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Intrusive thoughts mediate the association between neuroticism and cognitive function

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ABSTRACT

Although research has established a negative association between trait neuroticism and cognition, little is known about the mechanisms that underlie this relationship. We examined the tendency to experience intrusive thoughts and negative affect as potential mediators of the relationship between neuroticism and cognitive performance. We hypothesized that the tendency to experience intrusive thoughts reflects ineffective attentional control and would account for the relationship between neuroticism and cognitive performance over and above the mediating effect of negative affect. Three hundred seventeen adults (M_{age} = 49.43) completed a series of attention-demanding cognitive tasks as well as self-report measures of intrusive thoughts, negative affect, and neuroticism. Intrusive thoughts mediated the association between trait neuroticism and cognitive performance beyond negative affect. These findings are consistent with the hypothesis that the tendency to experience intrusive thoughts is a mechanism through which trait neuroticism influences cognitive performance.

1. Introduction

Neuroticism is a dimension of personality characterized by emotional distress (Larsen & Ketelaar, 1991), lability (Eid & Diener, 1999), and reactivity (Bolger & Zuckerman, 1995). Those with high levels of neuroticism are at increased risk for poor physical and psychological health (Mroczek & Spiro, 2007; Lahey, 2009). High levels of neuroticism are also associated with facets of cognitive health, including inefficient cognitive performance (Robinson & Tamir, 2005), cognitive decline (Wilson et al., 2005), and increased risk of Alzheimer's disease (Duchek, Balota, Storandt, & Larsen, 2007; Wilson, Arnold, Schneider, Li, & Bennett, 2007). However, the psychological mechanisms through which neuroticism influences cognitive function remain largely uninvestigated. One hypothesis is that high neuroticism individuals exhibit less efficient cognitive processing due to elevated "mental noise" caused by mental preoccupations with task-irrelevant intrusive thoughts (IT) and distress (Robinson & Tamir, 2005). The current study provides an explicit test of this hypothesis by examining the mediational effects of individual differences in IT and emotional distress on the neuroticism–cognition relationship.

1.1. Neuroticism and cognitive performance

Studies have generally found negative associations between neuroticism and a broad range of cognitive functions in both cross-sectional and prospective longitudinal designs. Cross-sectional studies show negative associations between neuroticism and attention-demanding cognitive tasks that comprise fluid intelligence, such as episodic memory, numeric and abstract reasoning, and tasks of perceptual speed (Jorm et al., 1993; Moutafi, Furnham, & Paltiel, 2005). In contrast, neuroticism and performance on crystallized tasks are not robustly associated (Costa, Fozard, McCrae, & Bosse, 1976). Prospective studies have shown longitudinal associations between neuroticism and different indices of cognitive decline and impairment. Individuals high in neuroticism are at increased risk for developing mild cognitive impairment as well as Alzheimer's disease and other dementias (Wilson et al., 2003). Neuroticism is also a risk factor for cognitive decline in the absence of dementia—those who score high in neuroticism decline an average of thirty percent faster than those low in neuroticism (Wilson et al., 2005). Altogether, cross-sectional and longitudinal evidence indicates that effects are most pronounced for attention-demanding tasks, such as episodic and working memory. These findings raise the question of what specific processes drive the association between neuroticism and cognitive performance in attention-demanding tasks.

The tendency to experience recurrent and intrusive thoughts represents a possible psychological mechanism underlying the

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relationship between neuroticism and cognitive performance. Intrusive thoughts (IT) reflect a range of related concepts such as worry and rumination, and occur with greater frequency in high neuroticism individuals (Muris, Roelofs, Rassin, Franken, & Mayer, 2005; Nezlek, 2005; Suls & Martin, 2005). IT may contribute to the neuroticism–cognition relationship by depleting attentional resources that are required to effectively perform attention-demanding cognitive tasks. Preoccupations with task-irrelevant intrusive thoughts can cause "mental noise" in high neuroticism individuals, resulting in less efficient and more variable cognitive processing (Robinson & Tamir, 2005; Robinson, Wilkowski, & Meier, 2006). Support for this hypothesis comes from analyses showing that high neuroticism individuals are more variable on response time tasks, possibly due to more frequent attentional lapses. Related work by Eysenck and colleagues suggests that performance-related IT interferes with online processing and results in impaired performance (Eysenck & Calvo, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007).

Individual differences in the tendency to experience IT are associated with lower working memory in college students (Klein & Boals, 2001) and older adults (Stawski, Sliwinski, & Smyth, 2006). A recent study also found that rumination was associated with impaired mental set shifting (Altamirano, Miyake, & Whitmer, 2010). Stawski et al. (2006) proposed that the experience of IT acts as a dual-task load that depletes attentional resources resulting in impaired performance in attention-demanding tasks. Consistent with this reasoning, studies have found that individuals who tend to experience more IT have lower working memory capacity (Kane et al., 2007) and are more likely to make more mistakes when they experience IT (McVay, Kane, & Kwapil, 2009).

An explicit test of whether IT mediates the relationship between neuroticism and cognition has yet to be conducted. Testing the role of IT as a mediator requires a simultaneous evaluation of negative affect (NA) against IT because elevated NA is both a core feature of neuroticism and related to greater frequency and intensity of IT (Moberly & Watkins, 2008; Muris et al., 2005; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Robinson et al., 2006). Studies have also linked NA with slower information processing and with declines in performance on attention-demanding tasks (Backman, Hill, & Fursell, 1996; Dotson, Resnick, & Zonderman, 2008). Thus, we examine if IT associated with neuroticism mediates the neuroticism–cognition relationship beyond the effects of NA.

1.2. Hypotheses

First, we hypothesized that individual differences in IT would mediate the association between neuroticism and cognitive function. Because of the robust empirical association between IT and NA, we examined this hypothesis in two steps. First, we tested for mediation by examining both IT and NA in separate models and second, by examining them simultaneously in the same model. Our second hypothesis was that individual differences in IT would mediate the effect of neuroticism on cognition beyond the effects of trait NA.

In addition to testing these hypotheses, we also examined age as a moderator of the neuroticism-intrusive thought-cognition relationship. Because previous research suggests that increasing age in adulthood is associated with diminished inhibitory control that could increase susceptibility to the effects of intrusive thoughts (Hasher, Zacks, & May, 1999), we expected stronger associations among these variables in older compared to younger adults. Specifically, we examined two predictions: (a) That the association between neuroticism and IT would increase with age, and (b) That the effect of IT on cognitive performance would be stronger with advancing age in adulthood.

2. Method

2.1. Participants

Three hundred seventeen adults were recruited using advertisements in local newspapers, flyers in community centers, and other public venues. Participants were given an introduction to the study and informed consent was obtained as approved by the Syracuse University Institutional Review Board. Participants were compensated \$75. Recruitment was stratified by age to obtain a uniform age distribution. Average age of the current sample was 49 (*SD* = 17.23, range = 19–83), and 49.69% were female. The average years of education were 13 years (*SD* = 2.71); 52.1% of participants were white, 37.6% black, 1.5% Hispanic, and 8.7% other.

2.2. Measures

Cognitive tasks were administered in a fixed order over two in-lab sessions that were approximately one week apart. The following tasks were administered in the first session: trail making test, logical memory I, existence choice reaction time (CRT) task, digit span, verbal set switching, reading span, verbal paired associates, number comparison, and the auditory verbal learning test (AVLT). The rest of the tasks were administered during the second session in the following order: category fluency, parity CRT, magnitude CRT, word span, number set switching, counting span, Raven's progressive matrices, letter fluency, orientation CRT, location CRT, spatial span, spatial set switching, operation span, and the Shipley vocabulary test. A number of health measures were also collected during these in-lab sessions and participants provided two cortisol samples across five consecutive days following the first session—these measures were not used in the current analysis. Between sessions, participants completed questionnaires assessing personality, intrusive thoughts, affect, and life experiences.

2.2.1. Fluid intelligence

Fluid intelligence was measured using Raven's progressive matrices (Raven, 1958). This task measured the extent to which individuals could think adaptively. Participants were presented with a series of incomplete abstract figures and they chose one of several abstract figures that best completed the figure. The dependent measure was the number of abstract figures completed correctly out of 30.

2.2.2. Episodic memory

Episodic memory was measured by three tests that assessed participants' ability to recall previously learned information. In the logical memory I test, the experimenter read two stories to the participants and they were then asked to recall as much of the story as possible (Wechsler, 1997). In the verbal paired associates (Wechsler, 1997), the examiner read eight pairs of unrelated words to participants at a rate of one pair every three seconds. The researcher then gave the participants the first word in the pair and they were asked to produce the second. This was repeated four times, with the same pairs presented in a different fixed random order each time. In the AVLT (Schmidt, 1996), participants were given one minute to study a list of 15 unrelated words. At the end of the minute, participants were given one minute to recall as many words as possible. Raw scores from each of the standard tasks were the dependent variables.

2.2.3. Primary memory

Participants completed two tests of short term memory: digit span and word span (Conway, Cowan, Bunting, Therriault, & Minkoff, 2002). Participants saw a series of digits or words one at