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Neuroticism as the intensity, reactivity, and variability in day-to-day affect

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ABSTRACT

Neuroticism has been linked to typical levels of affect, affect reactivity to negative events, and variability in affect over time. However, the intercorrelations among these characteristics make it unclear whether neuroticism reflects unique variance in each of these aspects of emotional life. Data from two daily-diary samples revealed that neuroticism was associated with average levels and variability of positive and negative affect and reactivity of negative affect to stressors, but was only uniquely related to mean levels of positive and negative affect. Findings highlight the substantial overlap in affect indices, suggesting that mean levels of affect, at the very least, are at the core of neuroticism, and reveal the need for further research using more nuanced approaches.

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1. Introduction

Neuroticism (vs. emotional stability) is typically conceptualized as the general tendency to feel negative emotions. However, neuroticism represents much more about individuals' emotional experiences than just the frequency or intensity of negative affect. More neurotic individuals also report more negative reactions to unpleasant events and stressors, as well as display more variability in negative affect over time (Bolger & Schilling, 1991; Longua, DeHart, Tennen, & Armeli, 2009; Murray, Allen, & Trinder, 2002; Maples, Miller, Hoffman, & Johnson, 2014). Similarly, theoretical perspectives on neuroticism have emphasized stronger negative responses to threats or punishments as core to understanding elevated neuroticism (Costa & McCrae, 1992; DeYoung, 2015; Eysenck & Eysenck, 1985; Suls & Martin, 2005). This implies that higher neuroticism not only reflects 1) greater average intensity of negative affect, but also 2) greater reactivity of negative affect to adverse events, and 3) greater variability in negative affect over time. In addition to these characteristics of negative affect, neuroticism has also been linked with the intensity and variability of positive affect, though less consistently (Ching et al., 2014; Eid & Diener, 1999; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; Leger, Charles, Turiano, & Almeida, 2016). Together, this evidence indicates that neuroticism is critical to emotional functioning beyond just describing average level of negative affect.

To this end, a multitude of theories and empirical investigations have sought to explain how neuroticism (and personality traits more broadly) relates to these characteristics of emotional functioning (e.g., Eid & Diener, 1999; Fleeson & Gallagher, 2009; Gross, Sutton, & Ketelaar, 1998; Kuppens, Oravecz, & Tuerlinckx, 2010). While prior work has examined certain pieces of how neuroticism relates to aspect of both positive and negative affect, the extent to which neuroticism distinctly reflects typical intensity, reactivity, and variability in affect remains unclear. Therefore, this study sought to examine the extent to which neuroticism is associated with unique variance in the average *intensity* of positive and negative affect, the degree of emotional *reactivity* to negative events, and the amount of *variability* in negative and positive affect.

1.1. Neuroticism and the intensity, reactivity, and variability in negative affect

Neuroticism has most frequently been connected to the intensity and reactivity of negative emotions. For instance, higher neuroticism predicted both greater average daily negative affect and

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greater emotional reactivity to stressors during 30-day diary studies collected each year for four years (Howland, Armeli, Feinn, & Tennen, 2017). Furthermore, a person's year-specific deviation in neuroticism from his or her average neuroticism score over a four-year period (i.e., their "yearly" neuroticism) uniquely predicted both average negative affect and its reactivity. In other words, year-specific increases in neuroticism predicted amplified year-specific negative affect and reactivity. The fact that changes in self-reported trait neuroticism co-occurred with changes in mean daily negative affect and daily emotional reactivity to negative events further bolsters the tie of this negative predisposition to the intensity and reactivity of negative affect.

Why does neuroticism reflect these tendencies? Biologically, people higher in neuroticism demonstrate brain activity and anatomy that is indicative of being more sensitive to threat and punishment and being worse at emotion regulation (DeYoung & Weisberg, 2019; Robinson, Moeller, & Ode, 2010). Moreover, higher neuroticism has been linked to lower levels of serotonergic functioning, which is critical for regulating depressive and anxious emotions (DeYoung, 2010; Munafo, et al., 2009; Wright, Creswell, Flory, Muldoon, & Manuck, 2019). Along with these biological differences, individuals higher on neuroticism also have more negative cognitive styles. Stressors are perceived as being more serious, having larger consequences, being less controllable, and reflecting more poorly on the self (Hankin, Fraley, & Abela, 2005; Leger et al., 2016; Rauthmann, Sherman, Nave, & Funder, 2015). Altogether, this evidence reveals that greater neuroticism reflects the tendency to feel elevated negative affect and to be more emotionally volatile (Gross, Sutton, & Ketelaar, 1998).

Neuroticism is also linked to the overall degree of variability in negative affect over time. Across approximately 500 U.S. participants reporting over 20,000 days, lower emotional stability (i.e., high neuroticism) predicted both lower mean scores and greater variability in negative emotional states (Fleeson & Gallagher, 2009). This pattern of relations has been replicated in the U.S. as well as Japan, China, and the Philippines (Ching et al., 2014). Moreover, these findings are not specific to aggregate measures of negative affect or distress as greater neuroticism positively correlated with the means and variability of specific negative emotions such as anger, fear, shame, and sadness over time (Eid & Diener, 1999).

It is important to acknowledge that affect variability associated with neuroticism could be driven by a wide variety of processes. For instance, greater variability in negative affect could be driven by less efficient emotion regulation strategies, such as greater rumination and suppression, and less reappraisal (Suls & Martin, 2005; Van Loey et al., 2014; Yoon, Maltby, & Joormann, 2013). These less effective strategies may fail to stifle aversive emotional responses or perpetuate prior ones in response to threat-cues. Indeed, these types of processes are critical to why more neurotic people have more drastic emotional reactions to stressors and aversive events reviewed earlier. These more volatile reactions would manifest in greater variability in negative emotions over time, suggesting that affective reactivity is one explanation for more variability among people with greater neuroticism. Given that emotional reactivity could be driving variability in affect, it is necessary to separate contributions of these specific processes to better understand how distinct aspects of emotional functioning contribute to neuroticism.

1.2. Changes to Stage 1 introduction

At this point, we wish to pause and acknowledge that significant changes in the remainder of the introduction and methods from the Stage 1 submission for this registered report occurred when writing the Stage 2 submission. The unedited version of the accepted Stage 1 submission is available on the study OSF page. As detailed later, these changes were necessary as conducting our analyses brought to light limitations and ambiguities of the analytic methods used in prior studies and originally proposed analyses in the Stage 1 submission (i.e., they did not identify how neuroticism uniquely associates with affective characteristics). Our clearer understanding of these limitations and misconceptions necessitated deviating from the Stage 1 submission by reinterpreting and reframing findings from prior work as well as changing our analytic plan. Note that prior to submission of the Stage 2 registered report, we wrote a letter to our action editor detailing the issues we encountered and our proposed solution to them (this letter is available on the project OSF page). After obtaining approval from the action editor, we then wrote the Stage 2 submission.

1.3. Does neuroticism distinctly reflect the intensity, reactivity, and variability in negative affect?

The evidence reviewed above implicates neuroticism simultaneously in the intensity, reactivity, and variability in negative affect. However, these three characteristics are dependent on one another and in order to obtain a more precise understanding of neuroticism it is necessary to examine whether and to what degree neuroticism reflects each characteristic independently. As mentioned earlier, one proposed explanation for greater variability in negative affect is that higher neuroticism is associated with greater emotional reactions to unpleasant events (Bolger & Schilling, 1991; Suls & Martin, 2005). Yet it is unknown whether more neurotic individuals actually have more variability in affect after accounting for the fact that these individuals also have heightened emotional reactions to stressors. If neuroticism is still meaningfully associated with affect variability after accounting for emotional reactivity, there may be further processes worth exploring that may be driving this variability.

Moreover, while variability in negative affect could be explained by affective reactivity, the degree of variability is constrained by average levels of negative affect (Mestdagh et al., 2018). For example, an individual with an average negative affect that is near the ceiling of a scale (i.e., 4.3 out of 5) has a greater statistical limitation on the degree of variability in negative affect than an individual with an average negative affect that is in the middle of the scale (3 out of 5). This statistical constraint occurs because a high mean level of negative affect would have to decrease as the variability increases, because more instances of less extreme negative affect are sampled. This same logic also applies to a person with an average that is near the floor of the scale (i.e., 2.2 out of 5). Altogether, the interrelations among affective characteristics obscure understanding of which are uniquely associated with neuroticism.

1.4. Does neuroticism distinctly reflect positive affect?

While an abundance of findings link neuroticism to multiple affective characteristics in negative affect, less is known about how neuroticism is associated with such characteristics in positive affect. Greater neuroticism has been tied to lower overall positive affect and less variability in positive affect; however, the relation with variability may not extend to more specific positive emotions such as happiness and joy, and may not hold across cultures (Ching et al., 2014; Eid & Diener, 1999; Kuppens et al., 2007; Williams, 1990). In terms of reactivity, neuroticism does *not* predict individuals' reactivity of positive affect to negative events (David, Green, Martin, & Suls, 1997; Gunthert, Cohen, & Armeli, 1999; Leger et al., 2016; O'Hara, Armeli, Boynton, & Tennen, 2014). Overall, findings are mixed and more research is needed to examine the connections between neuroticism and positive affect.

1.5. Study purpose

Many studies have investigated the associations of neuroticism with average, variability, and reactivity of positive and negative affect, but few have sought to account for the interdependence of such affective characteristics when examining their associations with neuroticism. Statistically controlling for mean levels, Wendt and colleagues (2020) found that neuroticism uniquely associated with variability in negative affect, but not positive affect. Using advanced multilevel methodology (i.e., location-scale modelling) that directly models the association between the mean and variability, Geukes and colleagues (2017) found that higher neuroticism scores predicted both higher mean levels and variability of negative affect. Similarly, another study found that in 790 participants who completed two assessments ten years apart, greater neuroticism predicted both feeling more different types of negative emotions during the day and more variability in the daily number of different types of negative emotions over time (Liu, Bangerter, Rovine, Zarit, & Almeida, 2018). However, during the second assessment ten years later, greater neuroticism actually predicted less variability in the daily number of different types of negative emotions participants felt over time.

Note that these latter studies used a location-scale modelling approach which incorporates the association between the mean and variance and thereby produces more accurate estimates of the associations of the mean and variance with between-person variables (e.g., neuroticism). However, as we discuss in further detail later, this modelling approach does not adjust for this association when estimating relations with third variables in many software implementations. In simple terms, this is similar to modeling the associations of a set of variables with an outcome using correlations rather than modeling these same associations using partial correlations or multiple regression. Thus, these studies do not speak to the unique associations of neuroticism with mean and variance of negative affect and more research examining these unique associations while also including affective reactivity in this dynamic is needed.

Because prior work has not empirically isolated how neuroticism uniquely relates to the mean, variability, and reactivity of positive or negative affect, it is unclear whether neuroticism is associated with unique variance in each of these affect functioning characteristics or if associations with these aspects of affect are driven by shared variance. The purpose of this study is to examine these unique associations. Given the inconsistency of prior findings and the statistical complexity in isolating the unique contribution of neuroticism to the mean, variability, and reactivity of affect, this study evaluated these associations across two independent samples in order to increase the reliability and generalizability of acquired results. Each sample consisted of a unique participant demographic composition and each used theoretically overlapping, yet methodologically distinct, measurements of neuroticism and daily affect. Patterns replicated across the samples should greatly increase confidence in the reliability and generalizability of the findings. By identifying the unique associations of neuroticism with the intensity, reactivity, and variability of day-to-day emotions, this study will advance the understanding of the nature of neuroticism by speaking to whether it is better conceptualized as reflecting negative emotionality and low positive emotionality, high negative emotionality and reactivity, or some other pattern of emotional functioning.

2. Methods

We employed daily dairy data from two existing samples. In the first sample, 212 college undergraduates completed daily dairy entrees each night for 30 days. In the second sample, 2,022 middle-aged adults from the Midlife in the United States (MIDUS) study completed daily diary entrees for 8 days. Prior knowledge of these samples is addressed in the "Statement of Data Knowledge and Gatekeeping" section below. Data collection procedures for the first sample was approved by the Loyola University Chicago's Ethics Review Board. MIDUS data collection was approved by the University of Wisconsin-Madison's Institutional Review Board.

2.1. Sample one

Data from sample one originated from two hundred twelve undergraduate students who completed a 30-day daily diary study seeking to examine experiences of drinking, mistreatment, and self-control in college (DeHart, Longua Peterson, Richeson, & Hamilton, 2014). Data regarding day-level processes in drinking, stress, sleep, and self-control from this study have been previously published (cf. DeHart et al., 2014; Hamilton & DeHart, 2019; Hisler, Krizan, & DeHart, 2018).

Procedure. After signing up for the study, participants completed an online survey measuring demographics, personality, and individual differences. Once this initial survey was complete, participants were granted access to a website on which they could complete their daily measures over the next 30 days. This website was only accessible between 3:00 pm and 9:00 pm each day. These times were selected so that participants could complete the daily measures after the day's classes, but before beginning evening activities that may prevent them from completing the diary entry (e.g., drinking). Participants received partial course credit for completing the first online survey assessing demographics and personality. To compensate and motivate completion of the daily dairies, participants earned $1 for each day of daily diary completed. Additionally, participants were paid a $5 bonus for each full week of daily diaries they completed and were also entered into a $25 lottery for that week.

2.2. Person-level measures

Trait neuroticism. Trait neuroticism was measured using the 10 items from the International Personality Item Pool (IPIP): "Get stressed out easily," "Worry about things" "Often feel blue," "Am relaxed most of the time (Revered coded)," "Seldom feel blue," "Am easily disturbed," "Get upset easily," "Change my mood a lot," "Have frequent mood swings," and "Get irritated easily." These items are available at https://ipip.ori.org/newBigFive5broadKey.htm and highly correlate with Goldberg's original items (r = 0.72). Participants indicated from "Strongly Disagree" (1) to "Strongly Agree" (7) how well these items described them. Responses to these 10 items were then average to create an index of neuroticism. As is typical for measures of neuroticism and consistent with theoretical considerations, these items address the intensity (e.g., "Worry about things"), variability (e.g., "have frequent mood swings"), and reactivity (e.g., "get upset easily") of negative emotions.

2.3. Daily measures

Affect. Each day when completing the daily diary, participants reported their current negative and positive affect. Specifically, they responded to ten items asking, "How much does the word _____ describe your mood right now?" For each item the blank was filled in with an emotion word and participants responded from "Not at all" (1) to "Extremely" (9). Negative affect was measured with "angry," "sad," "dejected," "nervous," "ashamed," and "guilty" (day-level α = 0.80). Positive affect was measured with "relaxed," "excited," "cheerful," and "happy" (day-level α = 0.81)

Negative events. In addition to the current emotion ratings, participants indicated whether any of 14 listed negative events had occurred during the day. This list of negative events was adapted from DeHart, Tennen, Armeli, Todd, and Mohr (2009). These events covered the domains of school, family, romantic relationships, and friends. These events were: "Received negative feedback on school work," "experienced a particularly stressful school event,", "Received criticism from a family member," "Had a disagreement or conflict with a family member", "Did not feel accepted by a family member," "Stopped speaking to a family member," "Received criticism from a romantic partner," "Had a disagreement with a romantic partner," "Did not feel accepted by a romantic partner," "Ended a romantic relationship," "Received criticism from a friend," "Had a disagreement with a friend," "Did not feel accepted by a close friend," and "Ended a close relationship with a friend." Participants first indicated whether an event occurred and then rated how positive or negative the event was from "Extremely negative" (1) to "Extremely positive" (7). Similar to prior methodology, if an event occurred, responses of 1, 2, and 3 will be recoded as 3, 2, and 1 in to a new negative event variable, respectively (David et al., 1997; Longua et al., 2009). Responses of 4, 5, 6, and 7 will be recoded as 0 to reflect that a negative event did not occur. Responses across all events within a day will then be averaged to create a negative event variable which captures both event frequency and intensity.

2.4. Sample two

Sample two consists of data from the MIDUS II National Study of Daily Experiences (Ryff & Almeida, 2010). In this study, a subsample of 2,222 participants who had previously completed the MIDUS II core survey were recruited to complete telephone interviews about their daily experiences across eight consecutive days.

Procedure. During the eight days of telephone interviews, participants received a phone call from a trained study personnel who then conducted the semi-structured interview designed to elicit reports of daily stressors. To prevent overlapping information across interview days, participants were asked about their experiences over the past 24 h (i.e., "since this time yesterday..") on the first day of the interview, but for all subsequent days they were asked about their experiences since they spoke to study personnel the prior day (i.e., "since we spoke yesterday. . .."). Interviews lasted approximately 10 to 20 min each day and participants completed an average of 7.4 interviews, resulting in 14,912 total interviews and a 92% response rate.

2.5. Person-level measures

Trait neuroticism. Neuroticism was assessed during the MIDUS II core survey which occurred between 2004 and 2006. Within this survey, participants completed the neuroticism scale from the Midlife Development Inventory (Lachman & Weaver, 1997). Participants were instructed to indicate how "moody", "worrying", "nervous", and "calm" (reverse scored) described their self from "not at all" (1) to "a lot" (4). The Midlife Development Inventory was created based upon other existing personality scales (Goldberg, 1992) and has good construct validity that holds across age groups (Zimprich, Allemand, & Lachman, 2012). However, the neuroticism scale from the Midlife Development Inventory lacks items assessing volatility and reactivity aspects of neuroticism. Thus, the three-item stress reactivity scale from the brief Multidimensional Personality Questionnaire was used to supplement these four neuroticism items (Patrick, Curtin, & Tellegen, 2002). Note that the stress reactivity scale has been found to correlate with neuroticism at around 0.70 (Church, 1994). The stress reactivity scale contains three items asking participants to rate the extent that "My mood often goes up and down", "I sometimes get myself into a state of tension and turmoil as I think of the day's events", and "minor setbacks sometimes irritate me too much" describe their self from "false" (1) to "true of you" (4). Together, these seven items were combined to create an indicator of neuroticism that captures its features relevant to the intensity, reactivity, and variability of negative affect (α = 0.84).

2.6. Daily measures

All daily measures of affect and negative events were completed during the National Study of Daily Experiences which occurred between 2004 and 2009.

Affect. Each day when completing the daily interview, participants were asked "How much of the time today did you feel _____?" Participants indicated "None of the time" (0), "A little of the time" (1), "Some of the time" (2), "Most of the time" (3), or "All of the time" (4). Negative affect was measured with "restless or fidgety," "nervous," "worthless," "so sad nothing could cheer you up," "everything was an effort," "hopeless", "lonely", "afraid", "jittery", "irritable", ashamed", "upset", "angry", and "frustrated" (day-level α = 0.78). Positive affect was measured with "in good spirits," "cheerful," "extremely happy," and "calm and peaceful", "satisfied", "full of life", "close to others", "like you belong", "enthusiastic", "attentive", "proud", "active", and "confident" (day-level α = 0.86). As in Sample 1, measures of affect sample states of both high and low arousal.

It is important to consider two important differences in affect measurement between the samples. First, Sample 1 measures assessed the *intensity* of emotion, whereas those in sample two assessed the *frequency* of the emotion. However, reports of frequency and intensity of emotion are highly correlated (e.g., ~0.90, (Ganzach and Yaor, 2019). Second, the affect reports in sample two asked about affect over the past 24 h whereas the affect reports in sample one were about affect in the moment. While retrospective reports of emotion tend to be slightly biased towards peak and most recent emotional experience, there is a high degree of convergence between retrospective and momentary ratings (Neubauer, Scott, Sliwinski, & Smyth, 2019). Thus, although there are clear differences in the way affect was measured between sample one and sample two, both measures capture theoretically-relevant aspects of emotional functioning.

Negative events. Participants were also asked whether seven negative events had occurred since they had last spoke to study personnel on the phone. Specifically, they were asked if: they had an argument or disagreement with anyone, they could have had an argument but decided to let it go to avoid a disagreement, anything happened at work or school that most people would consider stressful, anything happened at home that most people would consider stressful, they experienced discrimination on the basis of things such as race, sex, or age, anything happened to a close friend or relative that was stressful, and if anything else happened that most people would consider stressful. Responses were coded as "No" (0) and "Yes" (1) and then summed to create a total negative events variable.

2.7. Exclusion criteria

We excluded participants in both samples who did not complete at least seven days of diary studies. We selected at least seven days because the estimates that were used in our power analysis (see below) were derived from prior work which assessed positive and negative affect over at least five days (see Geukes, Nestler, Hutteman, Küfner, & Back, 2017; Rast, Hofer, & Sparks, 2012). Given that all study samples include more than seven days and that power analysis estimates are based off of seven days, this

exclusion criteria should eliminate participants who did not take the study seriously while also maintaining accuracy of power estimation. Note that this exclusion criteria still retained 88% of the MIDUS II National Study of Daily Experiences sample (Ryff & Almeida, 2010).

2.8. Analytic strategy

Following our Stage 1 review and in-principle acceptance of the proposed project, we became aware that our proposed modeling approach would not actually be able to address the key questions of this study regarding the unique associations of neuroticism with affective characteristics, despite having been described that way in the published literature (Hedeker & Nordgren, 2013). Upon thorough investigation we determined that an alternative analytic approach was needed. Therefore, in the spirit of transparency we next present the analytic plan presented in the Stage 1 submission, and then subsequently describe the problems associated with this approach along with an alternative approach that can address the research questions.

2.9. Stage 1 analytic plan

Prior to testing our key hypotheses (outlined below), we first examined the zero-order associations between neuroticism and the intensity (i.e., mean) of affect, the reactivity of affect (i.e., moderation of the effect of negative events on affect), and the variability of affect (i.e., variability of affect over the study period). These zero-order effects provided insight into the total covariation of neuroticism with the intensity, reactivity, and variability of affect.

After estimating these zero-order effects, we sought to test our hypotheses by conducting multilevel location-scale modeling (Hedeker, Mermelstein, & Demirtas, 2008). A multilevel approach was necessary to account for the interdependence of days within each person. Location-scale modeling is an extension of the standard multilevel model which estimates a random intercept (i.e., average), but relaxes the assumption of homoscedasticity (i.e., allows for the degree of residual variance to vary across all participants). Using this randomly varying residual variance term allows for estimating the degree of variability unexplained by a person's average and allows for the residual variance to be used as an outcome variable which can be predicted by variables at the between-person level (i.e., at level 2), such as personality traits. Additionally, the location-scale model can be estimated to include a parameter modeling the correlation between mean and residual variance terms (which has generally been thought to statistically adjust for their covariance, though as detailed below this is not always the case). Thus, the location-scale framework models the interdependence between the mean and the variance while also allowing for estimation of how individual differences predict these parameters within a single model. Covariates can also be entered into the model to account for the influence of additional factors, such as the effect of daily negative events on daily affect (reflecting daily emotional reactivity) and the cross-level association of neuroticism with day-to-day reactivity to negative events (see Hedeker, Mermelstein, Berbaum, & Campbell, 2009 for an example).

In terms of this study, location-scale modeling can be used to examine how neuroticism is associated with variance in mean levels of affect, variability in affect, and reactivity to negative events within the same model. The equation for this model when predicting negative affect is displayed below (this same model will be used when predicting positive affect). Note that variance, by definition, cannot be negative, which is achieved by using the exponential function when estimating the residual variance.

$$\text{Negative affect}_{ij} = \beta_{0j} + \beta_{1j}(\text{Number of negative events}_{ij}) + e_{ij},$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Neuroticism}_j) + u_{0j}, \quad \text{[Average Intensity]}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{21}(\text{Neuroticism}_j) + u_{1j}, \quad \text{[Reactivity]}$$

$$\text{Var of } e_{1j} = \exp(\beta_{2j} + \beta_{22}(\text{Neuroticism}_j) + e_{2j}), \quad \text{[Variability]}$$

In order to estimate power, software developed by Walter, Hoffman, & Templin (2018) was used to estimate the power of each study. Estimates used in the power analysis were taken from Rast et al. (2012) study of intraindividual variability in affect and Geukes and colleuges (2017) study of the association between neuroticism and mean levels and variability in affect. Power analyses indicated that both samples had above 90% chance to detect an $R^2 \geq 0.01$ of neuroticism with the intensity, reactivity, and variability of affect.

Next, because negative and positive affect themselves are correlated and neuroticism is hypothesized to describe both negative and positive affect, there is a need to isolate the associations of neuroticism and negative affect from the associations of neuroticism and positive affect. Thus, to isolate the unique role of neuroticism for a particular valence of affect, in a final set of analyses, we reconducted the location-scale model after adding positive affect as a day-level covariate when predicting negative affect, and negative affect as a day-level covariate when predicting positive affect. Positive events were not added as a covariate in order to ease model estimation given that positive affect should already partially capture the influence of positive events and because neuroticism has not been found to moderate the impact of positive events on positive and negative affect (David et al., 1997; Longua, DeHart, Tennen, Armeli, 2009).

2.10. Changes to the Stage 1 analytic plan

In our original Stage 1 submission we planned to conduct these location-scale models in the standalone MixWILD program (Hedeker & Nordgren, 2013). However, we encountered estimation and convergence difficulties in MixWILD, particularly in sample two. The output from these MixWILD models is available on the study OSF page. Personal communication with Dr. Donald Hedeker, the developer of MixWILD, revealed that such estimation and convergence difficulties can arise when modeling variables with large numbers of participants with low variability, as can be the case with negative affect. Additionally, in the process of comparing results from MixWILD to other statistical software programs that are capable of estimating location-scale models, it became apparent that the standard multilevel location-scale model in MixWILD was not adjusting for any covariation between the random intercept (i.e., individual differences in the average, or the location) and other level 2 predictors (in our case Neuroticism) when modeling the association with the random level 1 residuals (i.e., individual differences in the variances, or scale). In further discussions with Dr. Hedeker, it was determined that the MixWILD framework likely estimated the standard multilevel location-scale model with the standard assumption that a between-person variable (e.g., neuroticism) and the random effects (e.g., random intercept) are uncorrelated, which in this case is incorrect (see Table 1, 2, 5, & 6) and leads to unadjusted effects of each on the random residuals. Thus, within the context of the current data, the typical location-scale model as implemented in MixWILD was unable to estimate how neuroticism uniquely associates with the mean, variance, and reactivity affective parameters.

Because of these difficulties, we conducted additional analyses that were not part of our original registered analyses. To estimate the unique associations among neuroticism and the mean, variance, and reactivity, we switched to using multilevel structural

equation modeling in Mplus v8 (Muthen & Muthen, 2017) to estimate the location-scale models in a framework that is more flexible and relaxes some assumptions of standard multilevel model. In multilevel structural equation modeling as implemented in Mplus, all Level 1 random effects (i.e., intercept, slopes, and residual variances) become latent variables at level 2 that can be modeled with the typical flexibility of path analytic models, such that they can be outcomes, predictors, or allowed to freely covary (see Sadikaj et al., 2020 for a primer).

Specifically, we used Mplus to conduct multilevel structural equation models which estimated the basic within-person location-scale models, but instead of having neuroticism predict individual differences in each affective parameter in the model, we used the latent individual difference estimates of each affective parameter to predict neuroticism at the between-person level of the multilevel structural equation model (see Fig. 1). We did this separately for negative and positive affect models. By estimating the latent individual differences in these affective parameters from these models and then using these parameters in a multiple regression at the between-person level in the model, estimates will reveal the unique associations between neuroticism and each affective index.

It is important to note that Mplus v8 provides a more flexible framework for estimating the study's models of interest, although it can only do so using Bayesian estimation procedures (and therefore reported p-values are one-sided). Mplus also has the benefit of decomposing the total variance of all within-person variables in the model into their constituent latent within and between-person portions (Sadikaj et al., 2019). In brief, this decomposition corrects for differences in the reliability of estimates across people and creates more reliable and unbiased estimates of individual difference estimates (Ludtke et al., 2008; Ludtke et al., 2011).

In sum, our primary analyses include three steps for each sample, all of which were conducted using multilevel structural equation modeling in Mplus: 1) estimating the zero-order correlations among latent individual differences in affective indices and neuroticism, 2) estimating the location-scale models as indicated in the equation above (which simultaneously estimates associations of neuroticism with the mean, variability, and reactivity indices, but does not estimate how it is uniquely associated with each, and 3) estimating location-scale models that use individual differences in the mean, variability, and reactivity to simultaneously predict neuroticism in a multiple regression at the between-person level of the multilevel structural equation model (which does provide insight into which affective parameters are uniquely associated with neuroticism).

2.11. Hypotheses

We hypothesize that neuroticism will be associated with unique variance in the intensity of daily average negative affect (i.e., will positively predict the intercept), the reactivity of affect to daily negative events (i.e., will positively predict the within-person effect of daily negative events on daily negative affect), and greater variability in negative affect (i.e., will positively predict the amount of residual variance in affect). In terms of positive affect, we expect that neuroticism will only be associated with unique variance in the intensity of average positive affect.

2.12. Statement of data knowledge and gatekeeping

Given that this registered report utilized already collected data, we wished to explicitly detail our current knowledge of the data. We realize that the ideal situation for a registered report on secondary data would be one in which the authors had no knowledge of the data and a gatekeeper; however, sample one data was originally collected by the third author's lab, which was shared with the first and second authors approximately two years before the start of this project. Thus, we have had access to the data before the idea of submitting this registered report had occurred and are unable to have a gatekeeper for the data. As mentioned above, the first three authors have previously published manuscripts using sample one (cf. DeHart et al., 2014; Hamilton & DeHart, 2019; Hisler et al., 2018). In terms of sample two, both the first and second authors have previously published studies using this data, though none of these studies used data from the MIDUS Daily Experiences Study (Hisler & Brenner, 2019; Krizan & Hisler, 2019; Stephan, Sutin, Bayard, Križan, & Terracciano, 2018). None of these

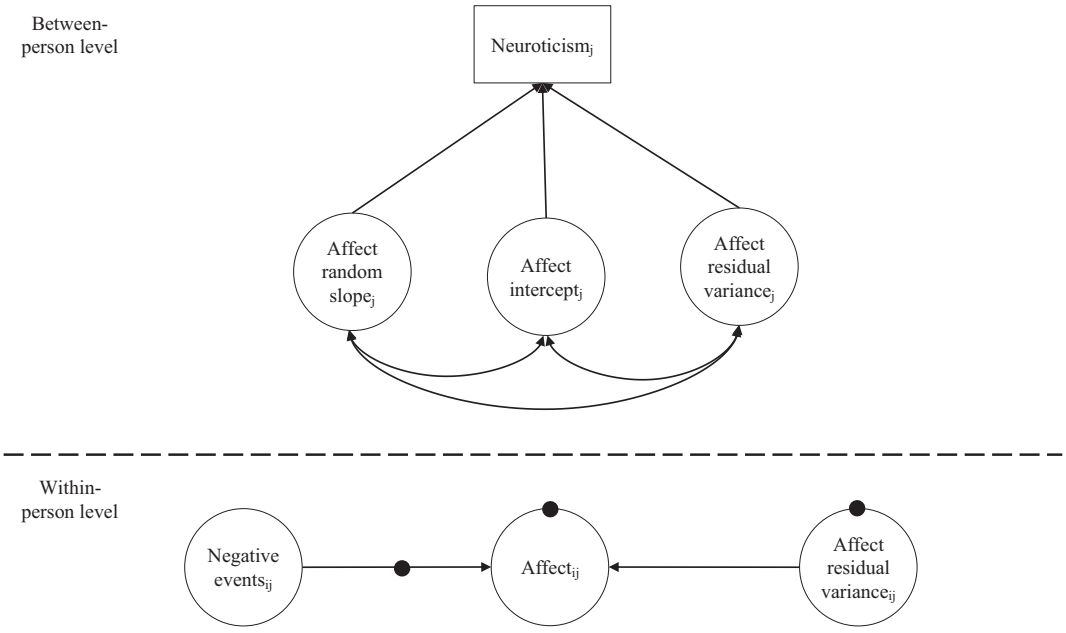

Fig. 1. Note. Filled in dots represent random effects, variables in circles represent latent variables, and variables in squares represent observed variables. Individual differences in stress correlated with all between-person variables, but paths are not depicted for sake of parsimony.

prior publications using sample one or two were focused on the relationships between neuroticism and affect (though the correlation between neuroticism and mean levels of negative affect is reported in Hisler et al., 2018). The fourth author had no prior data experience with either sample. Knowledge of measures used in the current study is stated in the Knowledge of Measures supplement. Overall, we collectively did have a basic understanding of participant characteristics and peripheral knowledge that the neuroticism and negative affect items are reliable and correlated with each other. However, we did not have knowledge regarding how neuroticism relates to the reactivity and variability of negative affect in either sample nor did we have any knowledge about the other variables (e.g., positive affect, negative events) and how they are related to neuroticism and affect.

2.13. Data deposition

All materials, data, analyses, and syntax from sample one are available within the Open Science Framework website (link to study OSF page). Because the authors do not have ownership of the MIDUS study data, we cannot openly share the data or materials. However, all syntax and output from analyses for sample two are also available within this Open Science Framework link. Individuals interested in accessing the MIDUS data can request access to the data and materials at http://www.midus.wisc.edu.

3. Results

3.1. Sample one

After exclusions, the final sample included 211 participants (M_{age} = 18.78, SD = 1.05; 58% female) who completed an average of 25.32 out of the 30 daily affect assessments (SD = 4.82) for a total of 5,343 affect daily assessments (84.4% completion rate).

3.2. Are affect indices correlated with themselves and with neuroticism?

The means, standard deviations, and correlations among the latent individual difference variables in the negative affect and positive affect models are displayed in Tables 1 & 2, respectively. Of particular note is that individual differences in mean levels of negative and positive affect, residual variance in negative and positive affect, and the effect of stress on negative and positive affect were all significantly different from zero and had substantial variability across people (all p's < 0.001). Thus, the hypothesized affect characteristics were present in this sample and varied across people; this variability may be associated with neuroticism. Correlations among individual differences in mean level, variability, and reactivity for negative affect ranged from 0.29 to 0.69 (all p's < 0.001). These correlations tended to be lower for positive affect as they ranged from −0.38 to 0.03 (all p's < 0.001). This pattern of correlations demonstrates sizable overlap in these different indices of affective functioning, especially in the case of mean levels and residual variance in negative affect, and that this overlap was much greater for negative affect than positive affect.

Affective characteristics were also correlated with neuroticism. People with greater neuroticism had more negative affect and less positive affect on average (*r*'s = 0.48 & −0.34, respectively, both *p's* < 0.001), greater variability in negative and positive (*r's* = 0.39 & 0.22, respectively, both *p's* < 0.01), and encountered more stressful events (*r* = 0.25, *p* ⟨0 0 1). People higher in neuroticism did not have any more intense emotional reactions to stressors for either negative or positive affect. Altogether, the zero-order correlations suggest that neuroticism was associated with mean levels and variability in both negative and positive affect, but not the emotional reactivity negative events.

3.3. Is neuroticism associated with affect indices?

The primary results of the location-scale models for negative and positive affect in sample one are presented in the top half of Table 3. When predicting negative affect, higher neuroticism was associated with greater average negative affect (β = 0.35, 95% CI = 0.26 to 0.43, p < .001) and greater variability in negative affect (β = 0.28, 95% CI = 0.19 to 0.37, p < .001), but not greater negative affect reactivity to negative events (β = 0.06, 95% CI = −0.08 to 0.20, p = .17). Similarly, when predicting positive affect, increases in neuroticism were associated with lower positive affect (β = −0.24, 95% CI = −0.32 to −0.14, p < .001) and greater variability in positive affect (β = 0.19, 95% CI = 0.07 to 0.28, p < .001), but not greater reactivity of positive affect to negative events (β = 0.10, 95% CI = −0.06 to 0.27, p = .13). Findings from both of these models remained the same when controlling for the opposite affect (e.g., when controlling for positive affect in the negative affect model).

Together, these findings demonstrate that neuroticism reflected a person's average negative and positive affect and degree of variability in both positive and negative affect, but did not reflect how reactive a person's emotions were to negative events.

3.4. Is neuroticism uniquely associated with affect indices?

The results of the regressions in which neuroticism was simultaneously predicted by the latent individual differences in mean levels, variability, and reactivity affect parameters estimated in the location-scale models are presented in the top half of Table 4. These results revealed that neuroticism only had a unique association with mean levels of negative affect (β = 0.40, 95% CI = 0.21 to 0.57, p < .001), though the unique association between neuroticism and variability in negative affect was near the boundary for significance (β = 0.15, 95% CI = −0.03 to 0.34, p = .06). Results were similar for positive affect, in which neuroticism had a unique association with mean positive affect (β = −0.27, 95% CI = −0.42 to −0.07, p = .003) and an association with variability in positive affect that was near the boundary for significance (β = 0.15, 95% CI = −0.02 to 0.30, p = .04).

Table 1
Descriptive statistics of and correlations among latent negative affect model variables in sample one (N = 211).

	M	SD	1	2	3	4	5
1. Mean negative affect	1.98*	0.84*	–				
2. Negative affect residual variance	0.54*	1.37*	0.69*	–			
3. Number of stressors	1.99*	1.84*	0.34*	0.41*	–		
4. Neuroticism	3.36*	1.71*	0.48*	0.39*	0.25*	–	
5. Random effect of stress on negative affect	0.12*	0.10*	0.29*	0.33*	−0.26*	0.09	–

Note. Mean residual variance is presented after exponentiation of estimate. *p<.001. p-values are one-sided.

Table 2
Descriptive statistics of and correlations among latent positive affect model variables in sample one (N = 211).

	M	SD	1	2	3	4	5
1. Mean positive affect	5.13*	1.40*	–				
2. Positive affect residual variance	1.92*	0.64*	−0.33*	–			
3. Number of stressors	2.03*	1.85*	−0.49*	0.26*	–		
4. Neuroticism	3.37*	1.15*	−0.34*	0.22*	0.25*	–	
5. Random effect of stress on positive affect	−0.14*	0.13*	−0.38*	0.03	0.35*	0.13	–

Note. Mean residual variance is presented after exponentiation of estimate. *p < .001. p-values are one-sided.

Table 3
Results of neuroticism predicting affective characteristics in the location-scale models for negative and positive affect in samples one and two.

	Negative affect			Positive affect		
	Mean β (95% CI)	Reactivity β (95% CI)	Variability β (95% CI)	Mean β (95% CI)	Reactivity β (95% CI)	Variability β (95% CI)
Sample 1	0.35* (0.26 to 0.43)	0.06 (−0.08 to 0.20)	0.28* (0.19 to 0.37)	−0.24* (−0.32 to −0.14)	0.10 (−0.06 to 0.27)	0.19* (0.07 to 0.28)
Sample 2	0.37* (0.32 to 0.54)	0.32* (0.20 to 0.39)	0.30* (0.19 to 0.35)	−0.30* (−0.33 to −0.26)	−0.01 (−0.07 to 0.08)	0.13* (0.09 to 0.18)

Note. *p < .001. p-values are one-sided.

Table 4
Regressing neuroticism on individual differences in affective parameters from location-scale models for negative and positive affect in samples one and two.

		Negative affect Neuroticism β (95% CI)	Positive affect Neuroticism β (95% CI)
Sample 1	Mean	0.40* (0.21 to 0.57)	−0.27* (−0.42 to −0.07)
	Reactivity	−0.09 (−0.27 to 0.09)	0.03 (−0.15 to 0.27)
	Variability	0.15† (−0.03 to 0.34)	0.15* (−0.02 to 30)
Sample 2	Mean	0.79 (−1.46 to 3.47)	−0.43* (−0.51 to −0.35)
	Reactivity	0.21* (0.05 to 0.38)	−0.09 (−0.22 to 0.05)
	Variability	−0.53 (−3.25 to 1.82)	0.02 (−0.08 to 0.11)

Note. *p < .05, †p < .10. p-values are one-sided.

3.5. Sample two

The final analytic sample included 1,750 adults (M_{age} = 56.73, SD = 12.09; 57% female) who, on average, completed 7.79 out of the 8 days of affect assessments (SD = 0.41). Altogether these participants completed 13,634 daily affect assessments out of the total possible 14,000 (97% completion).

3.6. Are affect indices correlated with themselves and with neuroticism?

Means, standard deviations, and between-person correlations among latent study variables are presented in Tables 5 & 6 for negative affect and positive affect, respectively. As in sample one, mean levels and variability across people in key affect characteristics were significantly different from zero. Correlations among mean level, variability, and reactivity for negative affect were much higher than sample one as they ranged from 0.72 to 0.95 (all p's < 0.001). These correlations were moderately lower for positive affect as they ranged from −0.33 to −0.51 (all p's < 0.001).

The correlations with neuroticism were largely consistent with the correlations from sample one, except that people higher in neuroticism in sample two had more negative reactions to stressors (r = 0.50, p < .001). Altogether, neuroticism in sample two was associated with mean levels and variability in both negative and positive affect, as well as the reactivity of negative affect to negative events.

3.7. Is neuroticism associated with affect indices?

The bottom half of Table 3 presents the results for the location-scale models when predicting negative and positive affect. Results from these models were largely consistent with those from sample one. When predicting negative affect, a person's level of neuroticism reflected their average level of negative affect (β = 0.37, 95% CI = 0.32 to 0.54, p < .001) and variability of negative affect (β = 0.30, 95% CI = 0.19 to 0.35, p < .001). Unlike sample one, however, higher neuroticism also associated with greater negative affect in reaction to negative events (β = 0.32, 95% CI = 0.20 to 0.39, p < .001). In term of positive affect, a person's level of neuroticism again reflected their average positive affect (β = −0.30, 95% CI = −0.33 to −0.26, p < .001) and variability in positive affect (β = 0.13, 95% CI = 0.09 to 0.18, p < .001), but not reactivity to negative events (β = −0.01, 95% CI = −0.07 to 0.08, p = .39). Again, findings from both of these models remained the same when controlling for the opposite affect (e.g., when controlling for positive affect in the negative affect model), suggesting the effects of neuroticism on each affect valence was independent of the other.

3.8. Is neuroticism uniquely associated with affect indices?

Neuroticism was again regressed on the latent individual differences in the affective parameters in the negative affect and positive affect location-scale models separately (see bottom half of Table 4). In contrast to sample one, neuroticism was only uniquely related

Table 5
Descriptive statistics of and correlations among latent negative affect model variables in sample two (N = 1,750).

	M	SD	1	2	3	4	5
1. Mean negative affect	0.16*	0.11*	–				
2. Negative affect residual variance	0.02*	1.36*	0.95*	–			
3. Number of stressors	0.50*	0.34*	0.58*	0.44*	–		
4. Neuroticism	1.75*	0.44*	0.52*	0.43*	0.18*	–	
5. Random effect of stress on negative affect	0.12*	0.06*	0.73*	0.72*	0.02	0.47*	–

Note. Mean residual variance is presented after exponentiation of estimate. *p < .001. p-values are one-sided.

Table 6
Descriptive statistics of and correlations among latent positive affect model variables in sample two (N = 1,750).

	M	SD	1	2	3	4	5
1. Mean positive affect	2.74*	0.68*	–				
2. Positive affect residual variance	0.09*	1.11*	−0.33*	–			
3. Number of stressors	0.50*	0.35*	−0.36*	0.20*	–		
4. Neuroticism	1.74*	0.44*	−0.41*	0.19*	0.20*	–	
5. Random effect of stress on positive affect	−0.10*	0.09*	−0.31*	−0.51*	0.26*	−0.03	–

Note. Mean residual variance is presented after exponentiation of estimate. *p < .001. p-values are one-sided.

to individual differences in stress reactivity (β = 0.21, 95% CI = 0.05 to 0.38, p = .007) for the negative affect model. Note that the exceptionally high correlation between mean levels and variability in negative affect (r > 0.90) likely produced the unreasonable estimates and confidence intervals seen in Table 4 and likely make findings from the model unreliable. In terms of positive affect, neuroticism was only uniquely related to mean levels of positive affect, replicating findings from sample one (β = −0.43, 95% CI = −0.51 to −0.35, p < .001).

4. Discussion

Raw associations from correlations and location-scale models across samples one and two support that neuroticism reflects both a person's average and variability in positive and negative affect and does *not* reflect a person's reactivity of positive affect to negative events. Interestingly, neuroticism was not associated with the reactivity of negative affect to negative events in sample one; however, neuroticism was associated with reactivity of negative affect to negative events in sample two, converging with prior work and suggesting that neuroticism also reflects reactivity of negative affect to negative events. Importantly, these associations remained even after controlling for the opposite valanced affect, implicating that neuroticism independently reflects emotion characteristics of both negative and positive affect.

These findings have important implications for understanding neuroticism. Though the associations with negative affect were replicated prior findings (Bolger & Schilling, 1991; Longua et al., 2009; Murray et al., 2002; Maples et al., 2014), consistently linking neuroticism to a person's average positive affect and variability in positive affect, but not their reactivity of positive affect to negative events across two samples provides greater confidence that neuroticism has independent implications for the functioning of positive affect. Moreover, these effects remained even after controlling for negative affect and in samples consisting of both young adults and middle age adults, suggesting that neuroticism uniquely describes these patterns in positive affect above and beyond its association with negative affect and throughout adulthood. These findings converge with the majority of previous studies, though previous research has generally not simultaneously examined whether average, reactivity, and variability in positive affect is related to neuroticism all within the same sample (Ching et al., 2014; Eid & Diener, 1999; Leger et al., 2016; O'Hara, Armeli, Boynton, & Tennen, 2014). While these findings do add to the evidence that neuroticism also reflects positive affect, future research should account for the influence of extraversion as extraversion has been conceptualized as reflecting positive emotion characteristics and neuroticism is correlated with extraversion. Accounting for extraversion would provide further evidence that neuroticism is uniquely descriptive of positive emotion characteristics in addition to those of negative emotions.

4.1. (Lack of) unique associations of affect indices with neuroticism

Although neuroticism was associated with mean levels, variability, and reactivity, when examining the unique relations between these affective characteristics and neuroticism, neuroticism was primarily only uniquely related to mean levels of negative and positive affect. There were associations between variability in positive and negative affect with neuroticism that were near the boundary for statistical significance in sample one; however, these associations were clearly null in sample two. Moreover, reactivity of negative affect uniquely associated with neuroticism in sample two, however, the markedly high collinearity among affect indices in this model suggest that this association is unreliable to interpret. Altogether, these findings seem to suggest that neuroticism, at a minimum, uniquely describes a person's mean level affect, and suggests that other affective characteristics are not as central to understanding neuroticism. This was in line with our hypotheses regarding positive affect, however, we had hypothesized that neuroticism would be uniquely related to each affective parameter for negative affect.

On one hand, given the number of studies and theories that have routinely link neuroticism to mean levels, variability, and reactivity of negative affect, finding that neuroticism only uniquely reflected mean levels is surprising. On the other hand, recent work examining the incremental contributions of individual differences in more complex affective parameters suggests such complex parameters may have little predictive power beyond the mean (though variability may have some utility; Dejonckheere et al., 2019; Wendt et al., 2020). Our findings largely converge with these, though Wendt and colleagues (2020) found that neuroticism did relate to variability in negative, but not positive, affect after adjusting for mean levels. Of particular note is that mean levels and variability in negative affect were highly correlated in both samples in our study (r's $\geq$ 0.69) and these large correlations leave little room for incremental associations. However, before throwing the baby out with the bathwater (i.e., throwing out complex affective parameters because they don't predict incremental variance) further research is needed on a) how they relate to the mean and b) whether they may uniquely be associated with other important outcomes.

Better understanding how such additional affective dynamics relate to the mean can give insight into the understanding of traits such as neuroticism. For instance, neuroticism is partially characterized by emotional variability and lability (Costa & McCrae, 1992; DeYoung, 2015; Eysenck & Eysenck, 1985; Suls & Martin, 2005). It may be that for people (or for just some people) high in neuroticism, they do not have a stable mean level of negative or positive affect. Rather, their affect may be in constant flux, routinely shifting from high to low between each affect assessment. In this case, a mean for these people's level of negative and positive affect can be calculated, but does not accurately capture such people's true emotion dynamics. Instead, more complex affect parameters such variability or reactivity more accurately capture the affective characteristics of such people. Thus, the importance of particular affective dynamics for a person may vary across people. Note that a related concern worth briefly mentioning here is measurement, as the frequency and mode of measurement of affect may have important implications for the relation between affective indices and outcomes. Altogether, more nuanced approaches to understanding how a person's (or specific types of people's)

affective states develop and change over time are needed and may bring greater clarity to the relations among affect indices and their implications for theory, health, and wellbeing.

While examining these associations in a more nuance manner is needed, it will also be necessary to examine their associations with a broader array of constructs. Neuroticism may not be uniquely associate with variability and reactivity of negative affect, but these affective characteristics may uniquely explain why neuroticism relates to important outcomes. For instance, neuroticism has substantial ties to borderline personality disorder, which has emotional instability as a core feature (Linehan, 1993; Suzuki et al., 2015). Associations of neuroticism with affective parameters capturing emotional instability may uniquely explain why it is associated with borderline personality. This possibility is suggested by Dejonckheere and colleagues (2019) (Ganzach and Yaor, 2019) findings that variability in negative affect had the largest incremental contribution beyond the mean when predicting borderline symptoms. The health consequences of stress are another domain that more complex affect indices may be useful in explaining associations with neuroticism. It may be that the intensity of a person's reaction to stress uniquely explains associations of neuroticism with the physiological and psychological effects of encountering a stressor and downstream health effects of repeatedly or chronically dealing with stressors. Such possibilities are ripe for future research and existing datasets, such as the MIDUS data, could easily be mined to examine them.

4.2. Study limitations

Findings from the current study have limitations that are important to consider when interpreting findings. First, affect was measured only once per day in both sample one and two. Using more frequent assessments of positive and negative affect may more accurately capture and reliably estimate a person's reactivity and variability in daily life. Thus, it is possible that utilizing samples which only measured affect once per day poorly measured reactivity and variability and thereby over-weighted the association of average levels of affect with neuroticism. It is worth noting here that sample one and two each used different time frames and response formats for affect assessments (i.e., the intensity of a particular emotion right now vs. the frequency of a particular emotion today), yet findings were largely similar across the assessment methods. Regardless, the assessment of affect only once per day also limits the interpretation of findings to how neuroticism relates to day-to-day affect characteristics rather than intra-day affect characteristics. Examining the associations of neuroticism with how people's emotions fluctuate within a day as opposed across days may reveal differential relations among affect indices and neuroticism.

Second, endorsement of negative affect items tends to be low in samples of healthy adults and can restrict its variability. This was true for both samples one and two, which is unsurprising because neither sample is drawn from clinical populations. Perhaps the low variability in negative affect reduced the associations of the reactivity and variability indices with neuroticism and may limit the generalizability of findings to only samples with mostly health adults. Future studies should recruit participants from clinical populations who experience more negative affect or have different affective functioning characteristics (e.g., participants with personality disorders).

Third, it is also important to consider the role of measurement when examining how neuroticism relates to different characteristics of emotional functioning. Proper measurement of different aspects of neuroticism and emotional functioning is key to assessing how neuroticism relates to different characteristics of emotional tendencies. For instance, if the measure of neuroticism does not sufficiently assess dispositions toward affective volatility or variability, then that measure of neuroticism is unlikely to have a strong relationship to variability or reactivity in negative emotions. Furthermore, if affective measures do not include emotions which are most frequently activated in reaction to negative events (e.g., anger, anxiety, other high arousal emotions) then it is less likely neuroticism would be associated with reactivity to a negative event even if the measure of neuroticism includes items measuring affective volatility. Findings from the current study could be limited to the choice of measures within each sample. Future research could utilize measures of neuroticism that capture reactivity and variability aspects to an even greater degree than that used in this study or affect measures that more heavily consist of emotions that vary more over time or occur in reaction to negative events.

5. Conclusion

Overall, this study sought to advance the understanding of how neuroticism manifests in emotional functioning during everyday life. Given that neuroticism has been shown to play a role in people's everyday typical emotions, their reactivity to negative events, and their emotional variability overtime, a necessary next step was to examine whether neuroticism uniquely contributes to these emotional characteristics in everyday life. This study found that neuroticism only uniquely reflected average levels of negative and positive affect. While theoretical accounts have proposed mean levels, reactivity, and variability of affect as distinct components of neuroticism, findings from this study suggest that mean levels of affect, at the very least, exist as a distinct affect characteristic of neuroticism. However, future research will need to keep examining these relations using more nuanced and contextualized approaches as well as examine the role of these different affective characteristics in the associations of neuroticism with important theoretical and health outcomes.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jrp.2020.103964.

References

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

Ching, C. M., Church, A. T., Katigbak, M. S., Reyes, J. A. S., Tanaka-Matsumi, J., Takaoka, S., ... Ortiz, F. A. (2014). The manifestation of traits in everyday behavior and affect: A five-culture study. *Journal of Research in Personality, 48*, 1–16.

Church, A. T. (1994). Relating the Tellegan and five-factor models of personality structure. *Journal of Personality and Social Psychology, 67*(5), 898–909.

Costa, P. T., & McCrae, R. R. (1992). Normal personality assessment in clinical practice: The NEO Personality Inventory. *Psychological Assessment, 4*, 5–13.

David, J. P., Green, P. J., Martin, R., & Suls, J. (1997). Differential roles of neuroticism, extraversion, and event desirability for mood in daily life: An integrative model of top-down and bottom-up influences. *Journal of Personality and Social Psychology, 73*, 149–159.

DeHart, T., Longua Peterson, J., Richeson, J. A., & Hamilton, H. R. (2014). A diary study of daily perceived mistreatment and alcohol consumption in college students. *Basic and Applied Social Psychology, 36*, 443–451.

DeHart, T., Tennen, H., Armeli, S., Todd, M., & Mohr, C. (2009). A diary study of implicit self-esteem, interpersonal interactions and alcohol consumption in college students. *Journal of Experimental Social Psychology, 45*, 720–730.

Dejonckheere, E., Mestdagh, M., Houben, M., Rutten, I., Sels, L., Kuppens, P., & Tuerlinckx, F. (2019). Complex affect dynamics add limited information to the prediction of psychological well-being. *Nature Human Behaviour, 3*, 478–491.
DeYoung, C. G. (2010). Personality neuroscience and the biology of traits. *Social and Personality Psychology Compass, 4*, 1165–1180.
DeYoung, C. G. (2015). Cybernetic big five theory. *Journal of Research in Personality, 56*, 33–58.
DeYoung, C. G., & Weisberg, Y. J. (2019). Cybernetic approaches to personality and social behavior. In M. Snyder & K. Deaux (Eds.), *Oxford Handbook of Personality and Social Psychology* (second ed., pp. 387–414). New York: Oxford University Press.
Eid, M., & Diener, E. (1999). Intraindividual variability in affect: Reliability, validity, and personality correlates. *Journal of Personality and Social Psychology, 76*, 662–676.
Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach*. New York: Plenum.
Fleeson, W., & Gallagher, P. (2009). The implications of Big Five standing for the distribution of trait manifestation in behavior: Fifteen experience-sampling studies and a meta-analysis. *Journal of Personality and Social Psychology, 9*, 1097–1114.
Ganzach, Y., & Yaor, E. (2019). The retrospective evaluation of positive and negative affect. *Personality and Social Psychology Bulletin, 45*, 93–104.
Geukes, K., Nestler, S., Hutteman, R., Küfner, A. C., & Back, M. D. (2017). Trait personality and state variability: Predicting individual differences in within-and cross-context fluctuations in affect, self-evaluations, and behavior in everyday life. *Journal of Research in Personality, 69*, 124–138.
Goldberg, Lewis R, (1992). The development of markers for the Big-Five factor structure. *Psychological Assessment, 4*, 26–42.
Gross, J. J., Sutton, S. K., & Ketelaar, T. (1998). Relations between affect and personality: Support for the affect-level and affective-reactivity views. *Personality and Social Psychology Bulletin, 24*, 279–288.
Gunthert, K. C., Cohen, L. H., & Armeli, S. (1999). The role of neuroticism in daily stress and coping. *Journal of Personality and Social Psychology, 77*, 1087–1100.
Hamilton, H. R., & DeHart, T. (2019). Needs and norms: Testing the effects of negative interpersonal interactions, need to belong, and perceived norms on alcohol consumption. *Journal of Studies on Alcohol and Drugs, 80*, 340–348.
Hankin, B. L., Fraley, R. C., & Abela, J. R. Z. (2005). Daily depression and cognitions about stress: Evidence for a trait-like depressogenic cognitive style and the prediction of depressive symptoms in a prospective daily diary study. *Journal of Personality and Social Psychology, 88*, 673–685.
Hedeker, D., Mermelstein, R. J., Berbaum, M. L., & Campbell, R. T. (2009). Modeling mood variation associated with smoking: An application of a heterogeneous mixed-effects model for analysis of ecological momentary assessment (EMA) data. *Addiction, 104*, 297–307.
Hedeker, D., Mermelstein, R. J., & Demirtas, H. (2008). An application of a mixed-effects location scale model for analysis of ecological momentary assessment (EMA) data. *Biometrics, 64*, 627–634.
Hedeker, D., & Nordgren, R. (2013). MIXREGLS: A program for mixed-effects location scale analysis. *Journal of Statistical Software, 52*, 1–38.
Hisler, G. C., Krizan, Z., & DeHart, T. (2018). Does stress explain the effect of sleep on self-control difficulties? A month-long daily diary study. Personality and Social Psychology Bulletin. Advanced online publication.
Hisler, Garrett, C, & Brenner, Rachel E, (2019). Does sleep partially mediate the effect of everyday discrimination on future mental and physical health? *Social Science & Medicine, 221*, 115–123.
Howland, M., Armeli, S., Feinn, R., & Tennen, H. (2017). Daily emotional stress reactivity in emerging adulthood: Temporal stability and its predictors. *Anxiety, Stress, & Coping, 30*, 121–132.
Krizan, Zlatan, & Hisler, Garrett C, (2019). Personality and Sleep: Neuroticism and Conscientiousness Predict Behaviourally Recorded Sleep Years Later. *European Journal of Personality, 33*(2), 133–153.
Kuppens, P., Oravecz, Z., & Tuerlinckx, F. (2010). Feelings change: Accounting for individual differences in the temporal dynamics of affect. *Journal of Personality and Social Psychology, 99*, 1042.
Kuppens, P., Van Mechelen, I., Nezlek, J. B., Dossche, D., & Timmermans, T. (2007). Individual differences in core affect variability and their relationship to personality and psychological adjustment. *Emotion, 7*, 262272.
Lachman, M, E, & Weaver, S L, (1997). *The Midlife Development Inventory (MIDI) personality scales: Scale construction and scoring (Technical Report)*. Waltham, MA: Brandeis University.
Leger, K. A., Charles, S. T., Turiano, N. A., & Almeida, D. M. (2016). Personality and stressor-related affect. *Journal of Personality and Social Psychology, 111*, 917–928.
Linehan, M. M. (1993). *Skills training manual for treating borderline personality disorder*. Guilford Press.
Liu, Y., Bangerter, L. R., Rovine, M. J., Zarit, S. H., & Almeida, D. M. (2018). Intrinsic emotional fluctuation in daily negative affect across adulthood. *The Journals of Gerontology: Series B, 73*, 100–112.
Longua, J., DeHart, T., Tennen, H., & Armeli, S. (2009). Personality moderates the interaction between positive and negative daily events predicting negative affect and stress. *Journal of Research in Personality, 43*, 547–555.
Lüdtke, O., Marsh, H. W., Robitzsch, A., & Trautwein, U. (2011). A 2x2 taxonomy of multilevel latent contextual models: Accuracy-bias tradeoffs in full and partial error correction models. *Psychological Methods, 16*, 444–467.
Maples, J., Miller, J. D., Hoffman, B. J., & Johnson, S. L. (2014). A test of the empirical network surrounding affective instability and the degree to which it is independent from neuroticism. *Personality Disorders: Theory, Research, and Treatment, 5*, 268–277.
Mestdagh, M., Pe, M., Pestman, W., Verdonck, S., Kuppens, P., & Tuerlinckx, F. (2018). Sidelining the mean: The relative variability index as a generic mean-corrected variability measure for bounded variables. *Psychological Methods, 23*, 690–707.
Munafò, M. R., Durrant, C., Lewis, G., & Flint, J. (2009). Gene× environment interactions at the serotonin transporter locus. *Biological Psychiatry, 65*, 211–219.
Murray, G., Allen, N. B., & Trinder, J. (2002). Longitudinal investigation of mood variability and the ffm: Neuroticism predicts variability in extended states of positive and negative affect. *Personality and Individual Differences, 33*, 1217–1228.
Muthén, L. K., & Muthén, B. O. (2017). 1998–2017. Mplus User's Guide. Los Angeles, CA: Muthén & Muthén.
Neubauer, A. B., Scott, S. B., Sliwinski, M. J., & Smyth, J. M. (2019). How was your day? Convergence of aggregated momentary and retrospective end-of-day affect ratings across the adult life span. Journal of Personality and Social Psychology. Advanced online publication.
O'hara, R. E., Armeli, S., Boynton, M. H., & Tennen, H. (2014). Emotional stress-reactivity and positive affect among college students: The role of depression history. Emotion, 14, 193.
Patrick, C. J., Curtin, J. J., & Tellegen, A. (2002). Development and validation of a brief form of the multidimensional personality questionnaire. *Psychological Assessment, 14*(2), 150–163.
Rast, P., Hofer, S. M., & Sparks, C. (2012). Modeling individual differences in within-person variation of negative and positive affect in a mixed effects location scale model using BUGS/JAGS. *Multivariate Behavioral Research, 47*, 177–200.
Rauthmann, J. F., Sherman, R. A., Nave, C. S., & Funder, D. C. (2015). Personality-driven situation experience, contact, and construal: How people's personality traits predict characteristics of their situations in daily life. Journal of Research in Personality, 55, 98–111.
Robinson, M. D., Moeller, S. K., & Ode, S. (2010). Extraversion and reward-related processing: Probing incentive motivation in affective priming tasks. *Emotion, 10*, 615–626.
Ryff, C. D., & Almeida, D. M. (2010). Midlife in the United States (MIDUS 2): Daily Stress Project, 2004-2009. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2010-02-26.
Sadikaj, G., Wright, A.G.C., Dunkley, D., Zuroff, D., & Moskowitz, D.S. (in press). Multilevel structural equation modeling for intensive longitudinal data: A practical guide for personality researchers. In J.F. Rauthmann (Ed.) Handbook of Personality Dynamics and Processes. New York, NY: Elsevier.
Stephan, Y., Sutin, A. R., Bayard, S., Križan, Z., & Terracciano, A. (2018). Personality and sleep quality: Evidence from four prospective studies. *Health Psychology, 37*, 271.
Suls, J., & Martin, R. (2005). The daily life of the garden-variety neurotic: Reactivity, stressor exposure, mood spillover, and maladaptive coping. *Journal of Personality, 73*, 1485–1510.
Suzuki, T., Samuel, D. B., Pahlen, S., & Krueger, R. F. (2015). DSM-5 alternative personality disorder model traits as maladaptive extreme variants of the five-factor model: An item-response theory analysis. *Journal of Abnormal Psychology, 124*, 343.
Van Loey, N. E., Oggel, A., Goemanne, A. S., Braem, L., Vanbrabant, L., & Geenen, R. (2014). Cognitive emotion regulation strategies and neuroticism in relation to depressive symptoms following burn injury: A longitudinal study with a 2-year follow-up. *Journal of Behavioral Medicine, 37*, 839–848.
Walters, R. W., Hoffman, L., & Templin, J. (2018). The power to detect and predict individual differences in intra-individual variability using the mixed-effects location-scale model. *Multivariate Behavioral Research, 53*, 360–374.
Wendt, L. P., Wright, A. G. C., Pilkonis, P. A., Woods, W. C., Denissen, J., Kuhnel, A., & Zimmerman, J. (2020). Indicators of affect dynamics: Structure, test-retest reliability, and personality correlates. *European Journal of Personality. Advanced online publications.*.
Williams, D. G. (1990). Effects of psychoticism, extraversion, and neuroticism in current mood: A statistical review of six studies. *Personality and Individual Differences, 11*, 615–630.
Wright, A. G. C., Creswell, K. G., Flory, J. D., Muldoon, M. F., & Manuck, S. B. (2019). Neurobiological functioning and the personality trait hierarchy: Central serotonergic responsivity and the stability meta-trait. *Psychological Science, 30* (10), 1413–1423.
Yoon, K. L., Maltby, J., & Joormann, J. (2013). A pathway from neuroticism to depression: Examining the role of emotion regulation. *Anxiety, Stress & Coping, 26*, 558–572.
Zimprich, Daniel, Allemand, Mathias, & Lachman, Margie E, (2012). Factorial structure and age-related psychometrics of the MIDUS personality adjective items across the life span. *Psychological Assessment, 24*, 173–186.