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Routine Cognitive Errors:

A Trait-Like Predictor of Individual Differences in Anxiety and Distress

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Abstract

Five studies (N = 361) sought to model a class of errors – namely, those in routine tasks – that several literatures have suggested may predispose individuals to higher levels of emotional distress. Individual differences in error frequency were assessed in choice reaction time tasks of a routine cognitive type. In Study 1, it was found that tendencies toward error in such tasks exhibit trait-like stability over time. In Study 3, it was found that tendencies toward error exhibit trait-like consistency across different tasks. Higher error frequency, in turn, predicted higher levels of negative affect, general distress symptoms, displayed levels of negative emotion during an interview, and momentary experiences of negative emotion in daily life (Studies 2-5). In all cases, such predictive relations remained significant with individual differences in neuroticism controlled. The results thus converge on the idea that error frequency in simple cognitive tasks is a significant and consequential predictor of emotional distress in everyday life. The results are novel, but discussed within the context of the wider literatures that informed them.

Keywords: Individual Differences, Cognition, Performance, Error, Negative Emotion

Routine Cognitive Errors:

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Early personality theorists, including Allport (1937), Cattell (1950) Eysenck (1947), and McClelland (1951), were encompassing in their assessment of personality tendencies. Self-reported personality traits, particularly toward anxiety, were considered to provide insight into individual differences in emotion and behavior. However, behaviors exhibited following experimental manipulations (Eysenck), fantasy-based reports of a projective type (McClelland), and cognitive processing tendencies (Cattell), were also considered to provide important information concerning the individual. This encompassing approach to personality assessment has arguably been replaced with a much narrower one defining personality in self-reported terms, to the potential cost of the field (Pervin, 1994).

To be sure, self-reported personality tendencies certainly do predict consequential outcomes (Ozer & Benet-Martinez, 2006). On the other hand, we suggest here, as elsewhere (e.g., Robinson, 2004; Robinson & Neighbors, 2006), that significant insights concerning individual difference in emotion can be obtained using implicit cognitive methods as well (also see Asendorpf, Banse, & Mücke, 2002; Schmukle & Egloff, 2005). In this context, the present studies pursue the idea that routine cognitive errors should afford significant insights into individual differences in anxiety and distress, quite aside from potential relationships involving the self-reported trait of neuroticism.

Broad Theoretical Considerations

Negative outcomes are the strongest predictor of negative emotions (Frijda, 1992; Smith & Ellsworth, 1985). Some negative outcomes may be entirely exogenous occurrences, uncaused

in any manner by the individual. Included in this category of events are earthquakes, congenital childhood diseases, and being in an accident due to the negligence of a drunk driver. Other negative outcomes might seem to be of exogenous origin, but not be entirely so. For example, although it is undoubtedly true that a relationship breakup is an objective outcome (and thus an exogenous event by some definitions), there are good reasons for thinking that individuals contribute to such breakups by their own problematic behaviors (Gottman & Driver, 2005; Smith, Glazer, Ruiz, & Gallo, 2004). Similarly, a student receiving a poor grade is typically responsible for it in some way, though poor instruction or arbitrary grading practices could potentially be involved as well (Greenwald, 1997).

Negative outcomes of a third type are endogenous in origin. Outcomes of this type are not due to one's unlucky fate, but rather are directly due to errors made by the self and the negative consequences that follow from them. Included in this category would be yelling at relationship partners to the detriment of the relationship (Wilkowski & Robinson, 2008), engaging in addictive behaviors despite their negative consequences (Wiers & Stacy, 2006), or engaging in behaviors that are likely to be generally problematic to successful functioning in multiple realms (Mischel & Ayduk, 2004). Baumeister and colleagues (e.g., Baumeister, Muraven, & Tice, 2000) have generally suggested that negative outcomes of this self-caused type occur to the extent that the self's resources are depleted, but Robinson, Schmeichel, and Inzlicht (in press) made a case for the idea that simpler cognitive failings often underlie more molar tendencies toward "self-regulation failure". In the present studies, we investigate one such simpler cognitive mechanism that should differentially predispose individuals to negative outcomes of an endogenous type and to negative emotional experiences for this reason.

Specific Theoretical Considerations

On the basis of a careful analysis of consequential errors observed in industrial settings, Rasmussen (1986) concluded that such errors were of three types – skill-based, rule-based, or knowledge-based. Reason (1990) extended this framework by linking it to cognitive processing considerations and to errors commonly exhibited in everyday life. Of most importance to the present hypotheses, skill-based errors are those of the most automatic type. Such errors are proposed to happen when tasks are mundane, relevant skills are high, and routine processing decisions are involved.

Rasmussen (1986) and Reason (1990) were primarily interested in errors of a normative type – i.e., due to momentary conditions rather than individual difference variables. However, skill-based errors may be relevant to understanding individual differences as well. Broadbent, Cooper, FitzGerald, and Parkes (1982) created a self-report scale seeking to capture individual differences in cognitive failures of a routine, automatic type (e.g., "Do you daydream when you ought to be listening to something?"). They found that self-reported cognitive failures of this routine type were reliable and predicted higher levels self-reported distress. However, a subsequent investigation (as well as many others reviewed) concluded that there was little evidence for the idea that self-reported cognitive failures predicted the cognitive outcomes that they should predict (Broadbent, Broadbent, & Jones, 1986). Similar conclusions can be made in terms of a more recent literature seeking to link low levels of dispositional mindfulness (e.g., "I do jobs or tasks automatically, without being aware of what I'm doing") to relevant cognitive performance tendencies (Brown, Ryan, & Creswell, 2007).

Generally speaking, self-reported and implicit measures of processing tendencies rarely correlate with each other (Asdendopf et al., 2002; Robinson, 2004; Robinson & Neighbors, 2006). For this reason, it can be hazardous to use any self-report scale to index cognitive

processes, particularly to the extent that automatic processing tendencies are posited (Bornstein, 2001; McClelland, 1987; Robinson & Compton, 2008). Accordingly, we sought to bypass self-reports of routine cognitive errors by assessing them directly.

Overview of Studies

Five studies were conducted. In all of them, cognitive errors were assessed in terms of error frequency within basic choice reaction time tasks. In all cases, the tasks were easy, simple, and errors were of little consequence to the individual. We did not force fast reactions and thus the relevant error rates should be viewed as of an unforced, endogenous type. However, we did provide error feedback to insure an investment in being accurate.

Errors in simple choice reaction time tasks are typically deleted (Robinson, 2007a). Perhaps because of this reason, we know of no studies that have sought to examine whether error rates in such tasks are stable over time. Study 1 examined this question and we hypothesized that individuals would exhibit trait-like levels of stability in their error rates. Study 3 examined a related question, namely whether tendencies toward cognitive errors would exhibit some degree of consistency across different relatively easy cognitive tasks. We hypothesized at least moderate correlations of this type, consistent with a trait-like tendency.

Studies 2-5 examined whether individuals making more frequent errors in such tasks would also be prone to more intense experiences of negative emotion. Diverse assessments of negative emotion were obtained in support of this hypothesis. Trait levels of neuroticism were assessed in these studies as well. To the extent that our results involve basic cognitive tendencies, they may remain significant with levels of trait neuroticism statistically controlled.

Study 1: Test-Retest Stability

Performance-based assessments of the individual have often suffered from low levels of reliability in both historical (McClelland, 1987) and modern (Fazio & Olson, 2003) terms. On the other hand, it was our intuition that individual differences in routine cognitive errors would be reliable, perhaps more so than other performance-based assessments of a cognitive type (for a review, see Robinson & Neighbors, 2006). To support this potential point, we conducted an initial study examining the test-retest stability of such tendencies to make unforced errors.

This said, there is no specific task that would be definitive in assessing individual difference tendencies toward routine cognitive errors. The Study 1 task, and its blocks and stimuli, had been used in previous studies of ours. Further analyses had indicated that all stimuli were unambiguous in that they were associated with high normative accuracy rates of classification (e.g., Robinson, Goetz, Wilkowski, & Hoffman, 2006). Thus, the Study 1 task seemed as good a one as any to start with. Importantly so, though, different choice tasks were administered across studies to support more general conclusions.

Method

Participants

Ninety-three (61 female) undergraduates from the University of Illinois-Champaign received extra credit for their participation.

Individual Differences in Routine Error Frequency

Overview. Routine errors were assessed in choice categorization tasks in Study 1 and in all subsequent studies as well. Choice tasks of this type are common to the cognitive literature (Pashler, 1998) and to our research program on cognitive approaches to personality assessment (e.g., Robinson, 2004). Participants were to categorize presented stimuli by responding with one of two response keys as accurately and quickly as they could.

Task. We sought to assess individual difference in commission errors in general terms rather than those that might be specific to a given choice distinction. A useful assessment strategy of this type is to ask individuals to complete multiple choice categorization blocks and average performance across them (Robinson & Oishi, 2006). Accordingly, individuals in Study 1 were asked to categorize presented stimuli across seven distinct consecutive blocks: not animal (e.g., *chair*) versus animal (e.g., *mouse*) words, unpleasant (e.g., *snake*) versus pleasant (e.g., *smile*) words, not blame (e.g., *worm*) versus blame (e.g., *crime*) words, not threat (e.g., *mildew*) versus threat (e.g., *cancer*) words, neutral (e.g., *coffee*) versus pleasant (e.g., *flower*) words, not intense (e.g., *quiet*) versus intense (e.g., *loud*) words, and neutral (e.g., *basket*) versus negative (e.g., *toilet*) words. These stimuli and blocks have been previously validated (e.g., Robinson et al., 2006) and there were 408 total trials.

In all choice blocks, participants were asked to press the 1 key at the top of the keyboard for the first category mentioned above (e.g., *chair*), but to press the 9 key at the top of the keyboard for the second category mentioned above (e.g., *mouse*). In all blocks, category labels were presented toward the left and right of the computer screen to aid in the response-mapping process for the particular block. All trials started with a 150 ms blank delay, following which a particular stimulus was randomly selected and centrally displayed. Participants were given as long as desired to respond to the trial, following which the trial stimulus was removed. To guard against trading speed for accuracy, inaccurate responses were penalized with a 1500 ms error message. Reaction time data will be reported to evaluate the effectiveness of our cognitive assessment in guarding against speed-accuracy tradeoffs.

Procedures

We sought to show that individual differences in routine cognitive error frequency are stable over time. Accordingly, participants completed the choice categorization task described above twice, with a one-month interim interval. For both assessments, the categorization task was completed in semi-private cubicles, on personal computer, in groups of less than seven.

Preliminary Considerations

The categorization tasks were relatively easy, as should be the case in modeling routine errors (Broadbent et al., 1982). Error rates averaged 5.91% at time 1 and 6.38% at time 2. To quantify speed for the purpose of assessing possible speed-accuracy tradeoffs, we deleted inaccurate trials, log-transformed millisecond scores to reduce skew, and then replaced 2.5 *SD* log-latency outliers with these outlier cutoff scores (Robinson, 2007a). Average speed was then calculated across trials.

Results

Possible Speed-Accuracy Tradeoff

Individuals may commit more errors because they favor speed over accuracy. However, we used procedures to guard against such speed-accuracy tradeoffs. Such procedures were successful as the correlation between error rates and processing speed was non-significant in the present study, both at time 1, $r = -.11$, $p > .20$, and at time 2, $r = -.01$, $p > .90$.

Test-Retest Stability

Tendencies toward erroneous responding were hypothesized to be stable over time, consistent with an individual differences perspective. This proved to be the case as individuals who were more prone to making routine cognitive errors at time 1 were also more prone to make them at time 2 as well, $r = .72$, $p < .01$.

Discussion

The reliability of cognitive (Robinson, 2007a) and social cognitive (Fazio & Olson, 2003) implicit measures is often low. This was not the case for the present implicit cognitive measure, which proved to be quite stable over time. For this reason, individual differences in such errors may have considerable utility in understanding outcomes thought to result from slips and lapses of a routine type (Reason, 1990).

Study 2: Routine Error Frequency as a Predictor of Negative Emotion

Errors are frustrating and costly to goal-pursuit success (Robinson et al., in press) and therefore a major hypothesized contributor to negative emotion (Mischel & Ayduk, 2004). For this reason, we conducted an initial study seeking to determine whether greater error frequencies in a cognitive task would predict higher levels of negative emotion. Broadbent et al. (1982) had proposed relationships of this type. Importantly, though, we assess errors objectively and therefore can make more definitive conclusions concerning the cognitive nature of this relationship. For the sake of discriminant validity, experiences of positive emotion and the trait of neuroticism were also assessed.

Method

Participants

Participants were 54 (43 female) undergraduates from the University of Illinois-Champaign receiving extra credit.

Individual Differences in Routine Error Frequency

Study 2, like Study 1, used a choice reaction time task to assess tendencies toward routine cognitive error. Four consecutive blocks required individuals to categorize presented stimuli according the following distinctions: not me (e.g., *them*) versus me (e.g., *me*) words, feminine (e.g., *kind*) versus masculine (e.g., *strong*) words, vegetable (e.g., *carrot*) versus fruit (e.g.,

cherry) words, and unpleasant (e.g., *jail*) versus pleasant (e.g., *smile*) words. Other details of the assessment were identical to Study 1 except that 224 trials were involved. The average rate of choice errors was 4.50%.

Negative and Positive Emotional Experiences

Participants were asked to indicate the extent (1 = very slightly or not at all; 5 = extremely) to which they had experienced five markers of negative affect (*distressed*, *hostile*, *irritable*, *jittery*, & *nervous*; *M* = 2.11; alpha = .79) during the past week. For purposes of discriminant validity, we also assessed experiences of positive affect during the same one-week period (*determined*, *enthusiastic*, *excited*, *interested*, & *strong*; *M* = 3.14; alpha = .76). Such markers are a subset of items from the Watson, Clark, and Tellegen (1988) PANAS scales, chosen on the basis of item-total correlations (Brown & Marshall, 2001). Levels of positive and negative emotion were independent, $r = 0$.

Neuroticism

Neuroticism was assessed by Goldberg's (1999) 10-item broad-bandwidth scale, which correlates very highly with alternate measures of neuroticism such as that from the NEO-PI (Costa & McCrae, 1992; John & Srivastava, 1999). Goldberg's scale asks individuals to rate the extent to which they agree (1 = very inaccurate; 5 = very accurate) that statements reflecting low (e.g., *seldom feel blue*) and high (e.g., *worry about things*) levels of neuroticism generally characterize the self, with the former items reverse-scored (*M* = 2.93; alpha = .89).

Procedures

Participants completed the measures on a personal computer in groups of 2-6. The cognitive task was completed first. Subsequently, participants reported on their trait tendencies toward negative and positive affect. Finally, neuroticism was assessed. This order of measures

insures that cognitive measures, likely the most malleable, are assessed first and trait measures, likely the least malleable, are assessed last (Robinson & Neighbors, 2006).

Results

Possible Speed-Accuracy Tradeoff

In Study 2, error frequency was a negative predictor of average reaction time, $r = -.34$, $p < .05$, such that those prone to cognitive errors performed the task more quickly. This result is likely anomalous given that there were no relations of this type in Study 1. Regardless, it was deemed useful to control for processing speed, which we did in analyses reported below.

Primary Results

As hypothesized, individuals displaying more routine cognitive errors also reported higher levels of negative affect, $r = .32$, $p < .05$. On the other hand, there was no such relationship between routine cognitive errors and positive emotional experiences, $r = .06$, $p > .65$. Such differential results are likely due to the specific link of problematic occurrences to negative rather than positive affective experiences (Watson, 2000).

Individuals displaying more routine cognitive errors also completed the categorization task more quickly, a result not obtained in other studies. In any case, it seemed desirable to control for processing speed in a multiple regression. Error frequency continued to predict negative affect with processing speed controlled, $t = 2.71$, $p < .01$, Beta = .37. Processing speed was a non-significant predictor in this same multiple regression, $t = 1.33$, $p > .15$, Beta = .18. Thus, greater tendencies toward inaccurate responses predicted higher levels of negative emotion, but faster processing speed did not.

Results Involving Neuroticism

Neuroticism was a non-significant predictor of error frequency, $r = .06$, $p > .65$. On the other hand, as might be expected, neuroticism was a robust predictor of individual differences in negative affect, $r = .39$, $p < .01$. Thus, it appears that error frequency and neuroticism *independently* predict negative emotional experiences. This point was confirmed in a multiple regression in which it was found that both neuroticism, $t = 2.91$, $p < .01$, Beta = .36, and tendencies toward routine cognitive error, $t = 2.20$, $p < .05$, Beta = .27, were significant predictors of negative affect when simultaneously controlled.

Discussion

Skill-based errors have been implicated in genesis of negative affect in the individual difference literature on cognitive failures (Broadbent et al., 1982) and, more recently, in the literature on mindfulness (Brown & Ryan, 2003). However, attempts to link self-reports of cognitive failures (Broadbent et al., 1986) and mindfulness (Brown et al., 2007) to relevant cognitive tendencies have rarely yielded dividends. Accordingly, we sought to bypass self-reported tendencies toward routine cognitive errors, instead defining them in objective terms that would seem more conducive to their assessment (Pashler, 1998; Reason, 1990).

Consistent with hypotheses, we found that individuals prone to make erroneous categorizations in a cognitive task were also those prone to negative emotional experiences. This relationship makes intuitive sense because error-prone processing should predict problematic outcomes in everyday life, in turn predicting the negative sorts of reactions that result from them (Frijda, 1992; Lazarus, 1991; Smith & Ellsworth, 1985). However, the present results are entirely novel to the cognition-emotion literature and noteworthy for this reason.

Of further importance, discriminant validity was established in three ways. When controlling for processing speed, individual differences in routine cognitive errors continued to

predict negative emotional experiences. Results cannot therefore be ascribed to speed-accuracy tradeoffs likely to differ between individuals. In addition, we were able to support the point that tendencies toward routine cognitive errors predicted negative emotional experience, but not positive emotional experiences, consistent with Watson's (2000) general analysis. Finally, the error-negative affect relation remained significant with trait levels of neuroticism controlled.

We hasten to add, in the latter connection, that neuroticism was a significant predictor of negative emotional experiences as well. Thus, our findings in no way dispute the robust tendency for the trait of neuroticism to predict negative emotions and symptoms (Clark & Watson, 1999). Rather, they suggest that cognitive assessments of the individual are likely to have considerable explanatory value and predictive validity quite independent of people's conscious (i.e., self-reported) views of themselves (Robinson & Compton, 2008).

Study 3: Replication and Extensions

In comparison to Studies 1 and 2, the cognitive task used in Study 3 was even more basic in nature, involving a color-word Stroop task (MacLeod, 1991). We hypothesized that individual differences in error frequency in the task would predict higher levels of negative emotion, as in Study 2. In contrast to Study 2, though, a full set of PANAS markers (Watson et al., 1988) was used. As in Study 2, we also assessed trait levels of neuroticism as well.

We suggest that routine cognitive errors constitute a trait-like tendency that varies between individuals. Study 1 supported one classic criterion of a trait-like tendency in that routine cognitive errors were very stable over time. Study 3 sought to examine the other classic criterion of a trait-like tendency, namely consistency across different assessment contexts or stimulus conditions (Diener & Larsen, 1984). Toward this end, we assessed routine cognitive errors in three cognitive tasks, each varying somewhat dramatically in the stimuli, procedures,

and response requirements involved (see below). If there is a trait-like tendency toward routine cognitive errors, we would expect at least moderate correlations of error frequency across the three tasks.

Method

Participants

Participants were 41 (38 female) participants from the University of Illinois-Champaign who received extra credit.

Individual Differences in Routine Error Frequency

The primary assessment of routine error frequency was a choice task, as in Studies 1 and 2. However, for purposes of replication, it was deemed useful to use a more basic choice task than that previously used. Toward this end, a color-word Stroop task was used. In it, there were six stimuli involved, which crossed three letter strings ("green", "red", & "xxx") with two font colors (green versus red). If the letter string was green (red), participants were to respond with the 1 (9) keys at the top of the keyboard. Stimuli were randomly selected for individual trials, presented at center screen, and there were 252 trials in total. Correct responses were followed by a 500 ms blank delay, whereas incorrect responses received a 2000 ms visual error message. The average error rate was 3.51%. Response speed was scored as in Studies 1 and 2.

Commission Errors in a Cueing Task

In addition to the primary assessment task, a version of Posner's (1980) cueing task was also administered. Participants were instructed to press the spacebar as soon as a white X was presented. We informed participants that the vast majority of trials would present such a white X stimulus, but that a minority of trials would not present such a target. For the latter set of trials (60 of 240), participants were instructed to refrain from responding. It is especially easy to

refrain from responding on such "catch" trials. Indeed, error rates for such trials were quite low (*M* = 1.67%). Nevertheless, we predicted that tendencies toward routine cognitive errors in the primary task would predict higher rates of responding to such "catch" trials. In the language of Reason (1990), higher error rates in this task would constitute action slips – i.e., responding when one should not do so.

Errors Exhibited in a Sustained Attention Task

A sustained attention task was also administered. In this 8-minute task, consecutive single digit stimuli were presented for 300, 300, and 600 ms, respectively. If all three consecutive stimuli were odd, or all were even, participants were instructed to press the spacebar. For other trials in which there was a mix of odd and even digits, participants were instructed to refrain from pressing the spacebar. The task strained abilities to sustain attention, particularly so because only 40 of the 240 trials required pressing the spacebar and no accuracy feedback was provided. Tendencies toward error in this task are of both commission and omission types and therefore an overall error rate score was computed, separately so for each participant (*M* = 14.18%). In the language of Reason (1990), higher error rates in this task would primarily constitute lapses of attention – i.e., failing to respond when one should do so.

Negative Affect and Neuroticism

Individual differences in positive and negative emotions were assessed by the 20 markers of the PANAS (Watson et al., 1988). Specifically, participants reported on the extent (1 = very slightly or not at all; 5 = extremely) to which they had experienced ten negative emotions (e.g., *afraid*, *upset*; *M* = 2.15; alpha = .87) and ten positive emotions (e.g., *active*, *proud*; *M* = 3.44; alpha = .91) during the last month. The positive and negative emotion scales were not

significantly correlated, r = -.19, p > .20. Neuroticism was assessed by the same Goldberg (1999) scale also used in Study 2 (M = 2.77; alpha = .89).

Procedures

A constant order of assessments was used to facilitate individual difference comparisons. The cueing task was administered first, the Stroop task was administered next, and the sustained attention task was the final cognitive task administered. Subsequent to the cognitive tasks, participants reported on their experiences of negative and positive emotion over the last month, following which they completed the neuroticism scale. All responses were made on personal computers in private cubicles in group sizes of less than 7.

Results

Possible Speed-Accuracy Tradeoff

The correlation between error frequency and response speed in the Stroop task was non-significant, r = -.24, p > .10. Thus, there was no speed-accuracy tradeoff in the primary task.

Routine Errors as a Predictor of Negative Affect

Individuals who made more errors on the Stroop task experienced more intense experiences of negative emotion, relative to low-error individuals, r = .45, p < .01. On the other hand, the frequency of routine cognitive errors did not predict positive affect, r = .14, p > .35. Such results are consistent with those of Study 2. Also consistent with Study 2, higher levels of neuroticism predicted higher levels of negative affect, r = .59, p < .01.

There was a marginal relation between neuroticism and the frequency of routine cognitive errors, r = .32, p > .05. No such relation had been observed in Study 2 and we therefore believe it to be sample-dependent. In any case, was deemed useful to conduct a multiple regression in which negative emotional experiences were predicted on the basis of error

frequency and neuroticism, both predictors simultaneously controlled. Controlling for their overlapping variance, we found that both neuroticism, $t = 3.76$, $p < .01$, Beta = .50, and error-proneness, $t = 2.19$, $p < .05$, Beta = .29, were independent predictors. Thus, we were again able to show that individual differences in routine cognitive error frequency predict negative (but not positive) emotional experiences independent of trait levels of neuroticism.

Results Involving the Other Cognitive Measures

The three cognitive tasks were quite different in their requirements (e.g., only the Stroop task required individuals to respond on all trials). If individual differences in routine cognitive error are reliable, however, error frequencies for the three tasks should be positively correlated. This proved to be the case as the primary error measure, from the Stroop task, positively predicted error rates in the sustained attention, $r = .45$, $p < .01$, and Posner cueing, $r = .49$, $p < .01$, tasks as well. It was also the case that individuals who made more errors in the sustained attention task made more errors on the catch trials of the Posner cueing task, $r = .45$, $p < .01$. Thus, these results indicate that individuals are prone to routine cognitive errors (or not so prone) irrespective of the particular task involved.

We next examined whether error frequencies in the vigilance and cueing tasks would predict individual differences in negative emotional experience as well. The correlation involving error rates in the vigilance task was in the predicted direction, but it was not significant, $r = .23$, $p < .20$. On the other hand, error frequencies in the Posner cueing task did predict more intense experiences of negative emotion, $r = .46$, $p < .01$, and this remained the case when controlling for levels of neuroticism in a multiple regression, $t = 2.65$, $p < .05$, Beta = .33.

Discussion

We do not contend that the three tasks administered in Study 3 exhaust the universe of tasks that could be used to assess routine cognitive errors. However, the tasks administered do appear to assess very different types of routine cognitive error. For this reason, to the extent that error frequencies predict each other across the tasks, novel support for the second criterion of a trait-related tendency – namely, consistency across different situations or contexts – would be supported. Evidence supported the idea that routine cognitive errors can be considered characteristic of individuals across quite different tasks. We hasten to add that these results support the cross-task consistency of routine cognitive errors, but that other tasks would be necessary to assess whether inter-individual consistency can be observed with reference to rule- or knowledge-based errors of the sort detailed by Reason (1990).

Of additional importance, the results of Study 3 replicated those of Study 2 in supporting the idea that proneness to errors in relatively simple tasks is related to negative affect in a robust manner. Specifically, it was again found that higher levels of routine cognitive error predicted higher levels of negative emotional experiences as well. The two cognitive tasks that best predicted such experiences were those that required a high rate of responding. We therefore suggest that skill-based slips of action, rather than skill-based lapses of attention, appear to be a more potent predictor of negative emotional experiences. This idea would seem to fit with the mindfulness literature, which often defines mindless processing in terms of action slips (Brown et al., 2007). Further studies of the present type, however, would be useful in contrasting action slips versus attention lapses as predictors of distress-related outcomes.

Study 4: General Distress Symptoms and Displays of Negative Emotion

Studies 2 and 3 examined relations between routine cognitive errors and relatively common experiences of negative emotion (e.g., irritation). A purpose of Study 4 was to extend

this analysis to general distress symptoms of potentially greater clinical significance, albeit in dimensional rather than diagnostic terms. Accordingly, we asked individuals in Study 4 to report on their recent distress-related experiences of depression (e.g., felt depressed) and anxiety (e.g., felt anxious) using relevant general distress scales from the MASQ (Watson & Clark, 1991). We hypothesized that routine cognitive errors would positively predict both such sets of symptoms.

Individuals are in a unique position to understand their own negative emotional experiences and symptoms (Barrett, Mesquita, Ochsner, & Gross 2007). However, it is also of interest to examine whether those with tendencies toward routine cognitive error also exhibit signs of distress that can be observed by others (Shedler, Mayman, & Manis, 1993). To examine this question, we conducted a "mental health" interview of the sort used by Spalding and Hardin (1999), following which the interviewer rated the extent to which distress-related negative affect was displayed during the interview. A significant conceptual replication would occur to the extent that individuals making more routine cognitive errors are rated as more distressed by experimenters immediately following the one-on-one interview of Study 4.

Studies 2 and 3 examined relationships between routine cognitive error frequency and negative affect in single-session assessment protocols. Although there is no reason to think that the negative affect measures assessed in these studies can be biased by state-related experiences of distress (Watson, 2000), it still seemed desirable to use a different type of assessment protocol in Study 4. Accordingly, the frequency of routine cognitive errors was assessed in one session, general distress symptoms were assessed in a second, and the interview was conducted in a third session, with at least one week separating sessions. To the extent that routine cognitive errors predict experiences and displays of distress in Study 4, then, results could not be ascribed to momentary states and their influence on both sorts of variables.

Method

Participants and Individual Differences in Routine Error Frequency

Participants were 68 (51 female) undergraduates from North Dakota State University who received extra credit. Individual differences in routine error frequency were assessed using the same color-word Stroop task also administered in Study 3. The average error frequency rate in Study 4 was 3.36%. Response speed was scored as above.

General Distress Symptoms and Neuroticism

The MASQ (Watson & Clark, 1991) includes two subscales to measure general distress symptoms and both of them were administered here. For both subscales, participants were asked to indicate the extent (1 = very slightly or not at all; 5 = extremely) to which they had experienced each of the relevant symptoms during the past week. The general distress anxiety subscale assesses symptoms thought to be more characteristic of anxiety-related disorders (e.g., *felt nervous*; here, $M = 1.62$; alpha = .92), whereas the general distress depression subscale assesses symptoms thought to be more characteristic of depression related disorders (e.g., *felt depressed*: here, $M = 1.66$; alpha = .90). Neuroticism was assessed by the same Goldberg (1999) scale also used in prior studies (here, $M = 2.33$; alpha = .91).

Displayed Negative Affect

We conducted an ostensible "mental health" interview to elicit behaviors characteristic of anxiety and negative affect (Robinson & Cervone, 2006; Shedler et al., 1993). Our interview was closely modeled after procedures reported by Spalding and Hardin (1999). Participants were asked a series of nine questions and asked to provide 2-3 sentence answers to each of them. Three of the questions were relatively neutral (e.g., *describe a time in the past year that you saw a movie*), whereas the remaining six of the nine questions were designed to provoke negative

affect (e.g., *describe a time in the past year when you felt nervous*). Thus, on balance, questions probed areas associated with potential distress for the individual.

Such interviews were conducted by a single experimenter with a single participant and lasted 5-10 minutes. Immediately following each interview, the experimenter rated the extent (1 = not at all; 7 = extremely) to which the participant had displayed behaviors consistent with four distress-related feelings (*anxious*, *distressed*, *nervous*, & *tense*). To assess molar tendencies to display negative emotions, items were averaged (M = 2.84; alpha = .76).

Procedures

One purpose of Study 4 was to examine whether tendencies toward routine cognitive error predict subsequent experiences and displays of negative emotion. Accordingly, the study involved three assessment sessions. In the first, error frequency was assessed in a color-word Stroop task. Approximately two weeks later, participants returned to complete the general distress and neuroticism questionnaires, in that order. Approximately one week after the second session, they returned for the interview. The first two sessions involved small groups of 2-6, whereas the interview was conducted with one participant at a time.

Results

Preliminary Analyses

Individuals making more frequent cognitive errors were not faster overall, ruling out speed-accuracy considerations, $r = .04$, $p > .75$. On the other hand, as might be expected, neuroticism was positively predictive of general distress symptoms, both of an anxious, $r = .54$, $p < .01$, and depressive, $r = .45$, $p < .01$, type. Interestingly though, neuroticism did not predict displayed negative emotion during the interview, $r = .02$, $p > .85$. The latter result is not unexpected on the basis of prior findings linking displays of emotion, particularly in an interview

setting, to implicit and non-conscious factors (Asendorpf et al., 2002; McConnell & Leibold, 2001; Shedler et al., 1993; Spalding & Hardin, 1999). Finally, neuroticism did not predict the frequency with which routine cognitive errors were made, $r = .12$, $p > .30$.

Primary Analyses

We hypothesized that individuals exhibiting more frequent errors in the Stroop task would be prone to general distress symptoms and experiences as well. This proved to be the case for both general distress anxiety symptoms, $r = .25$, $p < .05$, and general distress depression symptoms, $r = .31$, $p < .01$. We also hypothesized that routine cognitive errors would predict greater displays of upset and distress during a distress-eliciting interview. This hypothesis was also supported, $r = .31$, $p < .05$.

Neuroticism was a strong predictor of two of the three Study 4 outcomes. Multiple regressions were therefore performed in which both neuroticism and the implicit cognitive measure were simultaneous regressed. In predicting general distress symptoms of anxiety type, both error frequency, $t = 3.21$, $p < .01$, Beta = .32, and neuroticism, $t = 5.73$, $p < .01$, Beta = .57, were significant predictors. In predicting general distress symptoms of a depression type, it was also the case that both error frequency, $t = 3.79$, $p < .01$, Beta = .38, and neuroticism, $t = 5.26$, $p < .01$, Beta = .52, were significant predictors. In predicting displays of negative emotion during an interview, though, error frequency, $t = 2.67$, $p < .01$, Beta = .32, but not neuroticism, $t = 0.51$, $p > .60$, Beta = .06, was a significant predictor. In sum, Study 4 replicated prior results, but extended them to general distress symptoms of potential clinical significance and to behavioral manifestations of distress apparent to an interviewer.

Discussion

Study 4 was the first to assess routine error frequency and distress-related outcomes with at least a week-long delay between such assessments. Because individual differences in error frequency continued to predict negative emotional outcomes in the context of such a temporal delay, the results cannot be viewed in terms of state-dependent processes of the sort that would last minutes, hours, or even days. Such results therefore further attest to the dispositional vulnerabilities that appear characteristic of individuals with tendencies toward routine errors.

Second, the MASQ general distress scales administered in Study 4 have been shown to possess clinical significance (Watson & Clark, 1991). In more particular terms, such symptoms capture a common core to the anxiety and mood disorders and may be best viewed in terms of the DSM-IV diagnosis of Generalized Anxiety Disorder (Clark, Watson, & Mineka, 1994). Our findings are intuitive along such lines because theories of this disorder emphasize tendencies – whether rumination, worry, or avoidance – whose common element appears to be of some degree of inattention to the current stimulus context (Borkovec & Sharpless, 2004). We suggest that a cognitive probe of skill-based errors (Reason, 1990) may have value to this literature, while recognizing that studies of a clinical type would be useful in further substantiating our individual difference model of distress-proneness.

Third, we were able to show that individuals making more frequent routine cognitive errors also exhibited higher levels of behavioral distress during a purported mental health interview. Thus, this probe of distress-proneness appears to possess explanatory value in relation to outcomes beyond those that are self-reported in nature. We do recognize that further studies of this type appear warranted. For example, would the reports of knowledgeable informants – i.e., friends or acquaintances – replicate the observer-based findings of Study 4? If so, relevant extensions of these findings would have considerable value in understanding interpersonal

reactions and functioning of an anxiety-related type (Robinson, Meier, Wilkowski, & Ode, 2007). This theme is revisited in the General Discussion.

Study 5: Predicting Negative Emotion in Everyday Life

The results of Studies 2-4 have been robust in linking individual differences in routine cognitive errors to negative affect and other indications of distress. However, emotional experiences and symptoms were examined by asking individuals to characterize their occurrence over the recent week or month. It would therefore seem useful to conduct an experience-sampling study to confirm this relationship in relatively more momentary terms. We accordingly performed a fifth study in which emotional experiences were assessed at randomized times by the use of hand-held computer recording devices. As the intensity and duration of momentary affective experiences are potentially separable (Schimmack, Oishi, Diener, & Suh, 2000), participants were asked to report on both.

There are several benefits to experience-sampling protocols that we should emphasize. First, they capture emotions as they occur in one's ecological context (Bolger, Davis, & Rafaeli, 2003). Second, by the use of randomized prompts, one ensures that collected data characterize *representative* moments of experience (Fleeson, 2007). Third, by averaging multiple momentary reports, the aggregated averages should be particularly useful in characterizing personality tendencies irrespective of transitory situational influences (Epstein, 1983). Fourth, protocols of this type minimize biases that sometimes occur when people retrospectively characterize their feelings (Larsen & Fredrickson, 1999; Robinson & Clore, 2002). Thus, to the extent that error-proneness predicts negative emotional experiences in Study 5, the results would constitute a substantial conceptual replication of the findings reported in Studies 2-4.

Method

Participants and Neuroticism Assessment

Participants were 105 (63 female) undergraduates from University of Illinois-Champaign. They received credit for an upper-division psychology class for their participation. Neuroticism was assessed in the same manner as in prior studies (M = 2.83; alpha = .83).

Individual Differences in Routine Error Frequency

Individual differences in routine error frequency were assessed in a manner similar to Studies 1 and 2, though more extensively so. Nine consecutive choice categorization blocks were used: not me (e.g., *them*) versus me (e.g., *me*) words, unpleasant (e.g., *liar*) versus pleasant (e.g., *life*) words, not animal (e.g., *stick*) versus animal (e.g., *mouse*) words, not blame (e.g., *landslide*) versus blame (e.g., *addiction*) words, not threat (e.g., *stench*) versus threat (e.g., *snake*) words, neutral (e.g., *chance*) versus positive (e.g., *charm*) words, neutral (e.g., *method*) versus negative (e.g., *misery*) words, feminine (e.g., *tender*) versus masculine (e.g., *forceful*) words, and not intense (e.g., *quiet*) versus intense (e.g., *loud*) words. There were a total of 412 trials. As in prior studies, participants received an error message (here, 1500 ms) if they were incorrect and there was a short blank delay (here, 150 ms) between consecutive trials within a block. The average error frequency was 6.31%.

Experience-Sampling Protocol

Participants completed a one-week experience-sampling protocol. Emotional experiences were assessed in everyday life through the use of palmtop computers. During each of the seven days involved, participants received six randomized pages throughout the course of the day and had 15 minutes to respond to each. To accommodate different waking-sleeping schedules, such pages only occurred between the hours of 10 a.m. and 10 p.m. Individuals completing less than half of the reports were removed and this resulted in a sample size of 105.

When paged, a first set of questions pertained to the intensity of momentary experiences of emotion. Specifically, participants were asked to report the extent (0 = not at all; 7 = extremely) to which they were currently experiencing four positive (*calm*, *excited*, *happy*, & *pleasant*; *M* = 2.61; alpha = .85) and four negative (*irritated*, *sad*, *tense*, & *unpleasant*; *M* = 0.88; alpha = .86) emotion markers. Subsequent to reporting on the intensity of their momentary experiences, a second set of questions asked individuals to report on the percentage of time during the previous hour that they felt each of the same eight emotion markers, a duration-based measure (1 = 0% of the time; 7 = 100% of the time). Duration-based estimates for positive (*M* = 3.68; alpha = .75) and negative (*M* = 1.10; alpha = .86) were reliable as well.

Procedures

As in Study 4, assessments of the individual difference variables were made at different points in time. The trait of neuroticism was assessed early on in the semester. At mid-semester, the cognitive task was administered. At least two weeks subsequent to assessing individual differences in routine cognitive error frequency, participants completed the experience-sampling protocol. Laboratory assessments of neuroticism and cognitive performance were completed in small groups at private cubicles. The experience-sampling protocol was completed over four successive weeks and involved pre-programmed palmtop computers.

Results

Preliminary Results

Higher tendencies toward cognitive error were independent of processing speed, $r = -.03$, $p > .70$. Across studies, then, error-proneness in the tasks administered cannot be ascribed to trading speed for accuracy. Study 5 was the first study in which neuroticism predicted higher levels of error frequency during the cognitive task, $r = .20$, $p < .05$. Neuroticism was also a

significant or marginal predictor of all of the experience-sampled emotion measures: negative emotional intensity, $r = .29$, $p < .01$; positive emotional intensity, $r = -.25$, $p < .05$; negative emotional duration, $r = .36$, $p < .01$; and positive emotional duration, $r = -.19$, $p < .10$. Such results comport with suggestions that neuroticism is a robust positive predictor of negative emotional experiences, and often an inverse predictor of positive emotional experiences, in daily life (Suls & Martin, 2005).

Primary Results

As hypothesized, higher levels of routine error frequency predicted more intense negative emotional states in momentary terms, $r = .23$, $p < .05$, and such states were longer-lasting as well, $r = .21$, $p < .05$. Error frequency, though, did not predict the intensity of positive emotional experiences, $r = -.13$, $p > .15$, but did predict positive emotional experiences that were shorter in duration, $r = -.25$, $p < .01$. The last result is interesting, but would have to be replicated to gain further confidence in it, particularly given the intensity-related results from this study and the results from Studies 2 and 3 as well. Thus, the general conclusion is that errors of a routine type, termed skill-based errors by Reason (1990), appears to be a stronger and robust predictor of negative emotional states relative to positive emotional states.

Multiple regressions were performed to understand the respective roles of the implicit error frequency measure and neuroticism in predicting the Study 5 outcomes. In a multiple regression predicting the intensity of negative experiences, both the cognitive measure, $t = 2.89$, $p < .01$, Beta = .28, and neuroticism, $t = 2.43$, $p < .05$, Beta = .24, were independent predictors. This was also true in a multiple regression predicting the duration of negative experiences, as both the error frequency measure, $t = 2.45$, $p < .05$, Beta = .23, and neuroticism, $t = 3.27$, $p < .01$, Beta = .31, were again independent predictors. Neuroticism was a unique predictor of positive

emotional intensity, $t = -2.29$, $p < .05$, Beta = -.23, whereas both the error frequency, $t = -2.89$, $p < .01$, Beta = -.28, and neuroticism measures, $t = -2.43$, $p < .05$, Beta = -.24, were inverse predictors of the duration of positive emotional experiences.

Discussion

Study 5 was important because we were able to show that individuals making more frequent errors of a routine type were also more vulnerable to more intense and longer-lasting negative emotional experiences in their daily lives. Results from this study, then, are perhaps the strongest in supporting the idea that routine cognitive errors can be considered a risk factor of anxiety and distress of a consequential and hitherto unappreciated and undocumented type. The consistency of the results across studies, furthermore, provides additional support for viewing error-proneness as an implicit vulnerability marker of negative emotional vulnerability.

General Discussion

Overview of Theoretical Considerations and Findings

The personality literature has shown that trait self-reports of negative emotion predict state self-reports of negative emotion so much so that it useful to consider them as alternative measures of the same thing – namely, negative emotionality (Clark & Watson, 1999; Meyer & Shack, 1989). No one disputes that neuroticism is a strong predictor of negative emotional experiences and in fact similar results were observed in the present studies. However, to the extent that neuroticism and negative emotional experiences are equated, a definitional problem occurs (Cervone & Shoda, 1999). As stated by Gross, Sutton, and Ketelaar (1998), there is a danger of tautology here, namely that that tendencies toward negative emotion predict tendencies toward negative emotion much as X should predict X according to any logical system.

Thus, to the extent that one seeks to understand *why* it is that certain individuals experience more intense and frequent negative emotional experiences, it would be useful to examine the processing mechanisms involved, potentially independent of trait-related considerations (Cervone, 2004). Drawing from previous literatures (e.g., Broadbent et al., 1982; Brown & Ryan, 2003; Fetterman, Robinson, Ode, & Gordon, 2010; Reason, 1990), we sought to examine whether individual differences in routine cognitive errors can be viewed in terms of a trait-like vulnerability marker. Three general considerations guided our investigation.

First, if routine cognitive errors render some individuals generally prone to negative emotional experiences, then routine cognitive errors should exhibit trait-like properties, most prominently in terms of consistency over time and across different stimulus conditions or contexts (Mischel, 1968). In support of this trait-like property, Study 1 established that the extent to which individuals made routine cognitive errors were highly consistent across time. Further, Study 3 found that routine cognitive errors displayed trait-like consistency across different stimulus contexts, procedures, and cognitive tasks. Accordingly, we suggest that routine cognitive errors in cognitive tasks appear to possess trait-like consistency.

Second, to the extent that routine cognitive errors represent a trait-like vulnerability to negative emotional experiences, this case would be strengthened by a body of conceptual replication efforts and findings. Study 2 found that routine cognitive errors predicted negative emotional experiences over the previous week time frame. Study 3 replicated and extended such results to a consideration of negative emotional experiences characteristic over the previous month. Study 4 found that routine cognitive errors predicted general distress experiences of both anxiety- and depression-related types. Study 4 further found that individuals exhibiting greater error frequency in a cognitive task displayed higher levels of negative emotion during a

purported mental health interview. Study 5, finally, provided support for what we regard as the ultimate criterion to be predicted – namely, emotional experiences occurring in everyday life. As hypothesized, higher levels of cognitive error predicted more intense and frequent negative emotional states in everyday life in the experience-sampling protocol of Study 5.

Third, it is a point of fact that the trait of neuroticism is a moderate to strong predictor of negative emotional states and symptoms (Clark & Watson, 1999; Meyer & Shack, 1989). Thus, support for a novel dispositional predictor of such states and symptoms would be supported to the extent to which discriminant validity can be demonstrated in relation to this trait. Studies 2-5 assessed both tendencies toward routine cognitive errors and self-reported individual differences in neuroticism. By examining correlations among these variables and their respective roles in predicting the outcome variables, we were able to show that our implicit predictor of dispositional vulnerability was generally not correlated with the self-reported trait of neuroticism, but was predictive of negative emotional experiences nonetheless, even controlling of individual differences in this trait.

Thus, the results converge on a unique implicit predictor of dispositional tendencies toward negative emotional states. At the same time, there are a number of unexamined questions that would benefit from further investigation. The General Discussion focuses on what we have learned as a result of the present findings and what further investigations and studies can be advocated on the basis of the present findings.

Routine Cognitive Errors

Prior to the present studies, individual differences in their tendencies toward routine errors had been assessed almost exclusively by self-report (Broadbent et al., 1982). However, such self-reports have been shown to be poor predictors of individual differences in performance

within relevant cognitive tasks (Broadbent et al., 1986). The present assessment approach bypasses self-report entirely by assessing routine error frequencies in implicit processing terms.

Errors in information processing can occur when individuals are asked to respond faster than desired, leading them to trade speed for accuracy (e.g., Greenwald, Klinger, & Schuh, 1995). However, our tasks were not of this type in that the tasks did not encourage responding faster than might be desired. Although errors were unforced, it is possible that individuals differed in the extent to which they favored speedy responding over accurate responding (e.g., Dickman & Meyer, 1988). Such speed-accuracy tradeoffs were not evident in our studies. Individuals who made more cognitive errors were not generally faster in their performance across studies. Furthermore, in the one study in which such a speed-accuracy tradeoff may have occurred (Study 2), error frequencies continued to predict negative affect with processing speed statistically controlled. Thus, the present findings should be viewed in terms of individual differences in error frequency rather than motives favoring speedier responding.

The success of the present predictions and findings follows from the straightforward idea that individuals who make more routine cognitive errors are also likely to be prone to mindless errors in daily life. Cognitive failures are rare in daily life, though (Broadbent et al., 1982; Reason, 1990), which is why we examined outcomes – such as general distress symptoms and momentary experiences of negative emotion – that would presumably track such errors over time (Frijda, 1992; Lazarus, 1991; Smith & Ellsworth, 1985). However, daily experience-sampling protocols might prove sensitive to everyday cognitive failures (Ode, Hilmert, Zielke, & Robinson, in press). If so, it would seem useful to provide more direct evidence for the idea that routine cognitive failures predict daily outcomes of an error-related type (e.g., eating without

thinking, forgetting names, and so forth). We do acknowledge that evidence of this type seems important in understanding the cognitive tendencies assessed.

Broader Theoretical Considerations

We were able to provide robust support for the idea that individuals who make routine or skill-based (Reason, 1990) errors are at risk for a variety of negative emotional experiences. We suggest that this is because some individuals withdraw controlled processing resources in the context of routine tasks – i.e., those in which it seems that automatic processing routines may seem to suffice. We note that this view of controlled processing resources and their use has a considerable recent precedent. For example, Lieberman (2003) suggested that stereotypes in person perception typically occur not because of limits on controlled processing, but rather because certain individuals disengage the cognitive machinery used to individuate persons when they deem automatic modes of responding sufficient (also Fiske, 1993). In understanding individual differences in anger and reactive aggression, we have similarly concluded that capacities related to control are seldom involved (Wilkowski & Robinson, 2008). Rather, angry individuals simply "let down their guard" when the performance context seems to favor automatic modes of responding (for relevant data, see Wilkowski & Robinson, 2007; for a more general analysis, see Robinson et al., in press).

Translated to the present, the routine cognitive tasks administered would be *precisely* those in which some individuals would presume their automatic processing routines to be sufficiently working, whereas others would not (Robinson et al., in press). Unfortunately for the former individuals, error-monitoring processes are often essential to performance in even quite routine tasks such as those administered – perhaps not all the time, but at least on a minority of trials (Kerns, Cohen, MacDonald, Cho, Stenger, & Carter, 2004; Miller & Cohen, 2001; Norman

& Shallice, 1986). In turn, letting down one's guard under such circumstances should precipitate and cause a higher rate of mindless behavioral errors in everyday life (Broadbent et al., 1982; Brown et al., 2007). It is this reason, we suggest, that routine cognitive errors were so successful in predicting individual differences in distress in daily life.

The question of whether anxiety states cause cognitive failures or action slips is an old one (e.g., H. Eysenck, 1947), but it now seems safe to say that this alternative direction of influence is implausible on the basis of available data. For example, M. Eysenck, Derakshan, Santos, and Calvo (2007) reviewed several sources of data indicating that anxiety does not undermine cognitive performance, but rather reduces its efficiency (also see Sarason, Sarason, & Pierce, 1990; and several studies from our lab: e.g., Robinson, 2007b; Robinson, Moeller, & Fetterman, in press). Thus, the most plausible direction of influence involved in the present findings is one in which greater error frequency predicts problematic outcomes in daily life rather than vice versa, though perhaps further studies of the present type would be valuable.

To what extent can the present findings be interpreted in terms of general intelligence? Although further data appear necessary, intelligence is assessed in conditions in which *maximal* rather than typical or *routine* performance is measured (Kaufman & Lichtenberger, 2006). By contrast, the present studies assess performance accuracy in somewhat minimal processing conditions that do not require retrieving extensive sources of knowledge or manipulating information in a highly controlled manner. To what extent can the present findings be interpreted in terms of working memory processes? Working memory processes are similarly those that are assessed under conditions of load and over protracted periods of time (Engle, 2002). Further, cognitive sources of data from this literature have shown that individual differences in working memory capacity do not predict performance in automatic processing tasks or conditions, but

rather only predict performance in conditions in which controlled processing resources must necessarily be recruited for successful performance (Engle & Kane, 2004). Hence, we suggest that the present results can be viewed in terms of minimal rather than maximal contributions to performance.

In retrospect, though, it would have been desirable to assess both routine cognitive errors and measures tapping maximal performance abilities. If we are correct, such maximal ability measures (e.g., intelligence) should correlate only weakly with routine cognitive errors, much as cognitive failures of a self-reported type have been shown to be largely independent of such ability measures (Broadbent et al., 1982) and those related to executive attention processes (Broadbent et al., 1986). Moreover, the mindfulness literature makes a similar point: Lapses of attention of a minimal rather than maximal type have significant value in predicting individual differences in distress and problematic functioning, potentially independent of the ability-related capacities of the individual (Brown et al., 2007). Nevertheless, we recognize that further research is necessary to clarify relations between routine cognitive errors and such ability measures.

Motivational processes are thought to be important to performance, though the motivation-performance interface has proven especially tricky in cognitive-behavioral paradigms of the present type (Ackerman & Heggestad, 1997; Sanders, 1998). Regardless, the present cognitive-behavioral measure – error frequency in routine cognitive tasks – was a novel one and it is useful to consider such questions of task motivation. We suggest that all individuals should have been sufficiently task-motivated for two reasons. Error rates were normatively low, thus indicating that all individuals likely sought to respond in an accurate manner. If they had not, furthermore, they would have encountered substantial error penalties. Hence, even individuals seeking to complete the experimental tasks as fast as possible should have been motivated to

avoid such substantial error penalties. Instead, and as mentioned above, we contend that high-error individuals operate under the assumption that their automatic processing routines are sufficient in such a cognitive-behavioral performance context and thus omit checks on accurate responding that low-error individuals do not.

Future Research Directions

It would seem important to extend the present findings. For example, routine cognitive error frequencies should predict informant reports of negative emotion, a result that would complement Study 4's link to experimenter ratings of distress. It would also seem useful to investigate results examining whether routine cognitive error tendencies may be of use in predicting changes in anxiety and depression symptoms over time.

In addition, we (Fetterman et al., 2010; Robinson et al., in press) recently suggested that the sorts of cognitive processes that give rise to cognitive error are also those that underlie diverse manifestations of self-regulation failure. If so, cognitive probes of the present type may be of use in predicting individual differences in other realms thought reflect, in part, the withdrawal of the self's controlled resources, such as procrastination (Tice & Baumeister, 1997), poorer work performance (Mount, Oh, & Burns, 2008), and addictive behaviors (Muraven, Collins, & Neinhaus, 2002).

In this connection, we do note that basic cognitive tasks, thus far of a reaction time type, have predicted outcomes as important as criminality (Jensen, 1998) and life expectancy (Deary & Der, 2005). It is arguable that response accuracy, relative to response speed, is an even more basic quality of cognition that should have significant implications for everyday life functioning. If so, routine cognitive errors, even in mundane cognitive tasks, might have an even wider scope of predictive validity than documented in the present studies.

Conclusions

We found that individual differences in routine cognitive error frequency exhibited trait-like properties, both across time and across tasks. Further, individual differences in routine cognitive errors were independent of the trait of neuroticism, but nevertheless predicted negative emotional experiences, symptoms, and displayed behaviors to a significant extent. Given the robust nature of the present findings, more attention should be paid to routine cognitive errors in future studies concerned with individual differences in effective social-emotional functioning.

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