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THE RELATIONSHIP BETWEEN BEHAVIOR ASPECTS OF EXECUTIVE FUNCTIONS AND PERSONALITY TRAITS IN HEALTHY YOUNG ADULTS

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The data that support the findings of this study are available from the corresponding author upon reasonable request

Compliance with ethical standards

The research was approved by the Institutional Ethics Committee of the Faculty of Philosophy (#02-374/15), the Committee for Ethics of Clinical Trials at the Faculty of Medicine (#01-39/229/1) at the University of Novi Sad. All procedures performed in this study were in accordance with the ethical standards of 1964 Helsinki Declaration and its later amendments.

Abstract

Executive functions (EF) are complex cognitive processes that govern our behavior and thoughts. Associations between personality traits and executive functions clarify the mechanisms of a person's ability to function in everyday situations. The main goal of this study was to explore different personality dimensions relevant to the prediction of two different executive functions – Inhibition and Working Memory. The Big Five Inventory (BFI) and the Adult Executive Functioning Inventory (ADEXI) were administered on a community sample comprising 549 young adults aged 18-35 years (mean age 22.10 years, SD 3.13). After controlling for age, gender and level of education, Conscientiousness and Extraversion were the most predictive personality traits, while Neuroticism and Agreeableness made specific contributions to the prediction of one of the two executive measures: Working Memory or Inhibition. Specifically, high Conscientiousness and Extraversion with low Neuroticism were significant predictors of Working Memory ability. On the other hand, high Conscientiousness and Agreeableness with low Extraversion predicted better Inhibition ability. These findings support the conclusion that these dimensions of individual differences seem to have numerous points of overlap at both psychological and neurobiological levels, but differences between these constructs are still significant.

Keywords: Executive functions, working memory, inhibition, personality traits, young adults

INTRODUCTION

Research evidence for the interplay between two fundamental constructs of individual differences suggests that personality and cognition are related at phenotypic and genetic levels (e.g., Curtis et al., 2015; Rammstedt et al., 2018; Nikolašević et al, 2021). At least on the surface, executive function as a cognitive measure shares many conceptual characteristics of some personality traits, which the literature has documented using similar concepts and characteristics to define strategies in both personality and executive function domains (Bergvall et al., 2003). Executive function represents cognitive functions that are vital for goal-directed behaviors as well as the self-regulation of thought and emotion (e.g., Suchy, 2009). More precisely, executive function (EF) represents an umbrella term for various higher cognitive functions that allow a person to successfully organize and manifest behaviors that are adaptable, goal-oriented, and controlled. (Anderson et al., 2008; Suchy, 2009). A plethora of skills and processes have been encompassed within definitions of executive functions – response selection, initiation, the ability to inhibit or delay responses, set formation, set maintenance time, the organization of behavior, goal anticipation, activity monitoring, cognitive flexibility, and the selection of problem-solving strategies.

Modern trends in theory and research on executive functions are oriented towards their analysis into a larger number of subordinate functions and the examination of mutual relations between such subcomponents of the executive system of functions. To date, Miyake and Friedman's model remains one of the most influential works in this field, with its contribution to the systematization and conceptualizations of executive functions being most substantially supported by empirical evidence. According to this three-factor model of EF (Miyake & Friedman, 2012), executive functions are composed of multiple subfunctions that may be

grouped together in three specific functions – task switching, memory updating, and response inhibition. These three EF abilities are separable (diversity), but also moderately correlate with one another and thus share a considerable common variance (unity). Inhibition refers to the ability to deliberately stop dominant, conflicting, or automatic responses when required and to protect working memory from different distractors (Diamond, 2013). Thus, the core of this EF component is reflected in the suppression of the dominant response or adequate control of interference stimuli (Miyake et al., 2000). More broadly, this ability to inhibit is also considered to be essential in the cognitive or emotional domain. Cognitive flexibility or set shifting reflects the ability to efficiently and quickly switch between mental sets, operations or multiple tasks (Miyake et al., 2000). Working memory or updating describes the capability to store and process a limited amount of data or information in which task-relevant information is constantly monitored and manipulated in order to enable complex behavior (Ullsperger & von Cramon, 2006).

For years, EF research was focused on cool cognitive aspects elicited by performance-based neuropsychological tests. These kinds of tests are always given under highly standardized conditions, with a single examiner and response time and accurateness as the usual dependent measures. In contrast to the use of performance-based neuropsychological tests, EF can be estimated using a behavioral assessment self-report scale that measures the extent of EF impairment in daily behaviors. Given the challenges of executive function estimation in standardized conditions and inherently limited relevancy in daily surroundings, behavioral assessment self-report scales of executive function have been devised to ensure an ecologically valid measure of capacity in complex, daily problem-solving situations (Roth et al., 2005; Toplak et al., 2013). These two kinds of assessment seem to grasp distinct levels of cognition,

i.e., success in goal/plan pursuit and the effectiveness of cognitive abilities (Toplak et al., 2013). Some authors explain this difference by suggesting that the construct of executive function can be divided into a cognitive segment that is estimated by performance-based tasks and a behavioral segment that is evaluated by the rating scales (e.g., Anderson et al., 2008). Others, like Tolpak et al. (2013), deem it more plausible that cognitive tasks estimate the underlying ability whereas the rating measures the application of those skills at home and in an academic environment.

On the other hand, personality traits are defined as a persistent set of thoughts, feelings, and actions that occur in response to particular situational demands (Mischel et al., 2004). Costa and McCrae (1992) similarly define personality traits as dimensions of individual differences in tendencies to show consistent patterns of thoughts, feelings, and actions. Researchers agree that most personality traits can be understood through the dimensions of two well-known personality models: the Five Factor Model and the Big Five Model. The mentioned models recognize the following traits: Extraversion, Conscientiousness, Neuroticism, Agreeableness, and Openness to Experience. These five basic dimensions were revealed primarily by factor-analyzing trait ratings. The robustness of this strategy and the persistence of these five dimensions have been supported by the results of various studies in a variety of languages and cultures (McCrae & Allik, 2002), through different ways of assessment (McCrae & Costa, 1987), and across different factor analysis strategies (Goldberg, 1990). These basic dimensions are stable over time and together integrate different psychological mechanisms that have proven helpful in explaining specific types of behavior (McCrae & Costa, 2004; Heine & Buchtel, 2009).

Since individual differences in EF are reflected in characteristic ways of thinking and behaving, the importance of examining their connection with the established patterns is imposed

by individual differences in personality. The examination and understanding of this relationship could have potential utility in a substantive or theoretical sense, but it could also yield applied and practical contributions. A line of research that has provided a significant theoretical framework is the examination of the neurocognitive aspect of personality (e.g., DeYoung et al., 2010) or the explanation of how EF mechanisms underlie personality. It is noteworthy that EF and personality have been related to similar brain structures that primarily relate to the prefrontal cortex (DeYoung et al., 2010). Executive functions as a set of cognitive processes and the prefrontal cortex as the neural base underlying executive functions both appear to be closely associated with personality (Chow et al., 2000). With the research lens focused on the level of biological mechanisms (molecular), some theorists refer to executive functions as neural endophenotypes, i.e., variables closer to the biological base that can be linked to complex behaviors that determine personality through connections with different genotypes (Canli, 2008). At the phenotypic level, there is general agreement that it is executive abilities that are essential for behavioral control. More precisely, they do not only constitute important components of self-control, emotions, and socially adjustment (e.g. Anderson, 2002; Hofmann et al., 2012) but they are also embedded in independent, purposeful, and goal-oriented behavior (Lezak et al., 2004). Hence, these cognitive measures predict real-world behavior that reflects problems regarding control over motivational and emotional propensities. Evaluating the phenotypic relations between trait impulsivity and EF constructs, some studies have imputed that EF and impulsivity represent opposite ends of the continuum (Bickel et al., 2012). Furthermore, certain aspects of EF are crucial to the occurrence and management of life stress or stress risk and resilience (Williams, et al., 2009), which are traditionally associated with personality. Therefore, integrating these two different spheres of individual differences should provide us with a greater

understanding of how people vary on constructs that may constitute the principal foundations of human behavior. Additionally, when it comes to the practical implications of the importance of understanding the connection between these two constructs of individual differences, they are reflected in the precise recognition of predispositions to certain types of tendencies towards inadequate patterns of behavior, and consequently, the creation of interventions in the applied environment to overcome them.

The examination of relations between personality traits and executive functions can be roughly classified into a few lines of inquiry according to the measures/model of personality used, the specific population in which these relations are explored, as well as the range that measures capture (tasks based on a single vs. multiple executive functions and a sole personality variable). There is almost no doubt that executive functions play an important role in psychopathological personality functioning, but there is a lack of data that would speak of their differential connection with the normal personality structure. Specifically, a numerous studies have demonstrated that different EFs are linked to maladaptive personality characteristics or personality disorders (e.g., Morgan & Lilienfeld, 2000). Another line of research has focused on personality–EF links, with personality traits most often operationalized in isolation and/or through clinical inventories. The investigation of the relationship between EF and Extraversion has resulted in controversial findings. While Murdoch and colleagues documented no connection between Extraversion and Shifting, Updating, and Inhibition, there are findings that indicate positive relationships with Shifting and Updating (Campbell et al., 2011). Research has also implied an association between Working Memory and Extraversion (Lieberman & Rosenthal, 2001). In most studies, Neuroticism proved to be negatively correlated with EF processes – Inhibition (e.g., Luu et al., 2000) and Working Memory (Updating) (e.g., Saylik et al, 2018).

DeYoung, Peterson, and Higgins (2005) found Openness to Experience to be positively related to achievement on cognitive tasks constructed to estimate executive function. Research on the relationship between Conscientiousness and cognitive performance has been less conclusive. Research has suggested that Conscientiousness may also be associated with Updating/Working Memory as well as Inhibition (e.g., Jensen-Campbell et al., 2002; Logan et al., 1997). One group of studies did not reveal significant correlations with various cognitive abilities (e.g., Reynolds et al., 2006). Studies of the relationship between EF and Agreeableness have resulted in controversial findings. Jensen-Campbell and collage. (2002) discovered that higher Agreeableness is related to better Inhibition and Cognitive Flexibility. On the other hand, some studies reported no association when Updating, Inhibition, and Shifting were examined individually (Murdock et al., 2013).

The smallest group of research has dealt with relations between entire personality models and executive functions. One study that used the Five-Factor Model as a measure of personality showed the five dimensions of personality to be differentially connected to executive functions, with the Extraversion dimension being negatively associated with attention and openness and moderately positively associated with fluency, while neuroticism, conscientiousness, and collaboration showed zero correlations with executive functions (Unsworth et al., 2010). In a group of older adults, a composite measure of executive functions was positively related with openness to experience and collaboration and negatively associated with neuroticism (Williams et al., 2010). Researchers have suggested that better achievement in Updating/Monitoring is related to a higher score on Openness and a lower score on Neuroticism. Openness also has a positive connection with the domain of Cognitive Flexibility (Murdock et al., 2013).

In studies linking personality and cognition, most researchers have referred to the Big Five model of personality and executive functions have predominantly been measured using performance-based tasks. To date, only few studies (Bell et al., 2020; Buchanan, 2016; Formicola, 2009; Meltze et al., 2017) have investigated EF measures as rating scale/self-report measures and personality traits. On a sample of college-age participants, Formicola (2009) revealed a significant association between Neuroticism and the two measures of Emotional Control and Shifting, which indicates that people with higher Neuroticism would find it more difficult to control their affect and have more difficulties in shifting when solving problems. Research has shown significant correlations between Openness and better capacity to shift during problem-solving, while higher Conscientiousness and higher Agreeableness have been found to be related to better ability to inhibit behavior. Another three studies (Bell et al., 2020; Buchanan, 2016; Meltze et al., 2017) conducted on samples of older adults consistently demonstrated that lower Conscientiousness and higher Neuroticism result in greater impairment in subjective executive functioning.

Current study

Since previous studies have indicated many controversies regarding the complex association between cognitive ability and personality as the most important constructs of individual differences, in a purely theoretical sense, the main purpose of this study was to further improve the understanding of their mutual relationships and expand the body of knowledge in this area. To date, a modest number of studies have dealt with the relationship between personality traits and executive functions. In spite of the fact that the body of literature is still scant, especially when it comes to behavioral aspects of executive functions and personality dimensions, almost all dimensions of the Five-Factor Model (Openness to Experience,

Agreeableness, Neuroticism, Extraversion, and Conscientiousness) have been revealed as the most stable correlates of executive functions. More specifically, the aim of this study was to discover different personality domains relevant to the prediction of two executive functions. Since these are two different EF domains, we expected each of them to achieve a specific pattern of connection with personality traits. When it comes to the dimension of Inhibition, based on the results of previous studies, we expected that the dimensions of Neuroticism (inverse), Extraversion (inverse), and Agreeableness (as opposed to the dimension of aggressiveness) would make the most significant contributions to the prediction of good inhibition ability. On the other hand, we expected better Working memory performance as a part of executive abilities to best predict the traits of Neuroticism (inverse), Openness to experience, Introversion, and Conscientiousness. Compared to existing literature, the current study sought to extend prior research by examining executive functions and personality traits using non-clinical inventories (behavioral inventory) in the non-clinical population in order to determine the nature of their connection in the general population. Thus far, research on the connection between the mentioned phenomena has mostly been oriented towards the adolescent age as well as older adulthood. Therefore, by focusing on young adults, this research makes an additional contribution to the findings in this area. Namely, executive functions show different rates of maturation, reaching their full maturity or being largely solidified (Happaney et al., 2004) in young adulthood. In this regard, this age represents a unique developmental period in which to examine questions related to the links between personality characteristics and EF. Therefore, by providing a clearer insight into the nature of the investigated construct and the various measures used to assess it, this research also contributes to the improvement of the body of knowledge, which would have important practical implications that could be useful to practitioners.

METHODS

Participants and procedures

The sample consisted of 549 young adults from Serbia aged between 18 and 35 years (M = 22.10; SD =3.13). The sample included about 80.5% female and 19.5% male participants. The majority (73%) were students or had finished university or college. They participated in the research on a voluntary basis without any incentive.

Ethical Compliance: Prior to conducting the research, we obtained the permission of the Ethical Committee of the Institutional Ethics Committee. Every subject was familiarized with research goals and gave their informed written consent to take part in the research. All procedures performed in this study were in accordance with the ethical standards of the Institutional Ethics Committee and with the 1964 Helsinki Declaration and its later amendments.

All instruments were administered using the Google Forms platform. After giving written informed consent, the participants proceeded to answering questions about sociodemographic characteristics and then filling out questionnaires including the ADEXI and the BFI. The data were collected during December 2019 and January 2020.

Measures

The Adult Executive Functioning Inventory (ADEXI; Holst & Thorell, 2018) was used to assess executive functions. The ADEXI is a self-administered scale containing 14 items that measure two dimensions/domains of EF. The measure of inhibition deficits is composed of 5 items (e.g., “I sometimes have difficulty stopping myself from doing things that I like even though someone tells me that it is not allowed”) and the measure of working memory deficits comprises 9 items (e.g., “I have difficulties with tasks or activities that involve several steps”).

Response options require subjects to rate themselves on a five-point scale (e.g., 1 = Not True and 5 = Definitely True), with higher scores indicating greater deficits and vice versa. This instrument represents an adult version of the Childhood Executive Functioning Inventory (CHEXI; Thorell & Nyberg, 2008). Both of these instruments are freely available and have demonstrated acceptability and usefulness in clinical and research utility. The psychometric quality of this scale has been proven and the instrument has been demonstrated to discriminate well between adults with ADHD and controls (Holst & Thorell, 2018).

The Big Five Inventory (The Big Five Inventory – BFI: John, Donahue, & Kentle, 1991). This inventory comprises five scales intended to assess the prototypical dimensions of the Five-Factor Model (Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness). The final version of the questionnaire comprises 44 items that the experts collectively identified as the best descriptors. Items are rated on a 5-point response scale. Research conducted thus far has shown the discriminant and convergent validity of the questionnaire to be satisfactory (e.g., John-and-Srivastava, 1999).

Statistical analysis

All statistical analyses were performed using SPSS IBM for Windows v.26 (IBM Corp, 2019). The normal distribution of all variables was evaluated by Skewness and Kurtosis. The internal consistency or coherence of the scales was assessed with Cronbach's alpha. Linear multiple regressions were performed in order to investigate relationships between executive measures and personality traits (BFI), entering age, gender and level of education as control variables.

RESULTS

Descriptive statistics and correlation coefficients for all measures used are summarized in Table 1. In terms of conventional criteria (±1.5; see Tabachnick & Fidell, 2013), the values of Skewness and Kurtosis for all scores indicated non-violation of normal distribution. Cronbach's alfa computation for personality measures yielded high coefficients of internal consistency, ranging from .0.723 to 0.886. This indicated good inter-item consistency. The calculated Cronbach's α coefficients for executive measures had a high value for the Working Memory domain, but proved weak for measures of Inhibition (α=0.589). The internal consistency coefficient of the total ADEXI score was high (α = 0.870). Correlations among the used personality measures showed a pattern of significant association whose intensity ranged from low to high. The correlation between the two dimensions of executive measures had a moderate intensity. Correlation coefficients between the criterion and the predictor mainly showed the negative direction of the relationship, with intensity ranging from low to high. Only the dimension of Neuroticism and the executive dimension had a relationship in the positive direction. The table 1. also shows correlations for the analyzed measures and control variables (age, gender and level of education).

<< INSERT TABLE 1 ABOUT HERE >>

Linear multiple regressions (enter method) were carried out to explore the significance of the used personality dimensions as predictors of executive functions. Specifically, Working Memory and Inhibition were set as the criteria, while the five personality traits were entered as predictors. Participants' age, gender and level of education were controlled in the regression models as well. A preliminary analysis was carried out in order to determine the normality,

linearity, and homogeneity of variance and covariance. The analysis confirmed that assumptions for performing the multiple regression analysis were valid. The potential multicollinearity among predictors was also excluded. Multicollinearity indicators suggested that multicollinearity was not present in the predictor set: all Variance inflation factor statistics were < 10.

<< INSERT TABLE 2 ABOUT HERE >>

According to the obtained results, both regression functions were statistically significant. Contributions of predictors and characteristics of regression functions are shown in Table 2. The results of the regression analysis with Working Memory as the criterion variable showed that the set of predictors explained 33.41% of the variance of the criterion. The analysis suggests that Conscientiousness and Extraversion negatively predict Working Memory measures. Conversely, Neuroticism had positive relations with the criteria. Table 2. shows that personality traits accounted for 28.98% of the variance in the executive measure of Inhibition. Conscientiousness and Agreeableness were statistically significant predictors of Inhibition. While Conscientiousness and Agreeableness were negative predictors, Extraversion showed positive relations with the criteria.

DISCUSSION

There is a divergence of opinions and findings regarding the overlap of the construct of executive function and personality traits. The main goal of our research was to shed light on this association, taking into account the full range of personalities within the Five-Factor Model and

using less frequently examined, behavioral aspects of executive functions and self-report measures on the non-clinical population. These results confirm previous findings on the relationship between cognition and the Big Five personality traits. Specifically, based on our results, there is an argument to maintain the opinion that personality predicts significant variability in executive measures, both Inhibition and Working Memory.

After controlling for age, gender and level of education among personality traits, Extraversion and Conscientiousness proved to be the best predictor traits, while Neuroticism and Agreeableness made specific contributions to predicting one of the two executive measures, Working Memory or Inhibition. Only the Openness trait showed no significant relationships.

The Working Memory dimension focuses on the ability to direct attentional and mnestic resources in order to allow for the manipulation and integration of relevant information into the consciousness to perform a task or reach a goal. Consideration of the correlates of the executive function of Working Memory reveals three main findings – the associations of Working Memory with Conscientiousness, Extraversion, and Neuroticism. Conscientiousness showed the highest correlation with this EF. Specifically, individuals who score highly on Conscientious, having the trait of self-discipline, tend to be persistent, organized, thorough, efficient, and responsible, showing better working memory capacity or better updating ability. This relation is somewhat expected since both constructs conceptually cover behavioral control and assumed goal directedness. The rationale underlying this relation is that persons with high scores on the Conscientiousness trait show a more adequate, step-by-step approach to various activities required to realize a plan. Our results are in line with previous findings that demonstrated strong associations between Conscientiousness and performance measures of executive function (e.g., Jensen-Campbell et al., 2002; Meltzera et al, 2017).

Our results and previous study findings are consistent in demonstrating that adult extraverts show better performance on more difficult tasks and updating tasks. On the other hand, introverts achieve the best results on set shifting tasks (Campbell et al., 2011). A relevant study revealed that under emotionally neutral, cognitively challenging conditions, adults with high Extraversion exhibited better working memory performance compared to introverts (Lieberman & Rosenthal, 2001). The authors suggested that with higher degrees of extraversion came higher levels of available dopamine.

On the other hand, the three earlier studies found no such relationship between personality traits and subjective executive function (Bell et al., 2020; Buchanan, 2015; Meltze et al., 2017). The suggested inconsistency between previous research and our study could primarily stem from age differences between study participants and the employment of different measures. All three previous studies were conducted on samples of older adults.

Finally, Neuroticism showed associations with measures of Working Memory. Specifically, negative affect corresponded to poorer subjective executive function of Working Memory. This result establishes what has been reported in earlier studies. Namely, pronounced personality traits related to anxiety, negative emotions, and stress are linked to more cognitive deficits, specifically, more perceived difficulties (Bell et al., 2020; Murdock et al., 2013; Luu, Collins, & Tucker, 2000). These negative affective states can lead to reduced engagement and problem-solving efforts. Therefore, impaired concentration and distraction have immediate negative effects on one's problem-solving capacity. Alternatively, adults with more pronounced Neuroticism are likely to persistently and repetitively think about problems, including problems with subjective executive function, and overemphasize their significance.

The Inhibition scale refers to the capacity to stop one's own actions, to resist and not act on impulse or stop one's own behavior at the right time. Consideration of the correlates of the executive function of Inhibition reveals three main findings – the links of Inhibition with Extraversion, Conscientiousness, and Agreeableness.

As in the case of Working Memory, the trait of Conscientiousness made the strongest individual contribution to the prediction of the Inhibition function. The obtained association suggests that more conscientious individuals are worse at inhibiting dominant responses, while less conscientious individuals are more successful in this type of process or ability. Conscientiousness is considered to be the most anticipated positive correlate of different executive functions, primarily Inhibition, because the definitions of these two constructs are highly similar (Williams et al., 2010). As mentioned earlier, there is a certain overlap between the construct of EF and Conscientiousness, in the sense that they share certain characteristics, such as self-regulation and effortful control. In other words, Inhibition demands the attributes associated with Conscientiousness, such as being able to manage and refrain from impulse behavior, which has been confirmed by the results of previous studies (e.g., Jensen-Campbell et al., 2002; Logan et al., 1997; Meltze et al., 2017). Moreover, Conscientiousness is the only Big Five trait that appears to be associated with volume disparities in the dorsolateral prefrontal cortex, a neural substrate that has a critical role in executive functioning (DeYoung et al., 2010).

The research yielded robust findings on the negative association between Inhibition and Extraversion. In other words, people who are dominant tend to be socially successful, strong, full of energy, and prone to experiencing positive emotions. They find it more difficult to inhibit their dominant responses in situations in which it is desirable to withdraw. Conversely, withdrawn, reserved individuals, who are patient and strictly control their feelings, tend to be

more successful in this process. More specifically, people who are low on Extraversion are less assertive, engage less in social activities, and prefer to scan situations before they partake. This certainly largely corresponds to the behavioral pattern that is characteristic of behavioral inhibition. The results of the research indicate the existence of associations between the measures of Agreeableness and the measures of Inhibition. A marked Agreeableness trait has been associated with a prosocial, altruistic, trustful, and cooperative nature and has likewise been linked to reduced anger and reduced aggression. This dimension is obviously connected to executive functions via the inhibition of unsuitable interpersonal behavior and it involves self-regulation processes (Williams et al., 2010). This result is in line with the finding of a study by Jensen-Campbell et al. (2002), who showed that greater pleasure was related to better inhibition and cognitive flexibility. Furthermore, this association was highlighted in an investigation performed on a sample of college-age participants in which executive function was estimated by self-reported measures (Formicola, 2009).

Somewhat surprisingly, the finding that Neuroticism did not significantly predict variability in the EF of behavioral inhibition (even though the zero-order correlation was significant) does not align with some previous studies that found an association (Luu et al., 2000). The disagreement could partly be explained by differences in methods of assessment of executive function. However, Linnenbrink, Rian, and Pintrich (1999) came to the conclusion that Neuroticism may be particularly associated with Updating/Monitoring, while Inhibition did not show a significant association in their study.

Another interesting finding to emerge from our study was that the well-documented association between Openness and executive function was not replicated in these data, at least when it comes to assessment through performance measures. Namely, based on zero-order

correlations, there is a significant association between Working Memory and Openness in comparison to simultaneous measuring with another personality trait. Differences in assessment modality likely explain a part of the disagreement. This is supported by the results of studies that used behavioral assessment of executive functions. In these studies, Openness was not related to the reported difficulty in the domain of subjective executive function (e.g., Bell et al., 2020). Findings from previous studies indicate that performance-based dimensions of Inhibition involve cognitive operations that are separate from affective and motivational processes evaluated by questionnaires (Toplak et al., 2013). However, these findings need further exploration.

Conclusions and Implications

More than clearly, neurosciences represent a research field in expansion that is dedicated to understanding the way cognitive functioning occupies one of the more important places in this field. Executive functions as an umbrella construct in this sphere obviously represent an oft-used construct in modern research. An investigation that uses the phenomena of border or frontier areas, such as cognitive and conative abilities, further enriches the body of theoretical knowledge. However, based on the current understanding of the relationship between these phenomena, it seems that a number of doubts of a conceptual nature still remain. Consequently, this research contributes to a better understanding and the improvement of knowledge about the mentioned constructs. Therefore, in a purely theoretical sense, it represents a kind of validation of the results in this field. A general conclusion that can be drawn from the above is that there is undoubtedly an overlap between the cognitive domains of executive functions and intelligence and the conative domain of personality traits. This overlap is not complete. On the contrary, the connections proved to be of low to moderate intensity, which indicates significant differences

between these constructs. To the best of our knowledge, the present research is one of the few to investigate executive functions and personality traits by using non-clinical inventories (behavioral inventory of EF) in the non-clinical population. The ADEXI is often compared to other behavioral rating scales. In this sense, it is more appropriate for the assessment of EF in adults with no clinical diagnoses. It is a tool that is different from other preexistent scales and inventories and it is useful in diverse contexts of evaluation. This study extends prior research by considering broad personality taxonomies and more EF measures. It contributes to the ongoing conceptual or empirical debate about relationships between the two concepts of individually differences. The added value of this study is reflected in the use of a sample of participants in young adulthood, when executive functions stabilize, which gives additional validity to the examination of this relationship.

When it comes to the practical implications, this research may help practitioners understand which personalized strategies in training or teaching best cater to the strengths of the individual. Specifically, this information can offer guidelines for the selection of the optimal training regimen based on individual personality profiles. It may be helpful to target these functions with interventions, which may subsequently alter one's feelings, thoughts, and actions or reinforce and stabilize character traits. For example, based on the level of neuroticism, the specific anxiety and/or depression level can be determined, along with the appropriate cognitive training task to reduce it. Additionally, several studies have concluded that considering the role of individual differences seems to be crucial when evaluating the efficacy of training, giving the recommendation that individual differences in personality should be considered in future cognitive intervention studies to optimize the efficacy of training (Studer-Luethi et al., 2012). These trainings can be applied equally well in professional and educational settings. Since this

research deals with young adults who are mostly students, personalized interventions can be aimed at creating adequate strategies designed to improve students' EF skills, consequently affecting academic performance (e.g., executive coaching; Dawson and Guare 2012) or leading to better management of work tasks in academic and professional environments, as well as management of life stress or stress risk and resilience.

Limitation of study and suggested

Despite these advancements, the following constraints must be taken into account when analyzing the results. The primary concern would be that the specific qualities of the sample used in our research might have influenced the results. Namely, the sample in our study contained, on average, upper-level education participants (college sample). Therefore, less variability could be expected in both measures of EF as well as personality dimensions, albeit to a lesser extent. This could decrease the correlation coefficient and consequently limit the generalizability of the findings. Furthermore, the study included a greater number of female relative to male participants. In this regard, it would be useful to validate the obtained results on a more balanced sample in terms of gender. Since a slightly lower reliability of the inhibition domain was obtained, the interpretation of the magnitude of the influence in the dimensions from the personality domain should be taken with some caution. Future research should examine the nature of the relationship between these measures with more fine-tuned testing, which implies the use of subdimensions or facets of personality traits. Likewise, future investigations may benefit from a more comprehensive exploration of executive abilities, including measures of the Shifting ability. In subsequent research, it would be useful to include respondents of different education levels, specifically, with diverse educational and career backgrounds, since EFs are related to these environmental variables. Consideration of the relationship in the context of

different developmental stages and through longitudinal follow-up would contribute to a clearer understanding of this research problem. In this regard, the inclusion of samples of different developmental stages would be highly significant in this research paradigm. Consideration of the genetic and environmental influences underlying the relationship between these two constructs would certainly contribute to a deeper understanding of the etiology of individual differences.

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Data availability statement:

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Conflict of Interest

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

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Table 1. Descriptive Statistics, Alpha (α) Reliabilities, and Correlations for the Analyzed Measures

	min-max	Mean	SD	*Sk*	*Ku*	*A*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1. Neuroticism	8-40	23.95	6.16	0.057	-0.516	0.832							
2. Extraversion	11.0-40.0	27.52	5.81	-0.298	-0.534	0.817	-.393**						
3. Openness	16.0-49.0	36.96	6.41	-0.543	0.132	0.814	-.188**	.261**					
4. Agreeableness	16.0-45.0	35.81	5.06	-0.692	0.650	0.755	-.391**	.339**	.147**				
5. Conscientiousness	14.0-45.0	32.73	5.99	-0.432	-0.143	0.833	-.388**	.248**	.133**	.376**			
6. Working Memory	9.0-44.0	20.19	5.57	0.676	1.15	0.832	.364**	-.314**	-.170**	-.241**	-.541**		
7. Inhibition	5.0-25.0	14.23	3.58	0.122	-0.324	0.589	.163**	.051	-.006	-.265**	-.464**	.419**	
Gender							.157**	.053	-.052	.115**	.034	.002	-.086*
Age							-.034	-.041	-.035	-.060	.143**	-.067	-.166**
Level of education							-.005	-.022	-.068	-.051	.140**	-.058	-.155**

Note. Sk – skewness; *Ku* – kurtosis; *α* – Cronbach's reliability coefficient. Numbers under diagonal, in the right part of the table, are bivariate correlations between pairs of measures

Table 2. Personality Traits as Predictors of Executive Function – Working Memory and Inhibition

Predictors	Working Memory			Inhibition		
	β	t	VIF	β	t	VIF
Gender	-0.006	-0.15	1.12	-0.054	-1.30	1.11
Age	-0.005	0.11	1.42	-0.071	-1.52	1.07
Level of education	-0.012	-0.28	1.40	-0.057	-1.23	1.07
Neuroticism	0.144	3.09**	1.49	-0.014	-0.30	1.49
Extraversion	-0.127	-2.87**	1.35	0.208	4.58**	1.34
Openness	-0.065	-1.62	1.11	0.018	0.43	1.11
Agreeableness	0.047	1.02	1.42	-0.174	-3.73**	1.41
Conscientiousness	-0.465	-10.56**	1.33	-0.457	-10.09**	1.31
F(8, 447)	29.53**			F(8, 453)	24.51**	
R^2	0.346				0.302	
R^2_{adj}	0.334				0.290	

Note. t – value of t-test; VIF – variance inflation factor; β = standardized regression coefficient; SE = standard error; r = zero order correlation; R2 = coefficient of determination; R2 adj = adjusted R2. * p < .05. ** p < .01.