Traits, States, and Encoding Speed: Support for a Top-Down View of Neuroticism/State Relations

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ABSTRACT Recent theories suggest that trait neuroticism gains its pernicious power particularly among individuals less capable of making distinctions concerning present reality. Four studies, involving 272 undergraduates, sought to provide some basic, assessment-related support for such theories in the context of individual differences in choice reaction time, which reflect abilities to make distinctions at encoding. Studies 1–3 focused on somatic symptoms, whereas Study 4 focused on neurotic behaviors and negative affect. As predicted, neuroticism consistently interacted with categorization speed in predicting these dependent measures. Specifically, neuroticism/outcome relations were robust among individuals slow to make distinctions at encoding; by contrast, neuroticism did not predict the dependent measures among individuals fast to make distinctions. Such data reinforce suggestions that neuroticism is particularly pernicious among individuals less capable of making distinctions at encoding.

Everyday life is characterized by a flux of events and states, giving rise to what William James (1890) characterized as the ''stream of consciousness'' (p. 243). Yet it has been suggested that not everybody experiences life in this way. Brown and Ryan (2003), for example, suggested that the experience of this stream, in relation to present reality, is more pronounced among individuals high in mindfulness. Borkovec, Ray, and Stöber (1998) similarly highlighted the manner in which worry, especially as manifest in generalized anxiety disorder, renders the individual relatively less capable of making

distinctions in the present. Common to these theories is the idea that anxious individuals are often trapped by habitual ways of thinking and that a focus on the present, for example, as facilitated by mindfulness training, is successful in breaking such habitual, self-defeating modes of thought linked to high neuroticism (Germer, Siegel, & Fulton, 2005; Hayes, Follette, & Linehan, 2004).

We explore similar ideas in the present study. However, our goals were basic and assessment related rather than clinical in nature. Prior work led us to believe that relations between trait neuroticism and neuroticism-related outcomes (e.g., somatic symptoms) might systematically vary (i.e., be higher among certain individuals than among others). Moreover, such relations should be stronger among individuals who are less capable of deriving meaning from the present, here defined in terms of choice reaction time performance. Our proposal builds on recent research related to trait/state dissociations and individual differences in choice reaction time.

Traits, States, and Encoding Speed

State- and trait-related judgments about the self appear to tap two different sources of self-knowledge (e.g., Barrett, Robin, Pietromonaco, & Eyssell, 1998; Klein, Loftus, & Kihlstrom, 1996; Marsh & Yeung, 1998). For example, Barrett et al. (1998) found that women reported higher levels of emotionality when making trait judgments but not when making state-related judgments. Klein et al. (1996) found that an amnesic patient could make reliable judgments about herself, despite the complete inability to recall recent life events. Marsh and Yeung (1998) found dissociations involving self-esteem in particular realms (e.g., the academic realm) on the one hand and global self-esteem on the other. This research, in general, suggests that more contextual (e.g., state-related) and less contextual (e.g., trait-related) judgments of the self are dissociated in some fundamental respects (Klein et al., 1996; Robinson & Clore, 2002a).

Robinson and Clore (2002a, 2002b) presented a theoretical analysis of such dissociations. The general conclusion of this research was that trait measures tap generalized beliefs about the self that may or may not correspond to more momentary emotional states. This sort of view was supported by a literature review (2002a). For example, we can understand findings such as those reported by

Barrett et al. (1998) in terms of the idea that women tend to believe that they are more emotional than men (Robinson & Clore, 2002a). Such beliefs differentially influence trait self-reports (among women vs. men) relative to state self-reports, thereby producing a trait/state dissociation. An empirical study (Robinson & Clore, 2002b) reinforced these conclusions.

If self-reported traits capture general beliefs about the self (Robinson & Clore, 2002a), it would seem desirable to develop other measures of personality that might be more capable of capturing momentary appraisal tendencies (Lazarus, 1995; Robinson, 2004). To capture such "in vivo" or "online" appraisal tendencies, Robinson and colleagues have relied on choice reaction time tasks (for reviews, see Robinson, 2004; Robinson & Neighbors, 2006; Robinson, Vargas, & Crawford, 2003). Almost all of this research has sought to examine trait-relevant skills, such as those related to agreeableness and blame categorization tendencies (Meier & Robinson, 2004). By contrast, the present research focused on the more general consequences of fast and slow encoding speed.

Nevertheless, the results of some recent studies are consistent with the present analysis. By and large, traits are not correlated with categorization skills, even those that are seemingly trait related (Robinson, 2004; Robinson & Neighbors, 2006). Moreover, multiple studies suggest that traits and categorization skills frequently interact in the prediction of everyday experience and behavior (Robinson, 2004; Robinson & Neighbors, 2006). Along these lines, Robinson, Solberg, Vargas, and Tamir (2003) found that trait extraversion predicted levels of life satisfaction particularly among those slow to distinguish neutral and positive events in a choice reaction time task. Similarly, Robinson, Vargas, et al. (2003) found that neuroticism predicted daily experiences of distress particularly among those slow to distinguish threats from non-threats in a choice reaction time task.

These data (Robinson, Solberg, et al., 2003; Robinson, Vargas, et al., 2003) suggest a somewhat general pattern whereby traits (such as extraversion and neuroticism) are more consequential among individuals slow to make trait-relevant distinctions in categorization tasks (Robinson, Solberg, et al., 2003; Robinson, Vargas, et al., 2003). Such results are consistent with a "fill in" by traits given poor encoding skills, a result to some extent anticipated by the two-process theory of Robinson and Clore (2002a, 2002b). The present

research sought to expand on this general idea within the context of individual differences in categorization speed more broadly defined.

Neuroticism and Categorization Speed

Intelligence is sometimes defined in terms of skills and sometimes defined in terms of processing abilities like reaction time (Baumeister, 1998; Cattell, 1943; Jensen, 1998). These two views of intelligence are not inconsistent: It has become quite clear that processing abilities—whether related to fluid intelligence (Cattell, 1943), g (Jensen, 1998), or working memory capacity (Barrett, Tugade, & Engle, 2004)—tend to support more "crystallized" forms of intelligence (Jensen, 1998; Kyllonen, 1996). Among other conclusions, speed of categorization appears to be a robust predictor of other intelligence-related skills (Jensen, 1993, 1998), such as performance on the WAIS (Bates & Stough, 1998; Jensen, 1998).

Our prior research (e.g., Robinson, Solberg, et al., 2003; Robinson, Vargas, et al., 2003) has led us to view categorization speed in terms of individual differences in encoding, with faster speed equated with better abilities to make the relevant distinction. Such individual differences, in turn, are seen as indicative of encoding tendencies in everyday life (Robinson, 2004). The idea that reaction time predicts important outcomes has been supported by extensive data linking g, as measured by choice reaction time, to a wide variety of everyday correlates such as educational attainment, occupational success—and, interestingly—variables such as crime and delinquency (Jensen, 1998). Thus, it generally appears that higher g, or faster processing, is associated with more adaptive flexibility in coping with the nuances of life (Jensen, 1998; see also Baumeister, 1998; Nettlebeck & Wilson, 1997).

The purported adaptive flexibility associated with reaction time was particularly interesting to us in light of clinical theories of neurotic distress (e.g., Borkovec et al., 1998; Germer et al., 2005; Nolen-Hoeksema, 2000). According to such theories, acute neurotic distress is associated with habitual, self-defeating modes of thought, such as those linked to worry (Borkovec et al., 1998), rumination (Nolen-Hoeksema, 2000), or perseveration (Robinson, Wilkowski, Kirkeby, & Meier, 2006). For this reason, authors have suggested that one effective way of reducing neuroticism-linked distress involves mindfulness training and/or other techniques related to increasing

neurotics' focus on present reality (Borkovec & Sharpless, 2004; Segal, Teasdale, & Williams, 2004). This comports with personality/social views of mindfulness and neuroticism (e.g., Brown & Ryan, 2003).

Perhaps even more relevant are theory and data involving reaction time measures. As noted above, Robinson, Vargas, et al. (2003) found that neuroticism was a better predictor of negative affect among individuals slow to distinguish threats from non-threats. This interactive pattern has since been conceptually replicated (Tamir, Robinson, & Solberg, 2006). So far, the results seem particular to threat-processing tasks. However, recent data suggest a wider perspective. Robinson, Wilkowski, and Meier (2006) found that greater reaction time variability across trials was problematic in the context of high neuroticism. Robinson, Wilkowski, Kirkeby, et al. (2006) found that response perseveration, as defined in terms of faster repeated relative to switched responses, was problematic in the context of high neuroticism. In both studies, dependent measures related to negative affect, depression, somatic symptoms, and so on.

We should note that these recent studies (Robinson Wilkowski, Kirkeby, et al., 2006; Robinson, Wilkowski, & Meier, 2006) controlled for individual differences in mean reaction time, which was the focus of the present research. Nevertheless, the general nature of the interactive patterns reported in these prior studies appears to converge on a similar conclusion: A focus on the current stimulus, for example as defined in terms less response perseveration (Robinson, Wilkowski, Kirkeby, et al., 2006), appears to be beneficial at high levels of neuroticism. Given this general sort of interactive pattern, as well as other data and theory (e.g., Robinson, Wilkowski, Kirkeby, et al., 2006), we predicted that neuroticism would interact with individual differences in general categorization speed in the prediction of neuroticism-linked subjective experiences.

Overview of Current Studies

One of the goals of the present investigation was to focus somewhat specifically on experiences of somatic symptoms (e.g., experiences of headache, nausea, and so on). We predicted that relations between neuroticism and somatic symptoms would be somewhat specific to individuals slow to categorize events within choice reaction time tasks. Results along these lines would support the idea that trait neuroticism infects symptom perception particularly when encoding

skills are poor. This hypothesis was investigated in three studies in order to fully support this class of predictions beyond any reasonable doubt.

Whereas Studies 1–3 were focused on experiences of somatic symptoms, Study 4 sought to extend our predictions. Study 4 specifically examined neurotic behaviors and negative affect within everyday life. In addition, Study 4, unlike Studies 1–3, used a classic font color Stroop task to measure encoding abilities and did so at two different times so that we could estimate the test-retest stability of encoding speed. We expected a high test-retest correlation and expected that neuroticism and speed would interact to predict daily neurotic behaviors and negative affect.

STUDIES 1–3

Studies 1–3 are quite similar in design, and there was a constant focus on somatic symptoms. For this reason, we present the results together rather than separately. To measure broad tendencies related to encoding speed, we used heterogeneous choice tasks, but the specific tasks varied from study to study.

Method

Participants

Participants in Studies 1, 2, and 3 were 56, 54, and 89 University of Illinois undergraduates who volunteered for the study in return for extra credit. There were 32 males and 23 females in Study 1. In Study 1, sex correlated with somatic symptoms, $r = .33$, $p < .05$, but not with neuroticism or speed, $|r|s < .20$, $ps > .20$. More important, there was no hint that sex moderated the conclusions reported below (e.g., the Neuroticism × Speed × Sex interaction was not significant, $p > .20$). We did not collect participant sex data in Studies 2 or 3, nor did we ask about ethnicity or age in any of the studies. In general, participants at this institution tend to be $90 + \%$ Caucasian and between the ages of 18 and 21.

Measures

Categorization tasks.   There were four categorization tasks in Study 1: me (e.g., *self*) versus not me (e.g., *them*), feminine (e.g., *gentle*) versus masculine (e.g., *rational*), vegetable (e.g., *broccoli*) versus fruit (e.g., *peach*), and unpleasant (e.g., *dirt*) versus pleasant (e.g., *smile*). Each

task was blocked such that participants performed it for multiple trials before moving onto the next task. There were 224 trials in all.

There were five tasks in Study 2 and these bore no overlap to those used in Study 1: animal (e.g., *dog*) versus not animal (e.g., *chair*), positive (e.g., *mother*) versus neutral (e.g., *carpet*), symptom (e.g., *aching*) versus not symptom (e.g., *mildew*), negative (e.g., *sweat*) versus neutral (e.g., *carrot*), and intense (e.g., *loud*) versus not intense (e.g., *quiet*). Tasks were blocked and there were 276 trials in all.

Study 3 had seven tasks: animal (e.g., *dog*) versus not animal (e.g., *chair*), unpleasant (e.g., *dirt*) versus pleasant (e.g., *smile*), blame (e.g., *crime*) versus no blame (e.g., *baldness*), threat (e.g., *knife*) versus no threat (e.g., *wrinkle*), positive (e.g., *mother*) versus neutral (e.g., *carpet*), intense (e.g., *loud*) versus not intense (e.g., *quiet*), and negative (e.g., *sweat*) versus neutral (e.g., *carpet*). There were 408 trials in all.

Within all blocks in all studies, participants were asked to press the 1 or 9 keys at the top of the keyboard as fast and accurately as possible in response to the stimulus and block at hand. In all blocks, category labels (e.g., feminine vs. masculine) remained on the screen to aid in the response-mapping process. Each trial began with a randomly selected word from the relevant block list. The word was presented centrally on the screen. If a person made a correct response, there was a 150 ms delay until the appearance of the next stimulus. If a person made an incorrect response, there was a 1500 ms error message.

Categorization speed.   To score categorization speed, we first dropped inaccurate trials (accuracy Ms = 95.50%, 94.62%, & 93.62% in Studies 1, 2, & 3, respectively). We then log-transformed the remaining trials to reduce the positive skew typical of reaction times. Subsequently, we replaced latencies 2.5 SDs below or above the grand latency mean for the particular study with these cutoff values (2.91%, 3.23%, & 2.94% of trials in Studies 1, 2, & 3, respectively). To score categorization speed, we then averaged across trials.

To determine whether categorization speed is a reliable individual difference variable, we then repeated the above procedures separately for odd and even trials of the categorization task, separately for each study. These independent assessments of categorization speed were very highly correlated, rs = .98, .93, and .96, ps < .01, in Studies 1, 2, and 3, respectively. Recall that participants performed different choice tasks (e.g., animal vs. not animal, etc.). We sought to determine the reliability of speed across different tasks. To do so, we first averaged speed within each task considered separately. We then performed a reliability analysis across these task speed scores. This alternative way of estimating reliability produced Cronbach's alphas of .89, .91, and .93 in Studies 1, 2, and 3,

respectively. In total, the reliability analyses indicate that speed is a very reliable individual difference variable.

Of final note, we assumed that individual differences in categorization speed would reflect skills rather than response biases (e.g., in favor of speed over accuracy). To examine our assumptions, we correlated the average speed of the individual with the average accuracy of the individual, separately in each study. Although there was some suggestion of a speed-accuracy tradeoff in Study 1 (i.e., faster speed and lower accuracy), $r = .34$, $p < .05$, there was no hint of such a tradeoff in Studies 2 or 3, $|r|s < .04$. Overall, then, participants who were faster were not less accurate, suggesting that speed taps encoding skills rather than response biases.

Neuroticism. In all studies, neuroticism was measured by Goldberg's (1999) short-form neuroticism scale. The scale involves characterizing the extent to which a series of statements indicative of high neuroticism (e.g., *worry about things*, *get upset easily*) generally characterize the self (1 = *very inaccurate*; 5 = *very accurate*). As reported by Goldberg, neuroticism scores based on this scale are reliable and valid and correlate highly with neuroticism scores based on the NEO-PI (Costa & McCrae, 1992). In the present studies, alphas were .89, .87, and .91 in Studies 1, 2, and 3, respectively.

Somatic symptoms. In all studies, participants were asked to indicate the extent to which a variety of somatic symptoms had caused them discomfort over the previous week (Studies 1 & 3) or past few weeks (Study 2). They used a 1 (*not at all*) to 4 (*extremely*) response scale to rate their experience of 11 somatic symptoms (e.g., *headaches*, *nausea or upset stomach*) in Studies 1 (alpha = .82) and 3 (alpha = .79). The symptoms were quite representative of those found on longer inventories such as the Pennebaker Inventory of Limbic Languidness (PILL: Pennebaker, 1982). The scale was basically identical in Study 2, except that the participants were given five response options (1 = *not at all*; 5 = *extremely*) and 14 symptoms (e.g., *aching*, *nauseous*; alpha = .80).

Procedures

The procedures in Studies 1 and 2 were identical. Participants first completed the categorization task. They then reported on their somatic symptoms and trait neuroticism, in that order. This implicit to explicit order has been recommended in the literature (Robinson & Neighbors, 2006).

Study 3 sought to extend the results by showing that the neuroticism × speed interaction can predict somatic symptoms in a prospective manner. Accordingly, Study 3 had two sessions. In an initial assessment

session, participants completed the categorization task and then reported on their levels of neuroticism. In a second assessment session, conducted several weeks later, participants reported on their somatic symptoms during the previous week.

Results

Correlations Among Predictors

We hypothesized that neuroticism and categorization speed would interact in predicting somatic symptoms. Before examining this hypothesis, we sought to determine whether there were any zero-order correlations between neuroticism and categorization speed. Such correlations tended to be small and not consistent across studies (Study 1: $r = .27$, $p < .05$; Study 2: $r = -.23$, $p < .10$; Study 3: $r = .01$, $p > .90$). The important point is that there did not appear to be any systematic relation between neuroticism and categorization speed.

Tests of Interactive Predictions

In each study, separately, we z-scored neuroticism and categorization speed and then computed an interaction term by multiplying these z scores. For each study, separately, we then performed a multiple regression predicting somatic symptoms on the basis of Neuroticism, Speed, and the Neuroticism × Speed interaction term (Aiken & West, 1991). We hypothesized that neuroticism would be particularly predictive of somatic symptoms among slow individuals, consistent with the idea of a "fill in" effect of trait neuroticism given poor encoding skills.

In Study 1, there was a marginal main effect for Neuroticism, $t = 1.90$, $p < .10$, $\beta = .25$, no main effect for Speed, $t = 1.52$, $p > .10$, $\beta = .19$, and a significant Neuroticism × Speed interaction, $t = 2.05$, $p < .05$, $\beta = .26$. In Study 2, there was no main effect for Neuroticism, $t = 1.50$, $p > .20$, $\beta = .22$, a main effect for Speed, $t = -2.16$, $p < .05$, $\beta = -.29$, and a significant Neuroticism × Speed interaction, $t = 2.29$, $p < .05$, $\beta = .33$. In Study 3, there was a main effect for Neuroticism, $t = 4.07$, $p < .01$, $\beta = .40$, no main effect for Speed, $t = -0.45$, $p > .65$, $\beta = -.04$, and a significant Neuroticism × Speed interaction, $t = 2.11$, $p < .05$, $\beta = .21$. In summary, neuroticism and categorization speed interacted in all three studies.

We hypothesized that neuroticism would better predict symptoms among slow (vs. fast) categorizers. To examine whether the data conformed to this pattern, we calculated estimated somatic symptom means for those low (-1 SD) and high ($+1$ SD) in neuroticism that were fast (-1 SD) or slow ($+1$ SD) in their categorization performance. These estimated means are displayed in Figure 1. As indicated by the figure, the results were parallel across studies in suggesting that neuroticism predicted somatic symptoms among slow, but not fast, categorizers.

To better document the finding that neuroticism was a more important predictor among slow (relative to fast) categorizers, we performed simple slopes analyses (Aiken & West, 1991). As suggested by Figure 1, neuroticism was not a predictor of somatic symptoms among fast (-1 SD) categorizers, $t = 0.06$, $p > .90$, $\beta = .01$ in Study 1, $t = -0.71$, $p > .45$, $\beta = -.11$ in Study 2, and $t = 1.15$, $p > .25$, $\beta = .16$ in Study 3. By contrast, neuroticism was a robust and significant predictor of somatic symptoms among slow ($+1$ SD) categorizers, $t = 3.29$, $p < .01$, $\beta = .48$ in Study 1, $t = 2.25$, $p < .05$, $\beta = .56$ in Study 2, and $t = 4.17$, $p < .01$, $\beta = .63$ in Study 3.

Discussion

To measure individual differences in the ability to make distinctions, we used choice reaction time tasks, which seem particularly suited to measure g or *fluid intelligence* (Jensen, 1998). We predicted that individuals with better encoding skills would report experiences that were less trait consistent. To provide a constant context for this prediction, we focused on the relation between neuroticism and somatic symptoms in three replication studies.

As predicted, neuroticism interacted with categorization speed in the prediction of somatic symptoms. Although neuroticism did not predict symptoms among individuals possessing superior encoding abilities, neuroticism did predict symptoms among individuals less capable of making distinctions among stimuli. Such results are consistent with the idea that trait neuroticism "fills in" when event-specific information is missing (Robinson & Clore, 2002a, 2002b). Such results also suggest that categorization speed appears to be an effective way of assessing the extent to which individuals can make distinctions among the events within their lives (Robinson, 2004).
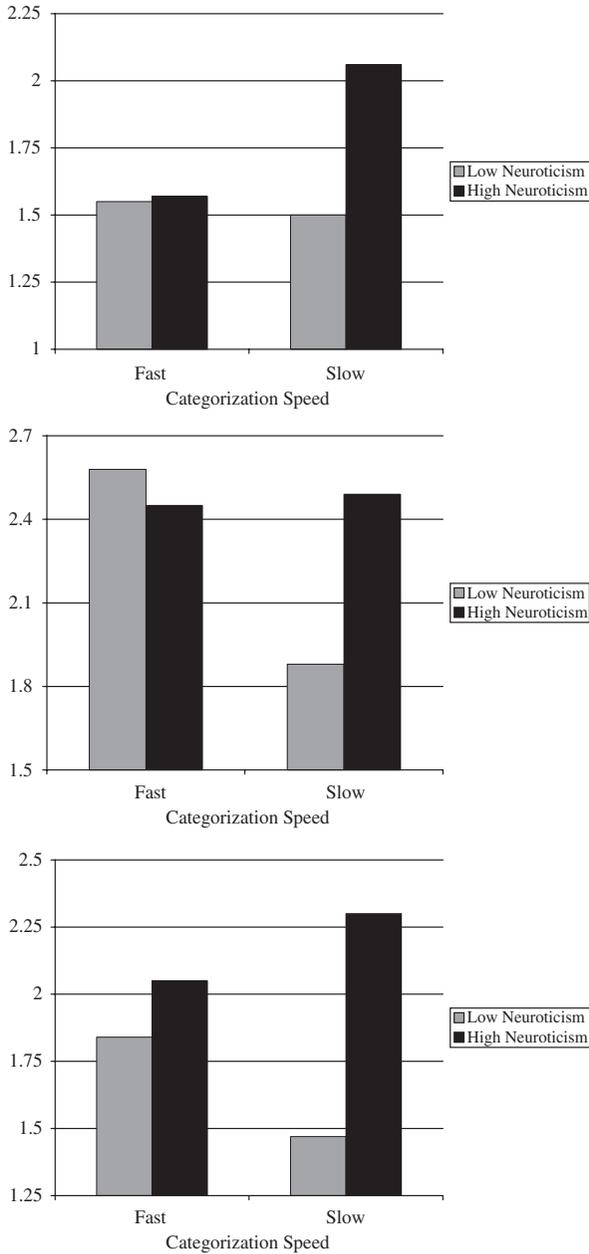
Figure 1
Estimated somatic symptom means for the neuroticism by categorization speed interaction, Studies 1 (top panel), 2 (middle panel), and 3 (bottom panel).

STUDY 4

Study 4 was designed to answer several questions not answered by Studies 1–3. First, the categorization tasks used in Studies 1–3 all involved words within the context of appraisal tasks broadly defined (Robinson, 2004). Study 4 therefore sought to change the nature of the task in support of the wider generality of the findings. In Study 4, participants completed a Stroop task in which they merely had to indicate whether particular letter strings were green or red in font color. Additionally, Study 4 also measured such performance at two times separately by 2+ weeks. This allowed us to make some conclusions concerning the test-retest stability of categorization speed.

Participants in Studies 1–3 were asked to retrospect on their experiences over the last week (Studies 1 & 3) or past few weeks (Study 2). It is therefore somewhat unknown whether the interaction found in Studies 1–3 is particular to retrospective time frames. To broaden the generality of our results, we used a different time frame in Study 4. Participants were asked to characterize their daily experiences for 15 days in a row. Because each daily report concerned a relatively circumscribed time frame—that is, the day in question—we could be relatively more sure that the present interactive effects pertained to shorter time frames than those examined in Studies 1–3.

Another goal of Study 4 was to examine different dependent measures than in Studies 1–3. Whereas Studies 1–3 concerned somatic symptoms, Study 4 asked individuals to characterize the frequency of their neuroticism-related behaviors (e.g., *criticized myself, worried about something*) as well as the intensity of their negative affect (e.g., the extent to which participants felt distressed or upset during a given day). A replication of the neuroticism × speed interaction in the context of these dependent measures would broaden the generality of our conclusions.

Method

Participants

Participants were 73 undergraduates from North Dakota State University. They received extra credit by their participation. Although we did not specifically collect age and ethnicity information, this undergraduate population is 90+% Caucasian, and the vast majority of the population is between the ages of 18 and 21.

The sample consisted of 19 males and 57 females. Sex did not correlate with any of the other variables in the study, $|r|s < .20$, $ps > .05$. In addition, sex did not modify our conclusions (e.g., there were no Neuroticism $\times$ Speed $\times$ Sex interactions, $ps > .30$). We therefore collapsed across participant sex.

Measures

Categorization task. Prior to and subsequent to the daily experience protocol, participants completed a standard Stroop task. They were asked to classify letter strings as green (1 key) or red (9 key) in font color. Stimuli for the task were created by crossing the three letter strings (*green*, *red*, and *xxx*) with the two font colors. There was a 500 ms blank delay in between trials and a 2000 ms error message in the case of incorrect responses. There were 252 trials in the task.

Categorization speed. Prior to scoring categorization speed, we deleted inaccurate trials (accuracy $Ms = 97.80\%$ & 96.64% at Times 1 & 2, respectively). We then log-transformed the reaction time distributions to reduce positive skew. Subsequent to this, we replaced log times that were 2.5 SDs below and above the grand latency mean with these cutoff values (2.74% and 2.76% at Times 1 and 2, respectively). We then averaged across trials to score categorization speed, separately for Times 1 and 2.

To estimate the reliability of categorization speed, we adopted two different approaches. First, we repeated the above procedures separately for odd and even trials of the task and then correlated these two independent assessments of categorization speed, $rs = .99$ & $.98$, at Times 1 and 2, respectively. Second, we calculated separate averaged speed scores for congruent (e.g., the word *green* in a green font color), incongruent (e.g., the word *red* in a green font color), and neutral (e.g., the string *xxx* in a green font color) trials. We then performed a reliability analysis by estimating Cronbach's alpha across the three trial types. Alphas were .98 and .97 at Times 1 and 2, respectively. Thus, individual differences in categorization speed were again very reliable.

We then examined whether there was any relation between categorization speed and categorization accuracy. Because there was not, either at Time 1, $r = .05$, or at Time 2, $r = -.04$, we generally concluded that there was no speed/accuracy tradeoff. In other words, categorization speed related to skills rather than to response biases in favor of speed.

Neuroticism. Neuroticism was measured by the same Goldberg (1999) scale also used in the first three studies (alpha = .86).

Daily dependent measures.   In the 15-day protocol, participants first indicated the frequency (1 = *0 times*; 2 = *1–3 times*; 3 = *4–6 times*; 4 = *7–9 times*; 5 = *10 or more times*) with which they had engaged in five neuroticism-related behaviors (*worried about something*, *criticized myself*, *was irritated at others*, *felt overwhelmed*, and *something stressed me out*). They also indicated the extent (1 = *very slightly or not at all*; 5 = *extremely*) to which they had felt five markers of negative affect (*distressed*, *irritable*, *nervous*, *afraid*, and *upset*) during the day in question. Behavior (alpha = .88) and negative affect (alpha = .90) scales were created by averaging across days and then across items.

Procedures

In the first assessment session, participants completed the Stroop task and then the measure of neuroticism, in that order. Subsequently, they performed the 15-day experience sampling protocol. The daily reports were completed by logging into a website after 8 p.m. each day. The daily report was quite short, thereby maximizing compliance rates. Indeed, the average participant completed 14.56 of the 15 daily reports (*M* compliance = 97.07%). Finally, following the completion of the protocol, they returned to the lab to complete a second (identical) Stroop task.

Results

Correlations

Recall that participants completed the same Stroop task twice, separated by 2+ weeks. Thus, we had two independent estimates of categorization speed. These independent estimates were correlated at $r = .63$, $p < .01$. Thus, categorization speed was a fairly stable individual difference variable. We therefore averaged across the two time frames. There was no correlation between neuroticism and categorization speed, $r = -.12$, $p > .25$. This comports with the general pattern in Studies 1–3.

Tests of Interactive Predictions

To test for potential interactions between neuroticism and categorization speed, we z-scored both and then computed an interaction term by multiplying these z scores. Neuroticism, Speed, and the Neuroticism × Speed interaction were simultaneously regressed in the prediction of each of the dependent measures.

In the prediction of daily neurotic behaviors, there was a main effect for Neuroticism, $t = 4.67$, $p < .01$, $\beta = .48$, no main effect for Speed, $t = 0.03$, $p > .95$, $\beta = .00$, and a significant Neuroticism × Speed interaction, $t = 2.00$, $p < .05$, $\beta = .21$. Similarly, in the prediction of daily negative affect, there was a main effect for Neuroticism, $t = 4.11$, $p < .01$, $\beta = .44$, no main effect for Speed, $t = 0.14$, $p > .85$, $\beta = .02$, and a significant Neuroticism × Speed interaction, $t = 2.16$, $p < .05$, $\beta = .24$.

To determine the nature of the significant Neuroticism × Speed interactions, we estimated means for individuals low ($-1\ SD$) and high ($+1\ SD$) in neuroticism and categorization speed, based on the regression equations. These estimated means, graphed in Figure 2, reveal that the interactions were parallel to those reported in Studies 1-3. Specifically, neuroticism was a stronger, if not exclusive, predictor of the dependent measures among individuals slow to categorize events in the Stroop task used in Study 4.

We therefore sought to follow up the significant interactions by performing simple slopes analyses among fast ($-1\ SD$) versus slow ($+1\ SD$) categorizers (Aiken & West, 1991). Among fast categorizers, neuroticism did not predict daily neurotic behavior, $t = 1.50$, $p > .10$, $\beta = .23$, or daily negative affect, $t = 1.01$, $p > .30$, $\beta = .16$. By contrast, among fast categorizers, trait neuroticism predicted both daily neurotic behavior, $t = 4.43$, $p < .01$, $\beta = .73$, and daily negative affect, $t = 4.19$, $p < .01$, $\beta = .71$. These results reinforce those of Studies 1–3 in suggesting that trait neuroticism effects are quite a bit stronger among slow (relative to fast) categorizers.

Discussion

Study 4 sought to replicate and extend the results reported in Studies 1–3. In terms of replication, Study 4, too, suggested that neuroticism and categorization speed interact and that the nature of this interaction favors neuroticism-related effects among slow categorizers. Of more importance, Study 4 suggests several extensions of this basic set of predictions. First, such interactive effects were found using a basic measure of font color classifications. Such results suggest that even relatively perceptual tasks are capable of assessing individual differences in discrimination abilities. We should note that this conclusion comports with research suggesting that relatively simple perceptual categorization tasks tend to correlate with intelligence (e.g.,
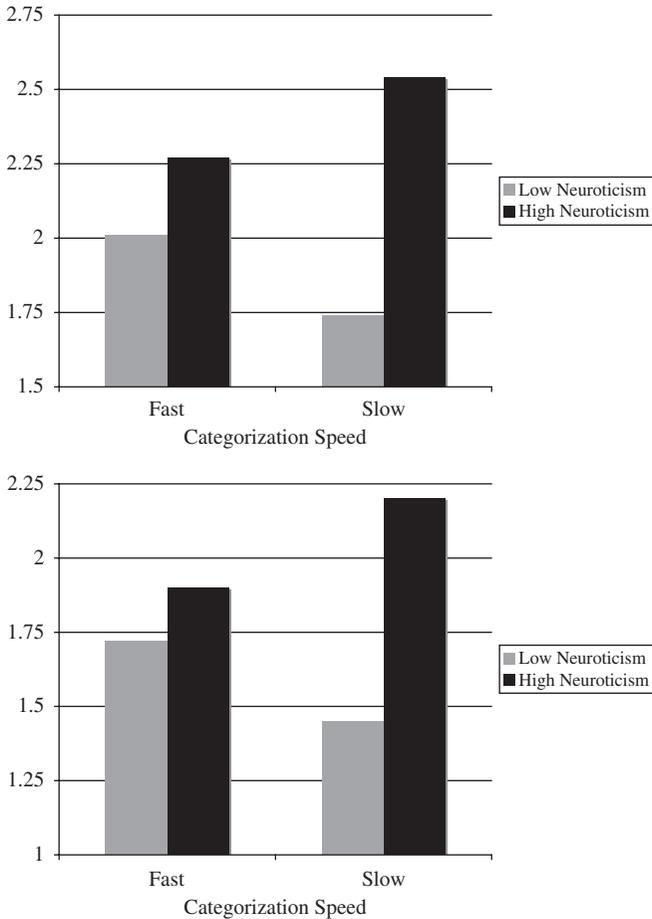
Figure 2

Estimated dependent measure means for the neuroticism by categorization speed interactions involving neurotic behaviors (top panel) and negative affect (bottom panel), Study 4.

as measured by the WAIS), to a surprisingly strong degree (Deary & Stough, 1996; Jensen, 1998). Such results of course highlight the manner in which individual differences in intelligence build upon basic differences discrimination abilities, even those associated with nearly 100% accuracy rates (Jensen, 1998). Second, the results of Study 4 indicate that categorization speed abilities are stable over time. This result provides further support for the examination of categorization speed as an individual difference variable (Baumeister, 1998; Jensen, 1998).

Third, we were able to replicate Neuroticism × Speed interactions in the context of an experience sampling protocol. Although even daily reports can be associated with some degree of memory-based distortion, such distortion tends to be rather minor in nature (Parkinson, Briner, Reynolds, & Totterdell, 1995; Robinson & Clore, 2002b). For this reason, we generally conclude that the present interactive pattern appears to characterize relatively online tendencies toward affect and behavior. Of course, such conclusions would be further, and perhaps more strongly, confirmed in experience-sampling protocols tapping momentary experiences (Conner, Barrett, Bliss-Moreau, Lebo, & Kaschub, 2003). Fourth, Study 4 suggests that the present interactive pattern characterizes behaviors and emotional experiences in addition to somatic symptom reports (Studies 1–3). Study 4 is therefore important in adding to the generality of the present interactive predictions.

GENERAL DISCUSSION

It is one thing to propose that correlations between traits and trait-relevant dependent measures are rarely large (Pervin, 1994; Robinson & Clore, 2002a). It is another to provide a principled, data-driven account of the manner in which trait/state relations are reinforced. The present four studies sought to do so. Specifically, we reasoned that individuals differ in their capacities to make distinctions in momentary experience and that such individual differences could be measured in terms of categorization speed. We suggest that fast categorizers are capable of making more and more rapid distinctions among their everyday experiences, whereas slow categorizers are less capable of doing so.

We then followed our prior work (e.g., Robinson, Solberg, et al., 2003; Robinson, Vargas, et al., 2003) in predicting that traits would be particularly consequential among individuals less capable of making rapid distinctions at encoding. We investigated such predictions in the context of correlations between neuroticism and neuroticism-relevant outcome variables. Studies 1–3 provided consistent evidence for the idea that the neuroticism/symptom relationship appears to be somewhat distinct to individuals who have difficulties parsing their momentary experiences, as inferred by their slow categorization performance. Study 4 extended this perspective with respect to more

"online" tendencies toward neuroticism-consistent behaviors and emotions. Overall, the present findings are novel in suggesting that neuroticism is more consequential to the extent that the person is relatively less capable of appreciating distinctions at encoding. The results have multiple implications, as discussed below.

The Psychological Significance of Categorization Speed

Prior work within our lab has suggested that choice reaction time tasks are quite useful in examining individual differences in emotional appraisal (e.g., Robinson, 2004) and self-regulation (e.g., Robinson & Cervone, 2006). However, our prior work using choice reaction time tasks has tended to focus on construct-specific categorization skills (e.g., related to blame—e.g., Meier & Robinson, 2004). Prior work has suggested that task-specific categorization performance is reliable (e.g., Robinson, Vargas, Tamir, & Solberg, 2004) and somewhat stable over time (e.g., Robinson, Solberg, et al., 2003). However, prior work has also suggested that some individuals are fast, whereas others are slow, regardless of the task under consideration (e.g., Robinson & Oishi, 2006). Indeed, in the latter connection, we found that categorization performance, considered across diverse tasks, was quite reliable, split-half rs = .93–.98. Such internal reliability coefficients point to a general speed factor, regardless of the task at hand.

In this connection, research has suggested that speed of categorization performance loads onto a g factor in intelligence research (Baumeister, 1998; Jensen, 1998). That is, despite wide variations in task parameters, individuals who tend to be fast (slow) in one task tend to be fast (slow) in another task as well. With respect to the origins of such abilities, researchers have focused on genetic contributions, the speed of neural transmission, and lack of noise in information processing (Baumeister, 1998; Jensen, 1998). Such psychometric work is somewhat persuasive in pointing to general abilities related to categorization speed. However, the psychosocial consequences of such individual differences have remained largely unexplored. We suggest that psychometric g, as assessed by reaction time tasks, may in part tap encoding abilities, defined as those responsible for assigning meaning to events as they occur.

This general proposal (i.e., fast categorization = better encoding abilities) has some very interesting implications that are worth

examining in future studies. For example, fast categorizers may be more capable of distinguishing among tastes, smells, and other sensations that differ from stimulus to stimulus (e.g., different perfumes, jams, wines, etc.). Such discrimination abilities have been linked to low levels of alexithymia (Lane, Ahern, Schwartz, & Kaszniak, 1997). In the domain of emotional intelligence, also, some work has suggested that more precise distinctions should necessarily translate into more sophisticated and useful emotion knowledge (Barrett, Gross, Conner, & Benvenuto, 2001). We therefore suggest, but did not demonstrate, that individual differences in categorization speed should correlate with individual differences in discrimination and coping abilities more broadly defined.

Finally, it may also be interesting to consider the current findings in light of bottom-up and top-down views of personality (Cervone, 1997). Bottom-up views of personality emphasize the manner in which global personality dispositions—say, related to neuroticism— are built upon more specific information-processing operations involving interactions with particular situations and stimuli. Top-down views of personality, by contrast, emphasize the manner in which global personality dispositions exert broad effects on motivation, self-report, and behavior. It is common to assume that both sorts of models of personality are viable but difficult to integrate with each other (Cervone, 1997). The present framework offers some considerable promise here. It appears, given the present results, that fast categorizers make judgments in a bottom-up manner, whereas slow categorizers make such judgments in a top-down manner. Therefore, the current work may represent at least an initial step in integrating social cognitive and trait views of personality into a common framework (see also Robinson & Cervone, 2006; Robinson, Solberg, et al., 2003).

Neuroticism, Distress, and Encoding

Borkovec et al. (1998) provide a penetrating analysis of individual differences in worry (e.g., as occurs in Generalized Anxiety Disorder). Because worry is a central, if not *the* central, feature of high levels of neuroticism (Watson & Clark, 1984), this analysis has quite a bit of relevance for considering how neuroticism functions. In worry, the individual focuses attention on repetitive personal concerns, many of which are unrealistic and out of place with respect to

actual life events. Rather than enjoying one's family, for example, the worrier becomes concerned about the possibility that one's family may be harmed in some unforeseen, as-yet-to-occur manner (MacLeod, 1999). Two aspects of this repetitive future focus are problematic. One, in focusing on future events rather than present ones, the individual literally loses touch with reality, which can be defined in terms of events as they occur. Two, in focusing on negative possibilities, the individual perpetuates, rather than successfully averts, the broad tendencies toward negativity that are characteristic of worry as well as high levels of neuroticism (Wells & Matthews, 1996; Williams, Watts, MacLeod, & Mathews, 1997).

Borkovec et al.'s (1998) analysis of worry has systematic treatment implications that are really quite simple. Rather than allowing the worrier to focus on future events, the worrier should instead be encouraged and trained to focus on present reality. This suggestion fits with a number of other strands of theory. For example, Segal et al. (2004) have focused on the beneficial effects of mindfulness training on preventing depression relapse. Mindfulness is a Buddhist concept most closely linked to a focus on what is happening in the present (rather than what happened in the past or will happen in the future; see Brown & Ryan, 2003, for a psychological perspective). Relatedly, quite a few ''humanistic-existential'' therapies such as those of Glaser (1965) or Rogers (1954) attempt, through one set of means or another, to bring awareness to present reality (rather than one's inner fantasy life, which distorts reality).

The present results, too, suggest that a focus on current occurrences, characteristic of fast categorizers, is psychologically beneficial within the context of high levels of neuroticism. Interestingly, however, the present findings also suggest that a focus on current occurrences may increase experiences of distress among individuals low in neuroticism. From this perspective, a focus on present events is an ''equalizer.'' Prior theory helps to contextualize this ''equalizing'' effect. Specifically, given that there is a trade off between event-specific and generalized self-knowledge (Robinson & Clore, 2002a, 2002b), a focus on specific events will tend to minimize the influence of trait-linked self-knowledge, whether such self-knowledge is neurotic or nonneurotic in nature (see also Robinson, Goetz, Wilkowski, & Hoffman, 2006; Robinson, Wilkowski, Kirkeby, et al., 2006; Robinson, Wilkowski, & Meier, 2006). Given that individuals seeking psychotherapy tend to be high in neuroticism (Widiger,

Verheul, & van den Brink, 1999), a focus on present occurrences can be generally recommended among such individuals (Borkovec et al., 1998; Segal et al., 2004).

Although a focus on present occurrences appears to be beneficial at high levels of neuroticism (Germer et al., 2005; Hayes et al., 2004), it is also worth pointing out the potential differences between the present categorization speed measure and the types of therapeutic techniques used to promote mindfulness and acceptance (Germer et al., 2005; Hayes et al., 2004). We trained neither attention nor awareness, but rather measured encoding skills in a task that might reflect genetically determined abilities (i.e., *g*: Luciano et al., 2001). Therefore, the link between the present data and therapeutic techniques such as mindfulness practice must be somewhat speculative. Nevertheless, it is also worth pointing out that the largest predictor of categorization performance is practice (Pashler, 1998; Sanders, 1998). Furthermore, practice is viewed as the most important contributor to mindfulness-related skills (Germer et al., 2005; Segal, Williams, & Teasdale, 2002). Therefore, it may be that discrimination skills, even of a reaction-time variety, can be trained that that such training would be useful in alleviating neuroticism-linked distress. We necessarily leave this prediction to future research.

Limitations and Future Directions

In the present studies, we focused on only one trait and its associated outcomes. This tight empirical focus allowed us to offer more consistent evidence in favor of a particular sort of interactive relation. However, this consistent focus also raises questions concerning whether other foci, e.g., related to the trait of agreeableness and recent behaviors of a prosocial nature, would yield parallel findings. We suspect that categorization speed would somewhat generally moderate trait-relevant outcomes regardless of the trait and outcomes in question. Indeed, Robinson and Oishi (2006) recently reported similar results in the context of relations between extraversion and life satisfaction. However, a wider consideration of other traits and outcomes is warranted.

Additionally, it should be mentioned that the two-process theory (Robinson & Clore, 2002a, 2002b) that guided the present results is fundamentally concerned with contributions to self-reports of experience, but not centrally with issues concerning the veridicality of

such self-reports. Presumably, people's general (e.g., trait-related) views of themselves have some basis in the reality of their experiences. That is, it seems reasonable to assume that self-beliefs are, in part, built upon one's specific experiences over time (Klein & Loftus, 1993; Robinson & Clore, 2002b). Still, however, generalized beliefs about the self gain some independence from more momentary sources of information, rendering it entirely possible that such generalized self-beliefs, over time, fall out of contact with the reality of one's daily life (Conway & Pleydell-Pearce, 2000; Klein & Loftus, 1993; Marsh & Yeung, 1998). The present results, while not directly focused on this issue, are at least somewhat consistent with the general idea that bottom-up and top-down sorts of self-reports can be quite distinct from each other (Barrett et al., 1998; Oishi, 2002; Robinson & Clore, 2002b).

Conclusions

The present research sought to integrate trait and social cognition views of the self. From a trait-related perspective, we expected neuroticism to influence reports of somatic symptoms, neurotic behaviors, and negative affect. From a social cognition perspective, we thought that such trait-infusion effects might be less pronounced among individuals better able to discriminate among events within choice reaction time tasks. As predicted, neuroticism and categorization speed interacted to predict the dependent measures. Of particular importance, trait neuroticism effects were specific to individuals less capable of discriminating events in their choice reaction time performance. Such data suggest that trait neuroticism biases experience and behavior when encoding skills are poor. In other words, the results are consistent with a top-down theory of neuroticism-related influences (Robinson & Clore, 2002a).

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