional reactivity to daily stressors comparing patients with major depressive disorder (MDD), bipolar disorder (BD) and non-affective psychosis (NAP) to healthy controls, MDD subjects reported greater levels of stress than the control group, as well as the highest levels of NA and lowest levels of PA (Myin-Germeys et al. 2003).

ESM studies have also examined psychopathology as a moderator of emotional reactivity and appraisals of stress. Myin-Germeys and colleagues (2003) found that the MDD group showed a larger increase in NA in response to subjective ratings of stress compared to controls, but the BD group showed a greater decrease in PA. Furthermore, Bylsma and colleagues (2011) found that mood-disorder groups reported greater increases in NA as a function of the subjectively rated stressfulness of an event. Not all research, however, uniformly supports increased NA stress reactivity in individuals with mood disorders. In a study examining differences in mood reactivity to daily events between participants with major depressive disorder (MDD) and healthy non-clinical controls, the authors found that MDD participants reported fewer positive events than controls; however, the two groups were not significantly different on frequency of negative events (Peeters et al. 2003). MDD participants did rate both types of events as more stressful than healthy participants; but, their mood responses to negative events were blunted in comparison to controls.

Compared to INT syndromes, less has been written or studied on the emotional basis of EXT psychopathology. Some EXT disorders may be more properly thought of as resulting from dysregulation in the approach/reward PA system (e.g., antisocial personality disorder), whereas others result from dysfunction in the inhibitory NA system (e.g., alcohol abuse); there may also be gender differences in the emotional dysfunction at the heart of the varied EXT syndromes (Sylvers et al. 2010). ESM studies have examined EXT behavior as a function of stress and affect, and in general these suggest support for alcohol and cigarette use as "self-medication" in response to negative affect states (Magid et al. 2009; Swendsen et al. 2000). Fewer studies have used diary methods to analyze patterns of emotional reactions to stressors as a function of EXT syndromes. Johnson et al. (2008) found that substance use in the past month moderated the within-day relationship between negative events and momentary happy mood, such that substance users experienced a greater decrease in happiness following a negative event as compared to non-substance users. It remains to be seen, however, whether similar findings would occur using more personality-based measures of EXT problems.

Given the prominence of disturbed emotions in mood disorders, most prior ESM studies of psychopathology have focused on these disorders, although there has recently been an increase in the use of these studies for personality disorders (Trull et al. 2008), eating disorders (Wonderlich et al. 2007), and substance use disorders (Piasecki et al. 2011). Schneiders and colleagues (2006) used a sample of 11–14 year old adolescents to examine mood reactivity to negative events as a function of domains of INT and EXT psychopathology. They defined high-risk and low-risk adolescents according to internalizing and externalizing problems (which they combined into total scores). Adolescents in the high-risk group rated negative events as more stressful and unexpected than adolescents in the low-risk group. Events appraised as stressful elicited greater anxiety, depression, and irritation and less positive affect. Finally, adolescents in the high-risk group were more emotionally reactive to negative events, with decreases in PA and increases in depressed mood following events that were appraised as relatively more stressful.

Current Study

To our knowledge, this is the first study to examine emotional reactivity to stressful events as a function of INT and EXT psychopathology in a young adult sample using daily diary methods. This type of ecological validity is important for the continued use of the spectrum model. Prior research has shown that daily negative events have a much greater impact on individual well-being than positive events (David et al. 1997; Lawton et al. 1995; Nezlek and Plesko 2003), thus we focused on negative stressful events rather than positive, stress-reducing events. Given the importance of cognitive appraisals of stressful events, we also collected subjective ratings of the event. We chose three variables previously linked to affective reactions: the stressfulness of the event, feelings of control, and ability to cope (Bylsma et al. 2011; Ellsworth and Scherer 2003; Peeters et al. 2003; Siemer et al. 2007).

Our first objective was to examine the ability of INT and EXT problems to predict mean levels of affective responses and cognitive appraisals pertaining to stressful events experienced on a daily basis. Following from previous research (e.g., Schneiders et al. 2006) we hypothesized that participants with higher levels of psychopathology would exhibit higher levels of negative affect, lower levels of positive affect, and more negative cognitive appraisals of stressful events.

Our second goal was to examine the influence of subjective cognitive appraisals of stressful events on daily positive and negative affect as a function of a person's level of INT and EXT psychopathology. The most detrimental aspect of high levels of INT or EXT psychopathology may be an increase or decrease in the strength of the relationship between appraisals and affect. We expected to find that INT, in

particular, predicts both lower PA and higher NA in response to events that are more distressing, out of the participants' control, or hard to cope with.

Method

Participants

Participants (N=78, 71 % female) were recruited through flyers on the campus of a large, Midwestern university. All participants were required to be 18 years or older and comfortable reading English. A total of 89 participants completed the baseline assessment measure and diary protocol; data from six individuals were lost due to equipment failure, and data from five participants were removed due to low compliance on the diary protocol (i.e., completing less than 25 % of possible responses), leaving 78 participants in the final sample. Average age of the sample was 20.8 (SD=2.23, range 18–32). Approximately 65 % identified themselves as Caucasian, 19 % Asian and 8 % African American. Initial multilevel modeling found no main effects of gender or age on the composite affective state ratings, so results are presented below for the full sample. Informed consent was obtained from all of the participants, and the local institutional review board approved the current study. All participants received monetary compensation for successful completion of the study.

Procedure

Eligible participants were scheduled for a 2-hour laboratory session that was conducted by trained undergraduate research assistants. At this initial session, participants completed a variety of personality and psychopathology assessments. For the current analyses, we focus only on the assessments described below. After completion of the questionnaires, participants were instructed on the use of the Palm Pilot handheld computers and the ESM protocol. Participants were shown how to respond, the time frame they had to respond in, and how many times a day they had to respond. Written instructions were also given to participants as an additional reminder regarding Palm diary use, a list of every possible stressor that they could be asked about, and the contact information for the lab in case of any difficulties with the Palm. A research assistant contacted each participant daily to ensure smooth operation of the Palms. At the end of the 1-week period, participants visited the lab again to return the Palm Pilots and receive payment. Participants were paid $30.00 for completing the baseline assessment and fulfilling the diary portion of the study. In order to encourage full participation and the most efficient data collection, participants who completed at least 75 % of the diary portion of the study were entered into a drawing for a gift card.

Measures

Assessment of Internalizing Participants completed the Inventory of Depression and Anxiety Symptoms (IDAS; Watson et al. 2007), a 64-item measure used to assess the level of internalizing symptoms. This is a reliable and well-validated measure, as shown by adequate internal reliability, as well as convergent and discriminant validity established across different populations (Watson et al. 2007, 2008). For the current study, the General Depression scale was used as an overall INT score. The General Depression scale contains items across all of the IDAS subscales, and prior research suggests that it stands at a higher level of the internalizing hierarchy than the other IDAS scales (Watson et al. 2007). Alpha for the scale was .84. The mean for the current sample (M=38.35) was comparable to a young adult sample tested in their mid-20s (e.g., M=37.49, Watson et al. 2007).

Assessment of Externalizing Externalizing symptoms were assessed with the Externalizing 100 (EXT-100; Krueger et al. 2007), a 100-item, shortened version of a longer Externalizing Inventory. It correlates highly (r=.98) with the full inventory and displays adequate convergent and discriminant validity with criterion measures (Hall et al. 2007). Previous research has found a three-factor hierarchical structure to the full EXT measure, with an overarching general externalizing factor, an aggression factor, and a substance use factor (Krueger et al. 2007). For the current study, we used the personality-based externalizing scale (EXT-P, 44-items, alpha=.89), as the rates of participants endorsing high levels of substance use in this sample was relatively small (full results available from first author).

Experience Sampling Methodology We used experience sampling methodology (ESM) to record behavior, daily experience, and emotions five times per day over a one-week period. ESM data were collected on personal digital assistants (Palm Pilot Zire model) using ESP software (Barrett and Barrett 2005), publicly available at http://www2.bc.edu/~barrettli/esp/. Participants were signaled to answer the ESM protocol five times per day, at random intervals (although no prompts appeared within 20 min of each other) between the hours of 11 a.m. and 11 p.m. Participants had 10 min to respond to the prompts before the PDA shut down, with an alarm reminding them every 2 min. After these time intervals or the completion of the protocol, the PDA shut down until the next alert. Participants were instructed not to answer the Palm alerts if they were in a dangerous situation or if it would be disruptive. The palms were programmed to prevent the participant from using the PDA for purposes other than the study or for retroactively completing missed questionnaires.

At each signal, participants answered questions regarding stressors and affect since the last prompt. All questions were the same for each signal. They were first asked to pick the most pertinent stressor at the moment of the signal; participants were forced to choose a stressor and no option was given to skip. Stressors were chosen from the Undergraduate Stress Questionnaire (USQ; Crandall et al. 1992). Participants were then asked to make three cognitive appraisals: Distress, Control, and Coping. They rated level of *Distress* by responding to the item "How much is this [stressor] bothering you?" on a 1 to 9 scale (1=*not at all*, 5=*somewhat*, 9=*extremely*), then rated *Control* by reporting on a 1 to 9 scale, "How much do you feel you can control this event?" followed by a rating of *Coping* with the item "How well do you think you can cope with this?"

Current affect was assessed by asking participants to rate items taken from the Positive and Negative Affect Schedule - Expanded Form (PANAS-X; Murphy and O'Farrell 1994; Watson and Clark 1994). Participants used a 1 to 5 scale (1=*Very slightly or not at all*, 3=*Moderately*, 5=*Extremely*) to rate the following affects: fear, hostility, guilt, sadness, joviality, self-assurance, attentiveness, and fatigue. Composite Positive Affect (PA) and Negative Affect (NA) scales were created by averaging the beep-level ratings for joviality, attentiveness, and self-assurance for PA and ratings of fear, hostility, guilt and sadness for NA. Following Nezlek and Gable (2001), we calculated the reliability of these PA and NA scales by examining a three-level model in which items were nested within beeps nested within people. The PA scale had lower beep-level (.50) but higher person-level (.92) reliability, and the NA scale also had lower beep-level (.59) than person-level (.93) reliability.

All Palms were programmed with the intention of signaling each participant five times per day for seven days, a total of 35 possible data points. Due to scheduling of laboratory sessions, the signals for some participants were spread out over eight separate days (e.g., the Palm signaled three times on Day 1, five times per day on Days 2–7, and two times on Day 8). The majority of participants (71 %) in the final sample of 78 had exactly 35 data points. For 20 (26 %) participants, the Palm programming continued to signal participants beyond 35 alarms (because they were still in possession of the Palm due to weekends or lags in dropping off Palms at the laboratory); these participants had between 36 and 51 data points. In order to maximize standardization, we only analyzed the first 35 data points for each individual. The response rate varied from 28.6 % to 100 % completed, with an average response rate of 70.1 %.

Statistical Analyses

Diary data have an inherently nested, non-independent structure, such that momentary ratings regarding cognitive appraisals and affect are clustered together within people, who differ from each other on individual difference variables (e.g., INT and EXT, a between-person variable). To account for the multilevel structure of the diary data, analyses were conducted using multilevel random coefficients models (MRCM; Nezlek 2007) with the HLM software program (Version 6.06; Raudenbush et al. 2004). MRCM is an extension of regression that takes into account the inherent dependencies in data collected over time from the same individuals. Data were fit to regression models using maximum likelihood estimation instead of ordinary least squares variance partitioning. Data at each *beep* (Level 1) were nested within *people* (Level 2). Level 1 affect and cognitive variables were group mean (within-person) centered, and Level 2 INT and EXT variables were grand mean centered[1].

Data analysis proceeded according to the following steps. First, the variability in momentary affect and cognitive variables was parsed to determine how much was due to beep-level or person-level variance. A series of fully unconditional models (one-way ANOVAs with random effects) were run with each of the Level 1 affect (NA, PA) and cognitive (Distress, Coping, Control) variables. This model can be described at Level 1 by the following equation:

$$Affect_{ij} = \beta_{0j} + r_{ij} \quad (1)$$

in which $Affect_{ij}$ is the Affect score at observation i for person j; the intercept β_{0j} is the average Affect score of person j; and r_{ij} is the Level 1 error term. The intercept can be explained at Level 2 by the following equation:

$$\beta_{0j} = \gamma_{00} + u_{0j} \quad (2)$$

where γ_{00} is the grand-mean outcome in the population, and u_{0j} is a random person effect. This model was used to determine how much of the total variability in the outcome variable resided within-persons versus between-persons. Intraclass correlation coefficients were computed according to the formula: $\tau_{00}/(\tau_{00}+\sigma^2)$.

Next, a series of random-coefficients regression models were run to determine whether the slopes between momentary affective states and cognitive appraisals varied randomly across people. The Level 1 model expands on Eq. 1, above, by including a Level 1 predictor:

$$Affect_{ij} = \beta_{0j} + \beta_{1j}(\text{Distress}) + r_{ij} \quad (3)$$

[1] We could conceivably have used a three-level HLM regression for the current analyses (beeps nested within days nested within people), but we had no a priori day-level predictors to add to our model. We did run fully unconditional three-level models to examine the variance explained at each level, and for all beep-level variables, variance explained at day level ranged from 3 % (Hostility) to 11 % (Sadness), with an average of 7 %.

And the Level 2 model becomes:

$$\beta_{0j} = \gamma_{00} + u_{0j} \quad (4)$$

$$\beta_{1j} = \gamma_{10} + u_{1j} \quad (5)$$

where γ_{00} is the average intercept across all persons, γ_{10} is the average regression slope across all persons, and u_{0j} and u_{1j} are unique increments to the intercepts and slopes, respectively, associated with person j.

Finally, in order to determine whether person-level variables moderated the relationships between the beep-level momentary events, cross-level interactions were examined in a conditional, intercept-and-slopes-as-outcomes model. This model examines the extent to which INT and EXT moderated the associations between the Level 1 variables. The Level 1 model is the same as Eq. 3; the Level 2 model adds person-level predictors to Eqs. 4 and 5. Combining all levels, the conditional model can be described by the following equation:

$$\begin{aligned} Affect_{ij} = {} & \gamma_{00} + \gamma_{01}(\mathrm{INT})_j + \gamma_{02}(\mathrm{EXT})_j + \gamma_{10}(\mathrm{Distress})_j \\ & + \gamma_{11}(\mathrm{INT\ X\ Distress})_j \\ & + \gamma_{12}(\mathrm{EXT\ X\ Distress})_j + u_{0j} + u_{1j}(\mathrm{Distress}) \\ & + r_{ij.} \end{aligned}$$

Results

Descriptive Statistics

Table 1 shows the descriptive statistics for the between-person psychopathology variables and the within-person event-level variables. A series of fully unconditional models provided grand means for the cognition and affect variables, as well as the amount of variance attributed to within-persons versus between-persons variance. On average, participants rated themselves as relatively lower in NA and higher in PA. The average level of Distress was just over 5 on a 1–9 scale, although average ratings for Coping were also quite high (M=5.56, SE=.12). The INT and EXT scores were significantly correlated with one another (r=.46, p<.001). Examination of the ICCs for these models revealed that a moderate amount of the variance in each of the Level 1 outcome variables was due to between-persons variance (18–38 %). This suggested that the moment-to-moment variation in affect and cognition associated with stressful events could be attributed to stable characteristics of the individual.

INT, EXT, and Momentary Affect and Cognitive Appraisals

Next, we tested whether our measures of INT and EXT psychopathology would predict mean levels of momentary affect and cognition. Means-as-outcomes models were run to examine whether the Level 2 variables significantly predicted mean values of the Level 1 affect and cognition variables. Person-level predictors were entered simultaneously and each outcome was modeled separately (see Table 2). INT was significantly associated with NA and PA, as well as two of the three cognitive variables, Distress and Control. Largely supporting our hypothesis, people with higher levels of INT psychopathology were more likely to react with greater negative affect, less positive affect, and more negative cognitive appraisals to stressful daily events. There was a trend toward a significant relationship between EXT and Control (p=.06), as individuals higher in EXT reported more attentiveness and greater control in response to a stressful event.

Table 1 Descriptive statistics for level 1 and level 2 study variables

Level 1				
	Mean	*SE*	Within-person variance	Between-person variance
Affect				
NA	2.08	0.06	0.48	0.30
PA	3.06	0.06	0.48	0.26
Cognitive appraisal				
Distress	5.08	0.12	2.93	1.04
Coping	5.56	0.12	2.49	0.99
Control	4.30	0.11	3.76	0.85
Level 2				
	Mean	SD		
INT	38.35	8.95		
EXT	63.58	12.10		

N=78. *NA* negative affect, *PA* positive affect, *INT* internalizing, *EXT* personality-based externalizing

Table 2 Effects of INT and EXT on momentary affect and cognition

	INT		EXT	
	Coefficient	*SE*	Coefficient	*SE*
Affect				
NA	0.02*	0.01	0.00	0.01
PA	−0.02**	0.01	0.01	0.01
Cognition				
Distress	0.04**	0.01	0.00	0.01
Coping	−0.02	0.02	−0.01	0.01
Control	−0.05**	0.01	0.02+	0.01

The analysis is based on 1,892 ESM reports nested within 78 persons. *NA* negative affect, *PA* positive affect, *INT* internalizing, *EXT* personality-based externalizing

+p=.06. * p<.05. ** p≤.01

Concurrent Affect and Cognitive Appraisals

In accord with previous research, we expected that cognitive appraisals of the stressor would be associated with affective states. To test this prediction, we conducted a series of random-coefficient regression models predicting affect ratings from ratings of Distress, Coping, and Control (see Table 3). All regressions were significant, supporting our expectation that cognitive appraisals surrounding a stressful event would influence affect regarding that stressor. Higher ratings of Distress were associated with greater NA and less PA, while Coping and Control were associated with more PA and less NA.

Cross-Level Interactions Between INT, EXT, and Momentary Affect and Cognitive Appraisals

In our final set of models, we examined whether the associations between cognitive appraisals and affect would differ depending on a person's level of INT or EXT problems. Table 4 presents the results of these cross-level interactions. INT moderated the association between Control ratings and level of NA, with those higher in INT showing less decrease in NA in response to events that they felt more in control of (see Fig. 1, Panel A). EXT moderated the association between Distress and level of NA, with those higher in EXT showing a greater increase in NA as a function of Distress (Fig. 1, Panel B).

There were no significant cross-level interactions between overall PA, the ESM variables, and INT or EXT. We subsequently examined each of the individual PA items in turn; there were no significant cross-level interactions between distress, coping, and control and either joviality or attentiveness as a function of INT or EXT. INT did moderate the associations between self-assurance and each of the three ESM predictors. Those higher in INT showed a steeper negative association between distress and self-assurance (t=−2.53, p≤.01) than those lower in INT. For both coping (t=2.01, p<.05) and control (t=2.20, p<.05), when levels of INT were higher, there was a steeper positive slope between the cognitive appraisal predictor and self-assurance, compared to a flatter slope for those lower in INT.

While not an original goal of the current study, it was also possible to examine whether INT and EXT moderated the relationships among the cognitive appraisal variables. These three measures of appraisal are not overlapping constructs; indeed, previous research has shown that level of stress and disruptiveness, but not coping, affect mood (Marco et al. 1999). We found that both INT and EXT moderated the association of Control on Coping. At low levels of Control, those higher in INT had slightly higher ratings of Coping than individuals lower in INT, but at greater levels of Control, those lower in INT had much higher ratings of Coping than those with high levels of INT (see Fig. 2, Panel A). With regard to EXT, there was a steeper slope between Control and Coping for those higher in EXT compared to those lower in EXT (see Fig. 2, Panel B). Finally, there was a significant cross-level interaction between EXT, Control and Distress. There was a steeper slope between Distress and Control for those higher in EXT, compared to a flatter slope for those lower in EXT (see Fig. 3).

Discussion

Many common mental disorders are highly co-morbid, which can be theoretically and statistically explained by two higher

Table 3 Multilevel regression estimates for associations among cognitive appraisals and affective responses to daily stress

	ESM predictor					
	Distress		Coping		Control	
ESM criterion	Coefficient	*SE*	Coefficient	*SE*	Coefficient	*SE*
Negative affect	0.11***	0.01	−0.13***	0.01	−0.03**	0.01
Positive affect	−0.10***	0.01	0.12***	0.01	0.06***	0.01

The analysis is based on 1,892 ESM reports nested within 78 persons

** p<.01. *** p≤.001, two-tailed tests

Table 4 Multilevel regression estimates for effects of INT and EXT on affective and cognitive responses to daily stress

ESM variables		Level 2 IV					
		INT			EXT		
Criterion	Predictor	Coefficient	*SE*	*t*	Coefficient	*SE*	*t*
Negative affect	Distress	−0.001	0.002	−0.87	0.003	0.001	2.05*
	Coping	−0.001	0.002	−0.73	−0.001	0.001	−0.76
	Control	0.003	0.001	2.06*	−0.001	0.001	−1.29
Positive affect	Distress	−0.003	0.002	−1.44	0.000	0.001	0.34
	Coping	0.003	0.002	1.73	0.000	0.001	−0.17
	Control	0.002	0.001	1.81	0.001	0.001	1.12
Distress	Coping	−0.005	0.005	−1.00	0.001	0.003	0.25
	Control	0.002	0.004	0.46	−0.007	0.002	−2.63**
Coping	Control	−0.011	0.004	−2.90**	0.006	0.003	2.24*

Analyses based on 1, 892 ESM reports nested within 78 persons. *INT* Internalizing, *EXT-P* Personality-based externalizing. *$p<.05$, **$p<.01$

order latent factors of INT and EXT psychopathology. INT and EXT domains may be useful in refining the categorization of mental illness and in better understanding etiology and development; however, to date, there is relatively little research on the validity of the spectrum model. In the current study, we addressed this limitation by examining whether levels of INT and EXT psychopathology were associated with affective and cognitive reactions to daily stressors.

In line with previous research, we found that stressful events that were rated as more distressing, and which people felt less able to cope with or control, were associated with less positive affect and greater negative affect. This supports a large body of work suggesting that emotional responses to stressful events are determined, in part, by cognitive appraisals of those events (for a recent review, see Joorman et al. 2010). The strength and consistency of our findings would indicate that cognitive evaluations of stressful events are the primary pathway by which emotions are processed. Of course, we have to acknowledge the possibility that emotions color our cognitive appraisals. One of the advantages of the ESM method used in the current study is the ability to minimize retrospective recall bias, and get in the moment evaluations of affect and cognition. Given that we asked participants to evaluate affective and cognitive reactions to stressors occurring since the last beep (between 10 and 120 min prior), however, it is certainly possible that a person's current emotional state would color their cognitive evaluations surrounding the stressful event.

Consistent with our hypotheses, INT scores were significantly related to momentary negative and positive affect and cognitive appraisals of the stressful event. Participants higher in INT rated stressful events as more distressing and out of their control, and they experienced greater NA and less PA as a result of those stressful events. Given the demonstrated links between both PA and NA and various disorders within the INT spectrum (e.g., Mineka et al. 1998),

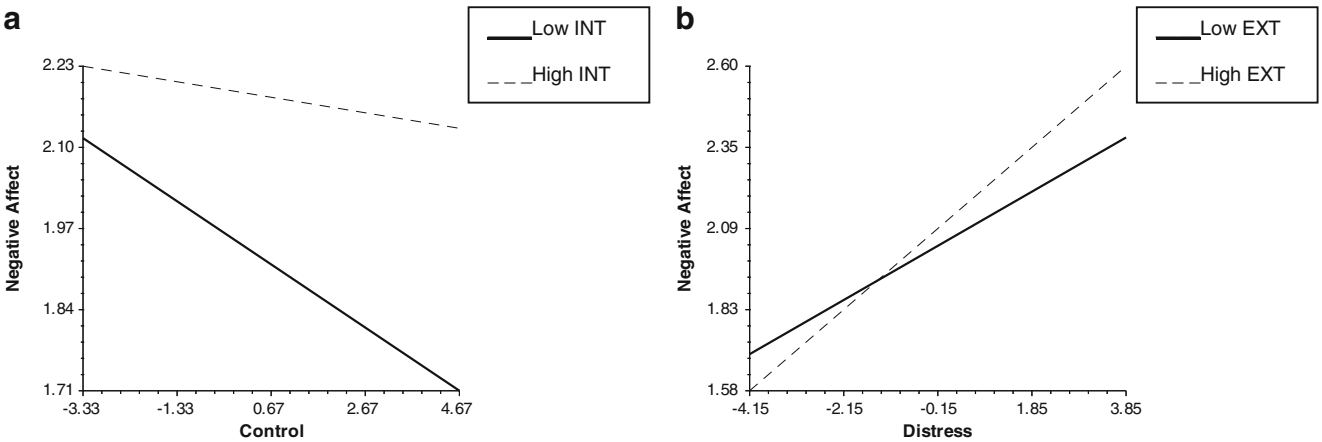

Fig. 1 Modeled effects of cognitive appraisal on negative affect as a function of internalizing (INT) and externalizing (EXT) psychopathology. Panel A: Cross-level interaction of INT on the association between control and negative affect. Panel B: Cross-level interaction of EXT on the association between distress and negative affect

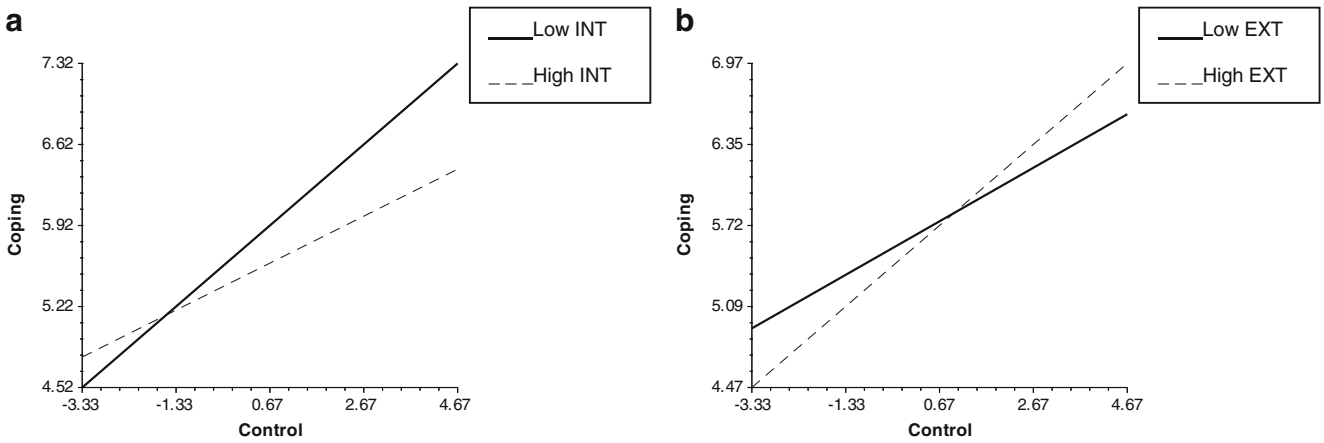

Fig. 2 Modeled effects of cognitive appraisal of control on ratings of coping as a function of internalizing (INT) and externalizing (EXT) psychopathology. Panel A: Cross-level interaction of INT on the association between control and coping. Panel B: Cross-level interaction of EXT on the association between control and coping

it is not surprising that INT scores were associated with both overall NA and PA. This is the first study to examine scores on the overall INT spectrum in relation to PA and NA as assessed using ESM-type method, however, and it is reassuring that our measure of INT (the IDAS) was associated with both the approach and withdrawal systems.

There were far fewer main effects of the personality-based EXT variable on the momentary affect and cognitive variables. It is possible that we assessed the type of externalizing psychopathology that is related to deficits in the approach/reward PA system as compared to deficits in the inhibitory NA system (Sylvers et al. 2010). It may also be that the affective states that we focused on (i.e., NA and PA) are less relevant for externalizing psychopathology, which would have been better captured with disinhibition-type emotional dynamics (Clark 2005). Finally, even if EXT syndromes are marked by episodes of state subjective distress, the most damaging consequences may not be the momentary affect but the behavior that follows; for instance, research suggests that negative urgency, or the tendency toward rash action following distress, predicts externalizing behavior (Settles et al. 2012).

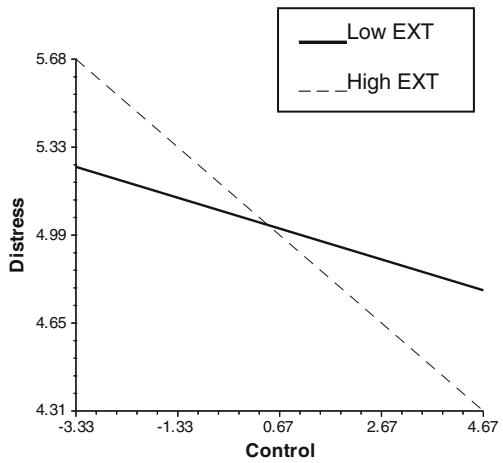

Fig. 3 Modeled effects of cognitive appraisal of control on ratings of distress as a function of externalizing psychopathology (EXT)

Our second objective was to examine whether INT and EXT would moderate affective reactions to cognitive appraisals of stressful events. Results of cross-level interactions in our multilevel models confirmed this prediction with regard to both internalizing and externalizing psychopathology. We found that INT moderated the relationship between Control and NA. Regardless of level of control over the event, those higher in INT had high levels of negative affect, compared to those lower in INT. There were no significant cross-level interactions between INT or EXT and the predictor variables on overall PA; however, INT did moderate the effect of distress, coping and control on self-assurance. Future research would do well to examine whether there are specific associations with different aspects of PA and NA that help to define the different internalizing syndromes (e.g., the relationship between PA and control may be especially salient for those with specific anxiety syndromes).

We did not find an interaction with INT, NA and distress. This contradicts previous work that finds a moderating effect of trait neuroticism or mood-disorder on negative affect in response to subjectively-rated stressfulness (Bylsma et al. 2011; Mroczek and Almeida 2004). We did find that EXT scores moderated the association between distress and NA. INT and EXT were highly correlated in the current sample, as has been found in structural modeling of the two domains (e.g., Krueger and Markon 2006). A previous study combined INT and EXT scores to create at-risk groups, which did differ on the association between distress and NA (Schneiders et al. 2006). Our findings may also reflect the nature of the sample, consisting largely of college-age women, and the externalizing score used, which consisted of personality traits (relational

aggression, impatient urgency, rebelliousness) as opposed to antisocial behaviors (alcohol and drug use, theft). We may have been capturing a blend of psychopathology sitting at the intersection of internalizing and externalizing problems, marked particularly by high levels of neuroticism, which is associated with both spectra (e.g., Hettema et al. 2006; Singh and Waldman 2010).

INT moderated the association between Control and Coping; for individuals with an elevated level of INT, having a sense of control over a current stressor did not seem to ameliorate its effect on one's coping regarding that stressor. EXT also moderated the Control-Coping relationship, such that greater externalizing was related to a steeper relationship between control and coping. There was also significant moderation of the association between Distress and Control by EXT, with greater control leading to steeper declines in Distress. It may be particularly important for individuals high in EXT to feel in control of their surroundings, particularly stressful events. For people higher in EXT, a constant feeling of having control over their environment may in fact diminish any affective responses to negative events. This would suggest that individuals with INT and EXT psychopathology might be differentiated based on the presence (vs. absence) of emotional responses to daily stressors. Of course, given that we cannot tease apart the causal direction of affect and cognition in this study, we must acknowledge this is only one possibility.

The current study does have several limitations that we must acknowledge. First, we found few significant main effects of externalizing psychopathology on the affect and cognitive appraisal variables, and even fewer interaction effects. We may have recruited an underrepresented sample with regard to this type of pathology, a potentially significant limitation. Our sample consisted primarily of female college students who may have been low in levels of externalizing psychopathology, or the assessment measure used may have failed to capture externalizing psychopathology in this sample. Even though the structure of externalizing psychopathology appears to be invariant across men and women, women do have lower mean levels of externalizing psychopathology (Eaton et al. 2010; Kramer et al. 2008). Future research may wish to sample from a population that includes more demonstrable levels of both personality- and substance-use based externalizing. Even older community-based adult populations would be more likely to find greater variability in externalizing pathology, but particularly informative results may come from treatment-seeking or correctional samples. A different sample with higher levels of externalizing psychopathology that also are more likely to lead to some sort of dysfunction or disability may yield more significant and consistent findings with regard to daily emotional reactivity to stressful events. Second, we used global measures of overall internalizing and externalizing problems, but what may separate each disorder within the spectrum is affective and cognitive reactivity to specific types of stressors. Individuals with depression, for instance, may feel a higher level of guilt in response to stressors that they feel they can control, but persons with panic disorder may experience much greater fear in response to stressors viewed as out of their control. Future research should endeavor to tease apart specific vs. general effects with regard to cognitive and emotional reactions to stressful events. Third, our diary protocol did not give participants the option of indicating that they were not currently encountering any stress. Thus, it is possible that we were measuring current concerns rather than stressors per se. Finally, even though our hypothesis was that individual differences in internalizing and externalizing psychopathology moderated affective reactivity to cognitive appraisals, the real impact of INT and EXT may be on behavioral responses to stress. Particularly for the externalizing spectrum, affective reactivity may not be as damaging, as the behavioral ways in which the individual handles that affect, through either aggressive actions or self-medication with substance use.

In summary, the current study provides support for the ecological validity of the INT and EXT spectrum model by demonstrating associations with negative and/or maladaptive affective and cognitive reactivity to stressful events. This dysfunctional processing of stressful events may further exacerbate the pre-existing pathology, and lead to damaging behavioral and interpersonal consequences. Findings from the current study suggest that the affective dimension of PA is less central to the everyday expression of INT and EXT psychopathology, at least in regard to reactions to stressful events. Future longitudinal studies are needed to tease apart the role of maladaptive affective and cognitive reactions to stressful events in the development of psychopathology.

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