

Openness as a Predictor for Cognitive Functioning

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Abstract

Human behavior is often associated with personality, but there are emergent findings suggesting that certain personality traits are correlated with levels of cognitive functioning. Researchers have discovered that being open can serve as a buffer against cognitive decline, because people who are more open may engage in more cognitively demanding thinking and tasks. Additional studies have found that openness may be positively correlated with cognitive flexibility and verbal, fluid, and crystallized intelligence. The current study examined the correlation between openness, cognitive flexibility, and fluid intelligence in 66 undergraduate college students. Participants completed a self-reported measure of openness and cognitive flexibility and Raven's Standard Progressive Matrices. As predicted, the results indicated a positive correlation between fluid intelligence and cognitive flexibility ($r=0.29$, $p=0.02$, $n=64$) and openness and cognitive flexibility ($r=0.34$, $p=0.01$, $n=63$). A trend toward a positive correlation was found between openness and fluid intelligence ($r=0.22$, $p=0.07$, $n=65$). Results may suggest that people with more open personalities may possess the ability for more advanced, abstract, and adaptable thinking.

Introduction

Personality is a dynamic phenomenon and plays an interdisciplinary role in being human, which contributes to our behaviors, thoughts, and emotional patterns.¹ There is an increasing amount of research suggesting that certain personality traits, such as openness (commonly referred to as "openness to experience"), are related to more advanced cognitive processes.² Openness is one of the Big Five personality traits and is characterized as a receptivity to new ideas and new experiences.³ The Big Five Personality Model proposes that personality can be evaluated across five major dimensions: Openness, Conscientiousness, Neuroticism, Agreeableness, and Extraversion.² Open people often have an intrinsic desire for knowledge and are capable of assimilating novel ideas.³ Studies have found open personalities to be correlated with cognitive aptitude and a receptivity to intellectual involvement.³ As such, openness may represent a behavioral pathway where cognitive engagement is associated with a lower risk for general cognitive decline.⁴ In order to expand upon these findings, this study investigated the relationships between openness, cognitive flexibility, and fluid intelligence in undergraduate college students.

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A substantial body of research has found openness to be positively associated with IQ test performance, leading some researchers to propose that it signifies the expression of intelligence in personality.² However, solely assessing intelligence is not sufficient for analyzing cognitive capabilities. It is important to consider a third variable: cognitive flexibility. Cognitive flexibility is the ability to selectively switch one's thoughts and behaviors in response to changing environments and ideas.⁵ Increased cognitive flexibility is linked to favorable qualities, such as better reading abilities during childhood, higher resilience to stress and greater levels of creativity in adulthood, and enhanced quality of life in older adulthood.⁵ In this regard, Deyoung et al. theorized that openness signifies a type of motivated cognitive flexibility.⁶

Given the interest in understanding the links between personality and cognition, studies have begun examining the relationship between open personalities and various types of intelligence in young adults. Multiple studies have examined the correlations between openness and/or verbal, fluid, and crystallized intelligence in young adults.^{2,6,7} Fluid intelligence is the ability to reason and solve problems in novel situations, without relying on previously acquired knowledge and skills.¹⁰ This is the opposite of crystallized intelligence, which is the ability to use existing knowledge to solve a current issue.¹⁰ Intelligence was either examined with the Wechsler Adult Intelligence Scale–III or Raven's Advanced Progressive Matrices, which are both well-established measures of intelligence. Deyoung et al. (2005) observed that fluid and crystallized intelligence were positively related to openness.⁶ However, Deyoung et al. (2014) found a stronger correlation with verbal intelligence and Schretlen et al. found a stronger relationship with verbal/crystallized intelligence.^{2,7} Due to the variability in findings, it may be advantageous to consider a different method for measuring cognitive aptitude.

Although cognitive flexibility is a unique aspect of cognition, there is a limited amount of research that investigates the relationship between openness, cognitive flexibility, and fluid intelligence in young adults. Often, research in this field has analyzed adult and older adult populations and has focused on general intelligence, such as the longitudinal study by Ziegler et al.⁹ Researchers assessed intelligence in 516 participants from ages 70-103 to see if people with open personalities experience less cognitive decline. The

results indicated that trait openness may be a buffer against cognitive decline, because the participants that scored higher on openness performed better on the intelligence tests as they aged. Although cognitive decline and dementia are typically associated with individuals over the age of 65, Salthouse has stated that some features of age-related cognitive impairment can begin in healthy educated adults that are in their 20's and 30's.⁸ This may indicate the importance of testing cognitive capabilities in younger populations.

In addition to these findings in older adults and in the general younger adult population, similar findings have been reported in college students. College students are a unique population since they engage in high amounts of social interaction, new experiences, and cognitively demanding tasks. Lin utilized undergraduate participants in order to test how their openness to change and cognitive flexibility impacted their academic performance.¹¹ Along with gathering data on class grades, the researchers tested variables using the Cognitive Flexibility Scale and the Openness to Change Inventory. The results indicated a positive correlation between cognitive flexibility and openness to change and between cognitive flexibility and academic performance.¹¹ These same findings were discovered by Murdock et al. who found that openness in college students (aged 18-29), was positively associated with cognitive flexibility, among other executive function capabilities.¹²

Associations between intelligence and cognitive flexibility have also received attention. Colzato et al. and Shi et al. both utilized Raven's Standard Progressive Matrices to explore the correlation between fluid intelligence and flexible thinking.^{13,14} Researchers concluded that the participants with higher intelligence possessed a higher degree of flexible thinking.^{13,14} Even further, Shi et al. determined that openness had a moderating effect on these factors when intelligence was average and below average.¹⁴ In sum, evidence suggests that intelligence and cognitive flexibility are positively related and, at times, may only be related when openness is involved.

Although most studies have focused on existing relationships between intelligence and cognitive flexibility, Brem et al. expanded on this relationship by training participants' executive functions.¹⁵ Researchers reported that the participants who underwent cognitive training of their executive functions, namely cognitive flexibility, also scored

higher on fluid intelligence tests. These findings suggest that cognitive flexibility may be improved with experience and practice.

Correlations between openness and cognitive functioning are well documented, but we are not aware of additional studies that directly compared these three variables. Given the evidence outlined above, the purpose of this study was to determine if there are positive relationships between openness, cognitive flexibility, and fluid intelligence in undergraduate college students. Three hypotheses were tested: (1) that openness will be positively correlated with cognitive flexibility, (2) that openness will be positively correlated with fluid intelligence, and (3) that fluid intelligence will be positively correlated with cognitive flexibility. Hypotheses were tested by measuring the variables via self-reported questionnaires and Raven's Standard Progressive Matrices intelligence test, then by assessing the data. The proposed study predicted that the personality facets associated with openness may be positively associated with higher levels of cognitive functioning through a tendency to ponder ideas, think creatively, and actively engage in or pursue cognitively stimulating activities.

Methods

Participants

Sixty-six undergraduate students enrolled in Introduction to Psychology at High Point University were recruited during research study sessions (Table 1). Participants included 55 women and 11 men ranging in age from 18-23 (mean (M)=10.20, standard deviation (SD)=1.17). Among participants, 83.4% identified as Caucasian, 6.1% as Hispanic, 4.5% as African American, 3% as Asian, 1.5% as mixed heritage, and 1.5% as other. The mean overall GPA was 3.24 (SD=0.50) and the mean major GPA was 3.35 (SD=0.44). All of the participants received credit for Introduction to Psychology.

Materials

Participants received a packet to report their demographic information, along with two questionnaires and Raven's Standard Progressive Matrices. Openness was measured with the Openness to Experience Scale, which is a reliable and valid measure for assessing openness¹⁶. This 90-item

Table 1. Descriptive statistics for gender, race, and age of sample

| Gender | Frequency | Percent |
|------------------|-----------|---------|
| Male | 11 | 16.7 |
| Female | 55 | 83.3 |
| Total | 66 | 100.0 |
| Race | Frequency | Percent |
| African American | 3 | 4.5 |
| Asian | 2 | 3.0 |
| Caucasian/White | 55 | 83.3 |
| Hispanic | 4 | 6.1 |
| Mixed Heritage | 1 | 1.5 |
| Other | 1 | 1.5 |
| Total | 66 | 100.0 |

Table 2. Average scores and standard deviations for Raven's Standard Progressive Matrices, Openness to Experience Scale, and Cognitive Flexibility Inventory- Revised

| | Raven's | Openness | Cognitive Flexibility |
|-------------|---------|----------|-----------------------|
| N | 66 | 65 | 64 |
| Mean | 39.1818 | 254.0000 | 48.2199 |
| SD | 8.18612 | 30.88891 | 6.47783 |

scale includes questions that are divided into six subscales: Curiosity, Aesthetics, Tolerance, Intellectual Efficiency, Ingenuity, and Depth. All items were rated using a 4-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). Some example statements are "I don't like trying new things and would rather stick with what I know", "I like to hear different people's views on political issues", and "I like coming up with imaginative plans". The higher the score the more open someone is.

Cognitive flexibility was assessed with the Cognitive Flexibility Inventory-Revised, which is a valid and consistent measure for evaluating cognitive flexibility¹⁷. This measure is comprised of 14 pairs of statements (each on a 1 to 6 scale; ranging from "Strongly agree with Statement A" to "Strongly agree with Statement B"). Examples include "I enjoy encountering difficult, conflicting, and disorderly concepts and find them challenging" or "I prefer simplicity, consistency, and orderliness. Whenever possible, I prefer not to encounter complex problems in school (although I deal with complexity when I have to)". Higher scores on this inventory indicate more complex epistemic beliefs.

Fluid intelligence was evaluated with Raven’s Standard Progressive Matrices, which is a well-established measure for non-verbal fluid intelligence¹⁸. This scale includes 60 puzzles where participants find the ‘missing piece’ in an increasingly complex visual display of abstract shapes. The score was calculated by how many problems the participants got correct out of 60. For 19-year-olds, a score between 55-60 indicates ‘intellectually superior’ intelligence. An ‘above average’ intelligence score is between 49-54 correct, ‘average’ intelligence is between 38-48, and ‘below average’ intelligence is a score of 37 or less.

Procedure

Participants provided informed consent and were given the packet containing demographic questions, two self-reported questionnaires, and Raven’s Standard Progressive Matrices. Participants could stop at any time. They were thanked, debriefed, and given an opportunity to ask questions.

Analysis

Hypothesis testing was performed using Pearson’s correlation coefficient and separate two-tailed t-tests without correction of alpha for multiple comparisons. Statistical significance was established at alpha <0.05. Effect size and observed power are reported for each correlation. Statistical analyses were conducted using IBM SPSS Statistics 25.

Results

The average scores for each assessment are listed in Table 2. Participants mainly scored in the average intelligence range on Raven’s Standard Progressive Matrices (M=39.18, SD=8.19). However, individual scores on this test ranged from 16/60 correct to 58/60 correct. The mean openness to experience score was 254 (SD=30.88) out of 360 and the mean cognitive flexibility score was 48.21 (SD=6.48) out of 84. These frequencies indicate a sample that is of average intelligence, slightly above average in cognitive flexibility, and above average in openness to experience.

Pearson product-moment correlation coefficients were calculated to evaluate each hypothesized relationship (Table 3). A significant direct correlation was observed between openness and cognitive flexibility (r=0.34, p=0.01, n=63; Figure 1). The effect size was 0.12. The power of the test was 0.55. A significant direct correlation was observed between cognitive flexibility and intelligence (r=0.29, p=0.02, n=64;

Figure 2). The effect size was 0.08. The power was 0.56. There was a trend towards a positive correlation between openness and intelligence (r=0.22, p=0.07, n=65). The effect size was less than 0.05. The power of the test was 0.39.

Table 3. Pearson Correlations for Openness, Cognitive Flexibility, and Fluid Intelligence

| Correlations | | Raven’s | Openness | Cognitive Flexibility |
|-----------------------|---------------------|---------|----------|-----------------------|
| Raven’s | Pearson Correlation | 1 | .223 | .294* |
| | Sig. (2-tailed) | | .074 | .019 |
| | N | 66 | 65 | 64 |
| Openness | Pearson Correlation | .223 | 1 | .337** |
| | Sig. (2-tailed) | .074 | | .007 |
| | N | 65 | 65 | 63 |
| Cognitive Flexibility | Pearson Correlation | .294* | .337** | 1 |
| | Sig. (2-tailed) | .019 | .007 | |
| | N | 64 | 63 | 64 |

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

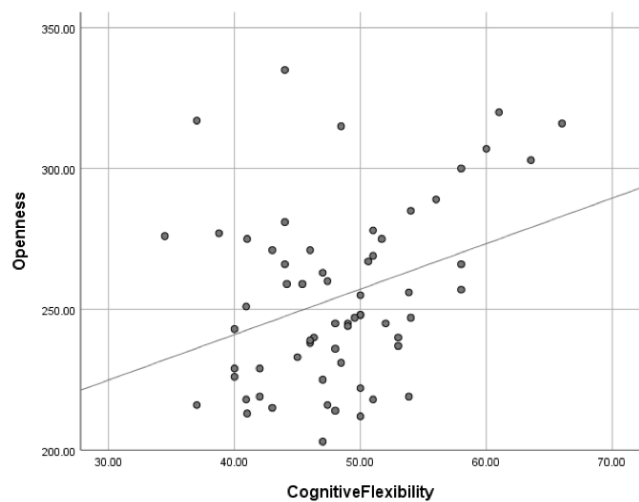


Figure 1. Individual Openness and Cognitive Flexibility scores

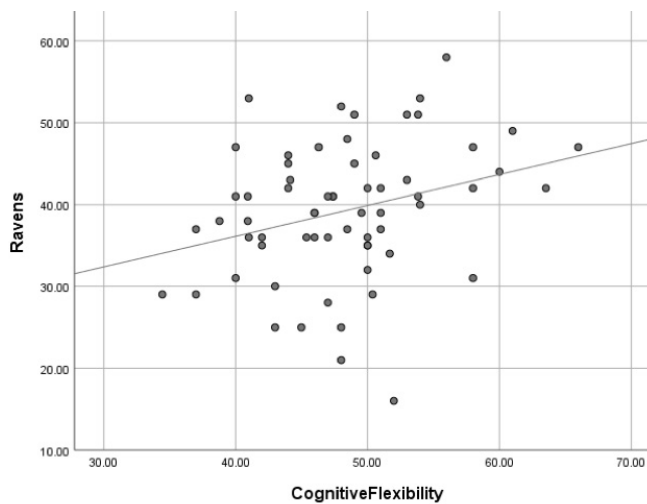


Figure 2. Individual Raven's Standard Progressive Matrices and Cognitive Flexibility scores

Discussion

The present study examined the connections between openness and elements of cognition: cognitive flexibility and fluid intelligence. Positive correlations found between openness and cognitive flexibility as well as fluid intelligence and cognitive flexibility were consistent with previous literature.^{2,7,11,12} This provides further evidence for Murdock's conclusions that there may be an underlying cognitive characteristic linked with openness.¹² Furthermore, results suggested that openness is more closely associated with cognitive flexibility than intelligence. This may indicate that people who are more open may be more inclined to have flexible mental processes, but not necessarily better reasoning. Contrary to our hypothesis, there was a trend toward a positive correlation for openness and intelligence, rather than a significant positive correlation. This may reflect the findings of Schretlen et al. and Deyoung et al., who found openness to be more positively correlated with verbal/crystallized intelligence, than with spatial/fluid intelligence.^{2,7}

A potential implication of these results is that openness reflects a propensity towards cognitive activities that ensure a greater cognitive reserve and reduced risk of cognitive decline and dementia later in life. If people continuously engage in more cognitively demanding tasks and/or continually seek new experiences and ideas, the cognitive aging process may be delayed. Approximately 5-8% of the world's older adult population has been diagnosed with dementia.¹⁹ Dementia is

not an inevitable consequence of aging. Rather, it is a result of lifestyle, biology, environment, and other factors.²⁰ Referring back to the Salthouse study, if cases of cognitive degeneration occur in early adulthood, then it would be advisable to make healthy lifestyle adjustments whenever possible.⁸ Changes should promote optimal mental functioning by remaining receptive to cognitively demanding thinking and tasks.

The current study had some limitations that should be addressed in future work. A small sample of college students that are comprised mostly of the same age, race, and gender are not representative of the entire population. Participants were chosen only out of those enrolled in Introduction to Psychology, which narrows the participant pool. Lastly, Raven's Standard Progressive Matrices was not timed per participant, which may have created variability in test results.

Despite these limitations, the current investigation extended existing work between openness and intelligence by considering cognitive flexibility as a third variable. Future exploration should include additional measures of openness, cognitive flexibility, and intelligence, to see if results are consistent with other scales, as well as a larger and more diverse sample that can be better generalized to the larger population. Similar to the Brem et al. study¹⁵, future research could be conducted utilizing cognitive enhancement tasks, in order to investigate its effects on the cognitive aging process.

Disclosures

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