



## Five factor model personality traits relate to adult attention-deficit/hyperactivity disorder but not to their distinct neurocognitive profiles

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### ARTICLE INFO

#### Keywords:

Adult ADHD  
Cognition  
Profiling  
Inattention  
Inhibition  
Big Five  
Openness  
Neuroticism  
Agreeableness  
Extraversion  
Conscientiousness

### ABSTRACT

Deficits in multiple neuropsychological domains and specific personality profiles have been observed in attention-deficit/hyperactivity disorder (ADHD). In this study we investigated whether personality traits are related to neurocognitive profiles in adults with ADHD. Neuropsychological performance and Five Factor Model (FFM) personality traits were measured in adults with ADHD ( $n = 133$ ) and healthy controls ( $n = 132$ ). Three neuropsychological profiles, derived from previous community detection analyses, were investigated for personality trait differences. Irrespective of cognitive profile, participants with ADHD showed significantly higher Neuroticism and lower Extraversion, Agreeableness, and Conscientiousness than healthy controls. Only the FFM personality factor Openness differed significantly between the three profiles. Higher Openness was more common in those with aberrant attention and inhibition than those with increased delay discounting and atypical working memory / verbal fluency. The results suggest that the personality trait Openness, but not any other FFM factor, is linked to neurocognitive profiles in ADHD. ADHD symptoms rather than profiles of cognitive impairment have associations with personality traits.

### 1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a common neuropsychiatric disorder that is characterized by symptoms of inattention, hyperactivity, and impulsivity. ADHD often persists into adulthood (Faraone et al., 2015). Current research does not support a single core (neuro)cognitive deficit of ADHD, but rather demonstrate that both childhood and adult ADHD are characterized by strong heterogeneity in cognitive underperformance with multiple cognitive pathways (Sonuga-Barke et al., 2010; De Zeeuw et al., 2012; Fair et al., 2012; Coghill et al., 2014b; Mostert et al., 2015b). The main domains of neuropsychological dysfunction in ADHD are: memory, inhibitory control, delay aversion, decision making, timing, and response variability. The levels of deficiency in each of these domains differ more or less independently within patients with ADHD, and there is considerable overlap between neuropsychological performance in patients with ADHD and normal controls (Coghill et al., 2014b). Use of multivariate classification techniques has led to the identification of subgroups of

individuals with ADHD based on a similar neurocognitive profile, both in children and in adults (Fair et al., 2012; Mostert et al., 2015a; van Hulst et al., 2015). Such results provide some structure to the heterogeneity in ADHD. However, the clinical utility of subgrouping based on neuropsychological characteristics in ADHD needs to be explored.

Contributing to the heterogeneity of ADHD is the presence of temperament and personality traits. Temperament traits can be described as a set of biologically based behavioral and emotional tendencies covering negative and positive emotion systems as well as attentional capacities (Rothbart, 2011). A recent study clustered children with ADHD into subgroups based on temperament dimensions of the Temperament in Middle Childhood Questionnaire. The results suggested three novel types of ADHD that were independent of existing clinical demarcations, including DSM-5 presentations (Karlunas et al., 2014). Type 1, the mild type, had milder impulsivity, inhibition, and attentional control impairments compared with the other two ADHD types. Type 2, the surgent type, had increased impulsivity, activity levels and assertiveness, decreased shyness coupled to high intensity pleasure

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<http://dx.doi.org/10.1016/j.psychres.2017.08.037>

Received 7 October 2016; Received in revised form 14 February 2017; Accepted 16 August 2017

Available online 19 August 2017

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seeking than the other two types. Type 3, the irritable type, had increased impulsivity and attentional control impairments than type 1 and increased negative emotionality compared to the other two types. Personality research in general has mostly used the Five Factor Model (FFM) (Costa and McCrae, 1992) as a well-supported organizing framework that has been characterized with respect to underlying temperament dimensions (i.e. the initial state of emotional, motor, and attentional reactivity from which personality develops in interaction with experience) (Rothbart, 2007). The five factors are Neuroticism, Extraversion, Agreeableness, Conscientiousness, and Openness. Briefly, Neuroticism is the predisposition to experience psychological stress in the form of anxiety, anger, depression or other negative affect. Extraversion refers not only to sociability but also to liveliness and cheerfulness. Agreeableness involves trust, altruism and sympathy. Conscientiousness encompasses both a disciplined striving after goals and strict adherence to principles, whereas Openness is seen in aesthetic sensitivity, intellectual curiosity, need for variety, and nondogmatic attitudes. A recent review of findings on ADHD and FFM personality suggests that, in general, ADHD has associations with the FFM traits of Neuroticism (positive), Agreeableness (negative) and Conscientiousness (negative). Mixed findings (positive, negative, and no associations) have been reported for Extraversion and Openness (Gomez and Corr, 2014).

Prior research, mostly assessing the relationship between single tasks or facets of executive function and single FFM traits in healthy participants, suggests that significant associations also exist between FFM traits and neurocognitive functioning, especially executive functioning (for an overview, see (Williams et al., 2009)). Three more recent studies extended that early research by considering all five FFM traits in relation to a more fully characterized domain of executive functioning. A first study among 58 healthy older (mean age 70 years) adults investigated four tests assessing all core aspects of executive functioning (cognitive flexibility, initiation, inhibition, response selection, working memory, generative fluency, and attentional vigilance) (Williams et al., 2010). The results showed that the executive functioning factor, that emerged from four executive functioning scores (one for each executive functioning test), was negatively correlated with Neuroticism and positively with Openness and Agreeableness. But although high Neuroticism was associated with poorer executive functioning, both the middle and high executive functioning groups were in the average range for Neuroticism (compared to normative values). Individuals with better executive functioning were characterized by high Openness and Agreeableness and average levels of Neuroticism. Executive functioning was not associated with Extraversion or Conscientiousness in this study.

A second study, including 182 students, examined three separate core executive function factors (i.e. inhibition, updating/monitoring information in working memory, and cognitive flexibility) as predictors of the five FFM traits (Murdock et al., 2013). Higher Neuroticism and lower Openness were associated with poor updating/monitoring, and Openness was positively associated with cognitive flexibility (the ability to shift one's attention between multiple tasks or mental sets). The authors suggested that Neuroticism and Openness may share some common underlying cognitive mechanism, in particular working memory. Connections between executive functioning and Extraversion, Agreeableness, and Conscientiousness did not emerge in this study.

A third study examined associations between FFM traits and cognitive performance to 1) uncover the specific facets of each trait that are most closely related to cognition, and 2) examine, how these associations may vary by age in 154 healthy older and younger adults (age 22–84). The cognitive domains measured were processing speed, reaction time, verbal fluency, inductive reasoning, and working and episodic memory. Neuroticism (trait) and in particular 'depression' (a facet of Neuroticism) were negatively associated with performance on cognitive tasks that require effortful processing. The results suggested that individuals, who are more angry and depressed, have slower processing speed and lower reasoning scores. Openness (trait) and 'ideas'

(a facet of Openness) were positively associated with verbal fluency, indicating that 'ideas' may be a key characteristic in the association between Openness and cognition. Those open to ideas are likely to spend more time exploring intellectual pursuits, which could translate into a greater facility with words. Extraversion (trait) and 'assertiveness' (a facet of Extraversion) were negatively related to reasoning and reaction time, indicating that extraverted individuals may be faster, but are less likely to take time to think thoroughly about a task. The FFM traits and their facets did not predict working memory or episodic memory in this study. The association between Neuroticism and cognitive performance was found primarily among younger adults. In older adulthood, better performance was associated with positive emotional aspects of personality (positive emotions (Extraversion)) and Openness to feelings (Graham and Lachman, 2014).

So far, the studies of cognitive performance and personality did not take the presence of psychopathology into account. In the present study, we follow-up on this previous work regarding the subtyping of ADHD by cognition and temperament. Specifically, we examined, whether adults with ADHD and healthy controls, who share similar neurocognitive profiles, also share specific personality traits, or, alternatively, whether ADHD is related to personality irrespective of a specific neurocognitive profile. To this end, we built on our earlier work, in which we had identified by community detection analysis three subgroups of patients and healthy controls based on cognitive profiles. Community detection is a technique based on graph theory to identify clusters within networks of participants that are highly correlated with each other, and marginally correlated with participants from other clusters (Newman, 2006). In this case the network represents correlations between individuals in terms of neuropsychological performance. The three subgroups were characterized by (1) poor performance on attention and inhibition, (2) high scores for impulsive behavior on the delay-discounting task (delay aversion), (3) impairment on working memory and verbal fluency (Mostert et al., 2015a). Given the recent evidence for the relationship between executive functions and FFM trait outcome as outlined above, we anticipated that our previously identified profiles 1 and 3 would be associated with higher Neuroticism and lower Openness. Further, in keeping with previously found associations between Extraversion and higher delay aversion rates (Hirsh et al., 2008), we also anticipated that Extraversion would be positively related to our cognitive profile 2. Alternatively, if it would be the ADHD symptoms that accounted for FFM trait outcome rather than the cognitive profiles, we expected to find associations of the FFM traits with diagnostic group, irrespective of cognitive profile membership. Such associations could be expected for Neuroticism, Conscientiousness, and Agreeableness. The results can add to the understanding of the associations between FFM traits and executive functioning, in particular in an adult ADHD population.

## 2. Methods

### 2.1. Participants

A total of 265 participants (133 adults with ADHD and 132 healthy controls) between 18 and 65 years old were included in this study. All participants were part of the Dutch node of the International Multicentre persistent ADHD Collaboration (IMPACT – <http://impactadhdgenomics.com> (Franke et al., 2010)). Participants had been recruited from the Department of Psychiatry of the Radboud University Medical Center (RadboudUMC) in Nijmegen and through advertisements. Patients were included if they had previously been diagnosed with adult ADHD by a psychiatrist according to the Diagnostic and Statistical Manual of Mental Disorders (4th edition; DSM-IV-TR; American Psychiatric Association, 2000). Exclusion criteria were psychosis, alcohol, or substance addiction in the last six months, current major depression, full-scale IQ estimate < 70, neurological disorders, sensorimotor disabilities, non-Caucasian ethnicity, and medication use

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