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Neuroticism Predicts Reasoning Performance in Young but Not Older Adults

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ABSTRACT

Objective: This study was designed to explore age differences in the relationship of neuroticism with reasoning performance in a representative adult sample.

Method: A probability sample of 242 adults (range 25–75 years; *M* age = 47.57 years) from the Midlife Development in the United States (MIDUS) Boston Study of Management Processes were measured on personality and cognition. Using Raven's Progressive Matrices Test as the dependent measure of reasoning, age and neuroticism were entered as independent variables into a hierarchical regression analysis with education and basic cognitive processes (processing speed and working memory) as control variables.

Results: Age (younger) and neuroticism (lower) positively predicted reasoning performance. These main effects were further qualified by an age X neuroticism interaction. Younger adults low in neuroticism performed significantly better on reasoning than those high in neuroticism, whereas the relationship of neuroticism with reasoning was not significant for the middle-aged and older adults.

Conclusions: Neuroticism affects reasoning performance in young adults but not older adults. Age-related improvements in emotional regulation are suggested as a mechanism for this relationship.

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There are known cross-sectional and longitudinal age-differences in performance on reasoning ability (Salthouse, 2005; Schaie, Willis, & Caskie, 2004) with reasoning negatively related to age. While there are many different theories about the cause of these age-related decrements in reasoning ability, including processing speed deficits (e.g., Hertzog & Bleckley, 2001; Salthouse, 1996), working memory problems (e.g., (Süβ, Oberauer, Wittmann, Wilhelm, & Schulze, 2002), and age-related degradation of the frontal regions of the brain (e.g., Elderkin-Thompson, Ballmaier, Hellemann, Pham, & Kumar, 2008), none of these theories fully explain age-differences in reasoning. It has been suggested, therefore, that the exploration of other potential variables is needed to explain age-related differences in reasoning performance.

Personality, particularly neuroticism, is one potential area of exploration for furthering understanding of individual differences in reasoning (Chamorro-Premuzic, Furnham, & Ackerman, 2006; Schweizer, 2002). High levels of neuroticism have been implicated in reduced reasoning performance, both in young (Chamorro-Premuzic et al., 2006; Furnham, Crump, Batey, & Chamorro-Premuzic, 2009; Schweizer, 2002) and older adults (Graham & Lachman, 2014; Wilson, Arnold, Schneider, Li, & Bennett, 2007). For instance, both Schweizer (2002)

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found that young adults high in impulsiveness (a facet of neuroticism) were more likely to have difficulty with reasoning tasks. Studies with older adults, however, have shown less consistent results. While some have found a similar neuroticism – reasoning relationship (Denburg et al., 2009), others have not (Boron, Turiano, Willis, & Schaie, 2007; Graham & Lachman, 2014). Many studies, however, have suggested that there may be long-term deleterious effects of neuroticism on cognition and well-being (e.g., Wilson et al., 2007). Because of these possible long-term effects of high levels of neuroticism on cognition, there is reason to believe that neuroticism may affect reasoning ability differently across the lifespan. It is, therefore, suggested that high levels of neuroticism will be more related to worse performance in older adults than younger adults.

The aim of the current study is to examine the relationship between age and neuroticism on a measure of reasoning in a representative adult sample. The hypotheses are as follows: age (younger) and neuroticism (low) will predict better reasoning and that age and neuroticism will interact to predict reasoning such that the effects of neuroticism will be greater for older adults than for younger and middle-aged adults.

Method

Participants

The data were attained from a substudy (Boston Study of Management Processes) of the national Midlife in the United States (MIDUS) study, which was conducted by the John D. and Catherine T. MacArthur Foundation. The MIDUS data uses a nationally representative sample, and this substudy consisted of a random intentional oversample using random digit dialing of adults in the greater Boston area. Participants were recruited into young, middle-age, and older age groups with an oversample of middle-aged adults. Of the original 302 participants, 242 had complete data, absence of stroke, and spoke English as their primary language. Further description of this sample can be found in Miller and Lachman (2000) and Pearman (2009). The mean age of the sample was 47.57 (SD = 13.11) years ranging from 25 to 75 years of age (median = 48). The sample was 58% male. Forty-six percent of the sample had a sixteen (Bachelor's degree) or more years of education. Within the sample, there were 81 young adults (ages 25–39; M = 32.67, SD = 4.10, median = 33), 103 middle-aged adults (ages 40–59; M = 49.24, SD = 4.96, median = 50), and 58 older adults (ages 60–75; M = 65.41, SD = 3.87, median = 65).

Measures

Reasoning

The Raven's Progressive Matrices Test (RPM) has historically been used as a measurement of the capacity to reason and solve novel problems. The Raven's is a figural reasoning task commonly used as measure of fluid intelligence (e.g. Haier, White, & Alkire, 2003; Lynn, Allik, & Irwing, 2004). Each of the Raven's items shows a group of eight symbols arranged in a 3 × 3 matrix according to a pattern. The last (bottom right corner of matrix) symbol is missing. Once the participant identifies the pattern, they choose the missing item from a selection of multiple choice answers. Scores on this version of the Raven ranged from 0 to 17 with higher scores indicating better performance.

Neuroticism

The Midlife Development Inventory (MIDI) Personality Scale (MIDI; Lachman & Weaver, 1998) was used to assess personality (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness). This scale correlates highly with other measures of personality, such as those based on the 5-factor model of personality like the NEO-PI (Costa & McCrae, 1992). Several studies have replicated the 5-factor structure of the MIDI (Joshanloo, 2018; Zimprich, Allemand, & Lachman, 2012) Each MIDI scale consists of five adjectives (e.g. worrying, friendly, self-confident). Participants indicate how much each item is characteristic of themselves on a scale ranging from 1 (*a lot*) to 4 (*not at all*). Items are reversed coded when necessary so that higher scores indicate higher levels of the trait and are then averaged to form a composite score. This scale has also been shown to have good internal consistency (Lachman & Weaver, 1998).

Covariates

Because of the known contribution of education (e.g., Tucker-Drob, Reynolds, Finkel, & Pedersen, 2014) to individual differences on reasoning tasks, education was used as a control variable in the analysis. In addition, because of previous findings that suggest that age-differences in reasoning may be accounted by more basic cognitive processes (Salthouse, 2001), processing speed and working memory were included as covariates. Speed of processing was measured using the standardized means of the letter comparison task (Salthouse, & Babcock, 1991) and the digit symbol substitution test from Wechsler Adult Intelligence Scale – Revised (WAIS-R; Wechsler, 1981). Working memory was assessed using the standardized mean of Forward and Backward Digit Span from the Wechsler Adult Intelligence Scale – Revised (WAIS-R; Wechsler, 1981) and a counting backwards task which required participants to count backwards by sevens from a three-digit number. These indices have been described previously in Miller and Lachman (2000) and Pearman (2009).

Procedures

This section of the substudy of the larger MIDUS study consisted of two times of measurement over a one- to two-year period. At Time 1, participants were mailed a series of questionnaires, including the personality scale. At Time 2, approximately a year later, the cognitive tests were administered at each participant's home.

Analyses

A hierarchical multiple regression analysis using reasoning as the dependent variable was conducted. The steps were as follows: Step 1, demographics (age and education) and cognition (processing speed and STM) and Step 2, personality variables. For Step 3, each age X personality variable interaction term was tested separately. The interaction terms all used centered variables.

Results

Table 1 shows the correlations between study variables. Of note, age was not related to neuroticism levels ($r = -.07$, $p = .27$) or any of the other personality variables. The overall hierarchical regression of reasoning was significant, $F(10,232) = 19.93$, $p < .001$. Step 1, which included the demographic and cognitive variables was significant, $\Delta R^2 = .42$, $F(4,238) = 43.82$, $p \leq .001$. Age ($\beta = -.24$), education ($\beta = .27$), processing speed ($\beta = .25$),

Table 1. Zero-order correlations among study variables.

Variable	1	2	3	4	5	6	7	8	9
1. Raven's Progressive Matrices	–								
2. Age	−.37**	–							
3. Education	.41**	−.01	–						
4. Processing speed	.51**	−.44**	.26**	–					
5. Working memory	.42**	−.06	.29**	.35**	–				
6. Neuroticism	−.17**	−.08	−.18**	−.08	−.03	–			
7. Extraversion	.00	.02	.02	.18**	.05	−.10	–		
8. Openness to experience	.06	−.04	.22**	.05	.09	−.15*	.44**	–	
9. Agreeableness	−.13*	.04	−.17*	.02	−.17*	−.03	.52**	.31**	–
10. Conscientiousness	.04	.10	.14*	.03	−.14*	−.30**	.25**	.26**	.30**

*p ≤.05; **p <.01.

and STM (β = .23) were all significantly ($p < .001$) related to the Raven's scores. Step 2, which included all 5 personality variables, was also significant overall, $\Delta R^2 = .03$, $F(5,233) = 6.32$, $p = .05$. Of the 5 personality variables in Step 2, only neuroticism was significant (β = −.10, $p = .05$), such that lower levels of neuroticism were related to better reasoning performance. Step 3 examined each personality by age interaction term. Only age X neuroticism was significant and therefore included in the final regression ($\Delta R^2 = .02$, $p \leq .05$). Along with the age X neuroticism interaction, age, education, and the cognitive variables remain significant in the final step (see Table 2 for final regression coefficients).

To further understand the interaction, the regression analyses on reasoning with neuroticism and the covariates were examined for each age group. Figure 1 has the details of this interaction. Neuroticism was related to young adults' reasoning performance ($\beta = -.23$, $p = .01$) but not to older ($\beta = -.10$, $p = .37$) or middle-aged ($\beta = -.01$, $p = .86$) adults' performance. It is notable that the younger adults high in neuroticism performed at basically same level of the middle age adults.

Discussion

Reasoning, as measured by a composite of Raven's Progressive Matrices, was predicted by age such that younger adults performed better than both the middle-age and older adults. It is notable that these age differences remain even when controlling for both processing speed and working memory. One possible reason for the age differences in reasoning are that age-related degradation of the prefrontal cortex and the caudate nucleus directly affect performance on these types of tasks (Glascher et al., 2012; Melrose, Poulin, Renee, &

Table 2. Summary of final regression coefficients for Raven's progressive matrices.

Predictor	*B*	SE *B*	β
Age	−.07	.02	−.24***
Education	.31	.08	.22***
Processing speed	1.09	.26	.23***
Working memory	1.09	.25	.27***
Neuroticism	−.57	.29	−.11***
Extraversion	−.70	.44	−.10
Openness	.74	.42	.10
Agreeableness	−.31	.41	−.05
Conscientiousness	.12	.45	.02
Age X Neuroticism	.04	.02	.10*

*p ≤.05; ***p ≤.001.

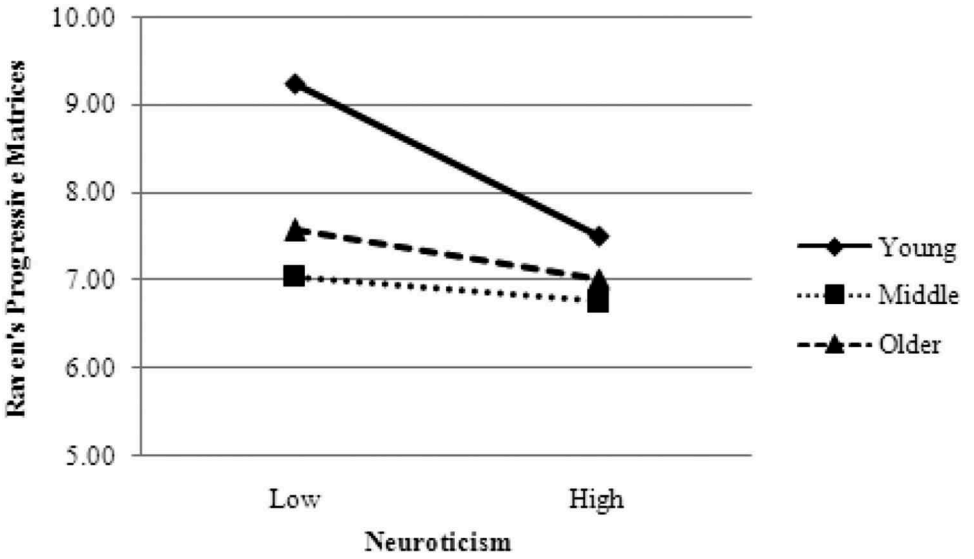

Figure 1. Age X neuroticism interaction for Raven's progressive matrices.

Low Neuroticism = M − 1 SD. High Neuroticism = M + 1 SD. Raven's scores are adjusted for education and basic cognitive processes (processing speed and working memory). Age groups are split using pre-established age groupings (see sample description). Younger adults low in Neuroticism performed significantly better on the Raven's task than the younger adults high in Neuroticism and both middle-age and older adults.

Stern, 2007; van Es et al., 2008; Waltz et al., 1999). Other researchers have also suggested that changes in response styles and strategy use may also contribute to age-related differences in reasoning (Babcock, 2002).

As hypothesized, low neuroticism predicted better performance on reasoning. Eysenck (1985) hypothesized that neurotic tendencies are associated with a propensity to respond to test anxiety by diverting attention from the primary test to managing affective response to that task. Indeed, Moutafi, Furnham, and Tsaousis (2006) found that the short-term effects of neuroticism on intelligence tests were mediated through test anxiety in adolescents and young adults. This explanation makes particular sense given the age by neuroticism interaction for performance in younger adults.

The hypothesis that neuroticism would be more important for reasoning in older adults was not supported as neuroticism was unrelated to performance in older adults. The current finding is similar to the findings of Graham and Lachman (2014) who reported that personality was not related to reasoning in older adults. It is possible that the lack of relation between reasoning and neuroticism in the older adults may be due to age-related improvements in affective self-regulation (see Carstensen, Mikels, & Mather, 2006; Mikels et al., 2010). That is, the aforementioned mental consequences of high neuroticism may be weakened over time by the enhanced self-regulation that comes with age. Another possibility is that age-related reductions in impulsivity (Diehl, Coyle, & Labouvie-Vief, 1996) diminish the negative effects of neuroticism on reasoning in middle-age and older adults. While further investigation is needed to explore these possibilities, the findings that

neuroticism has less effect on a fluid reasoning task in older adults is an important one for understanding cognitive processes in later life.

Of note, there have been several studies that have found results suggesting other personality variables contribute to age-related difference in cognitive performance in later life (e.g. Allen et al., 2005; Luchetti, Terracciano, Stephan, & Sutin, 2016). For this reason, all of the personality variables were included in the analyses. However, only neuroticism was related to reasoning in the regression analyses. A possible reason for the differences in these studies is the difference in outcome variables. For instance, in Allen et al. (2005), the dependent variable of interest was a delayed episodic memory task. Given the recent work showing that episodic memory is particularly vulnerable to anxiety and negative affect, possibly due to the role of stereotype threat and negative beliefs about memory, it is not surprising that neuroticism would be related to performance on memory tasks. There is a reasonable chance that the Raven's task is considerably less threatening to older adults compared to a standard memory test that may elicit age stereotypes and concerns. In addition, the reasoning task may trigger younger people's anxiety because it appears to measuring "intelligence". This may trigger a younger person that is high in neuroticism in the way a memory test may trigger an older person high in neuroticism. The current study did not include an episodic memory test so it is not possible to test this hypothesis. Future work, that includes reasoning as well as memory tasks, is needed to further disentangle these effects.

There are a couple of limitations to the findings and interpretations of this study. First, the personality facets of neuroticism (or the other personality variables) were not included in this study. Previous studies have shown that specific facets of neuroticism, such as impulsivity, may be predictive of reasoning (Boron et al., 2007; Graham & Lachman, 2014) and may facilitate identifying the reasoning related components of neuroticism. For instance, a predictive anxiety facet would provide us with a different understanding of the relationship than a predictive impulsivity facet. Secondly, because this is a cross-sectional analysis, it is impossible to determine causation between age, personality, and reasoning. A longitudinal analysis of personality and changes in reasoning across the lifespan would provide a deeper understanding of the intraindividual *and* interindividual differences in reasoning ability. Finally, the upper age range of the older participants was only 75. Future studies might include an older-old sample, especially given the extending age range of the general population.

Conclusion

This study, which used a representative sample of adults aged 25 to 75, showed that both age and neuroticism to have independent relationships with reasoning. In addition, age interacted with neuroticism most strongly in younger adults to predict reasoning performance. Although the neuroticism and reasoning relationship is small, accounting for only 5% of the total variance, it is a step toward furthering our understanding of reasoning and personality in adulthood.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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