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ACADEMIC ACHIEVEMENT AND PERSONALITY TRAITS:

An empirical and neurobiological investigation.

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Academic Achievement and Personality Traits: An empirical and Neurobiological Investigation

Submitted by Helena Bjurberg to the University of Skövde as a final year project towards the degree of B.Sc. in the School of Bioscience. The project has been supervised by Kristoffer Ekman.

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I hereby certify that all material in this final year project which is not my own work has been identified and that no work is included for which a degree has already been conferred on me.

Signature: _____

Abstract

The present thesis explores how personality traits are connected to academic achievement. First, a theoretical discussion on the neurobiological basis of different personality traits is presented, where variance in brain- activity, volume and chemistry describes possible differences in personality. Traits previously linked to academic achievement is also described in terms of neurobiology. This is followed by an empirical investigation of the connection between personality traits and academic achievement. Previous research suggest the Big Five (Costa & McCrae, 1992a) personality traits of conscientiousness, order and self-discipline to be positively associated with academic achievement. Also, similar suggestions have been put forward concerning the Values in Action (VIA-IS; Peterson & Seligman, 2004) character strengths of love of learning, self-regulation and persistence and academic achievement. 90 students in a medium sized Swedish senior high school completed the two personality inventories and their grades were collected. Positive correlations were found for the personality traits conscientiousness, order, and self-discipline and for the character strengths persistence, love of learning, perspective and open-mindedness. The results partly supported the hypotheses as well as extended the knowledge about what factors contribute to academic achievement. Discussion of the results and suggestions for further research concludes the thesis.

Keywords: personality trait, character strength, neurobiology, academic achievement, BFI, VIA-IS

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Introduction

The area of learning and education can gain from increased knowledge about what factors that enable academic achievement (O'Connor & Paunonen, 2007). An individual spend a lot of time as a student, and a great part of countries economics are spent on educational activities, thus it is valuable to understand academic achievement in different ways (Poropat, 2009). Furthermore, in a more broad sense it is suggested that academic achievement plays a necessary role in keeping cultural and scientific innovation up to date (Hirsh & Inzlicht, 2010).

A number of variables are said to have an effect on, and predict academic achievement. For example, it has been suggested that intelligence (IQ; the ability to learn, understand and think in a logical way about things, Oxford Learner's Dictionaries, 2014a) explains the variance in academic achievement to a larger extent than the variance in personality trait disposition such as the Big Five personality factors (Di Fabio & Busoni, 2007). The Big Five (also called Five Factor Model; FFM) is a hierarchical model of personality said to describe the general traits of human universal personality in five factors; extraversion, neuroticism (negative affectivity), conscientiousness, agreeableness and openness (DeYoung, 2010). Besides that, there are several suggestions that personality, gender and IQ (consisting of verbal and numerical ability tests generating a measure of general intellectual ability) all have a role to play in predicting academic achievement (Leeson, Chiarrochi & Heaven, 2008), particularly that personality traits predicts academic achievement to a higher extent when IQ is controlled for (Rosander, 2013; Noftle & Robins, 2007).

Accumulated research show that conscientiousness, the ability to persist in task- and goal oriented behaviour, in order to reach non-immediate rewards (John, Naumann & Soto, 2008) is the factor most strongly associated with academic achievement. Openness, manifesting the tendency to explore, detect and enjoy abstract and sensory information (John et al., 2008) occasionally has positive relationships to academic achievement. While extraversion, being sensitive to reward and positive affect (John et al., 2008), occasionally is negatively related to the same criterion (O'Connor & Paunonen, 2007; Noftle & Robins, 2007; DeYoung, 2010; Rosander, 2013). In addition, the definition of conscientiousness also includes following norms, planning subsequent tasks and putting them in order of importance, captured in the facets order and self-discipline (John et al., 2008). All the Big Five factors encompass lower level traits called facets, (John et al., 2008), and the ones belonging to conscientiousness show stronger associations to academic achievement than the conscientiousness itself (O'Connor & Paunonen, 2008). Furthermore, all the above mentioned behaviours belonging to conscientiousness are important in order to go through educational programs successfully (Veroude et al., 2013).

As a suggestion, the Big Five approach to personality traits is an appropriate model to use investigating the correlations between neurobiology and personality traits (DeYoung, 2010). This seems plausible because of their stability over time, universality, biological bases (Costa & McCrae, 1992a), and the structural organisation of the factors (DeYoung, 2010). Moreover, the search to understand the neurobiology of human personality has guided cognitive neuroscience for a long time, but this task is complex and incomplete (Bjørnebekk et al., 2013). Even so, the understanding of the neurobiology of personality traits is important, because personality traits predict and are associated to important outcomes and behaviours of an individual's life (Xu & Potenza, 2012). One such important outcome is academic

achievement, thus, one way to understand academic achievement is through the neurobiological mechanisms of personality traits (Veroude et al., 2013). For example neuroticism is associated with increased activation in the right frontal lobe (Davidson, 2002), extraversion is associated with increased functional connectivity between the inferior parietal lobule and anterior cingulate (Haas, Omura, Amin, Constable & Canli, 2006), openness is associated with the interconnecting white matter in regions of the prefrontal cortex (PFC) in both hemispheres, agreeableness is associated with better interconnectivity in PFC, parietal cortex and subcortical structures (Xu & Potenza, 2012), and conscientiousness is associated with increased brain volumes in most of the middle frontal gyrus in left lateral PFC (DeYoung et al., 2010).

Furthermore, VIA-IS is a classification of character strengths which gives the field of personality psychology a common vocabulary for positive traits. Character strengths such as persistence, prudence and perspective show positive associations with academic achievement (Lounsbury, Fisher, Levy & Welsh, 2009), thus suitable to be included in investigations concerning the knowledge about academic achievement.

Additionally, since all the studies concerning the relation between and effect of personality traits on academic achievement are carried out in other countries than Sweden, the present study aims at contributing to the field. This through investigating if the correlations between personality traits and academic achievement found in the studies above also can be seen in senior students in a medium sized high school in Sweden.

Therefore, the main aim of this thesis is to describe the neurobiology underlying personality traits, and to investigate the relationship between academic achievement and

personality traits. In the first part a brief, theoretical background to academic achievement, the history of the trait perspective as well as the Big Five model and character strengths will be given. Followed by an account of the neurobiology of personality traits, including how the variation in individual composition of personality traits correlates with the variation in brain-activity, volume and chemistry. Subsequently, previous empirical findings of the academic achievement – personality traits relationship will be presented. In the second part of the thesis, the empirical study with hypotheses, method and results will be presented. This is followed by a discussion of both the study and the neurobiology of personality traits, where suggestions for future research are presented and the thesis is finished with a conclusion.

Theoretical Background

Academic Achievement

Swedish mandatory education implies students to attend for nine years, following three years of voluntary senior high school. Even though it is not obligatory, 99 % of the students in lower education transfer into higher education at this level (Swedish National Agency for Education, 2014). In addition, the leaving grades from senior high school are used for admission to higher education such as universities (Swedish Council for Higher Education, 2014), and therefore deserves attention to the what and how underlying the grades. Furthermore, assessing academic achievement is an important requirement in order to be able to predict it (Richardson, Abraham & Bond, 2012).

Academic achievement is most commonly operationalized with grade point average (GPA) in research, which is the mean grade of the courses that are included in the final grade (Richardson et al., 2012). The benefits of GPA is that the measure is objective, reliable and temporally stable (Bacon & Bean, 2006), but has limitations concerning grade inflation

meaning that teachers give higher grades for similar performance at different levels (Johnson, 2003). GPA as an indication of a student's academic achievement is deliberately determined by the teacher. For making this decision, different more or less objective information is available for the teacher including tests, verbal presentations and the Swedish Scholastic Aptitude Test (SSAT). None of these should individually decide the grade, thus teachers are supposed to decide the final grade based on a variety of sources (Swedish National Agency for Education, 2012). Importantly, teachers are not allowed to include student's behaviour or industriousness in the judgement (Swedish National Agency for Education, 2013b). There are also national knowledge requirements to be considered by the teacher when setting the grades in each individual course included in the GPA (Swedish National Agency for Education, 2013c). Altogether, even though GPA is considered an objective (Bacon & Bean, 2006) and common way to operationalize academic achievement (Richardson et al., 2012); it is also based on the subjective judgment of entrusted teachers.

Predictors of academic achievement have interested researchers for a long time and there are number of variables that are suggested to predict academic achievement. First, gender seems to be a variable differentiating achievement, where females are shown to have higher average grades than males (Rosander, 2013; Buchmann & DiPrete, 2006; SOU, 2014:6). Second, research has shown that IQ is an important predictor to academic achievement (Thorndike, 1994; Busato, Prins, Elshout & Hamaker, 2000; Dickerson Mayes, Calhoun, Blixer & Zimmerman, 2009). Besides that, research has also shown results indicating that personality predicts academic achievement to a higher degree than do IQ (Spengler, Lüdtke, Martin & Brunner, 2013; Rosander, 2013; Duckworth, Peterson, Matthews & Kelly, 2007). More specifically personality traits such as conscientiousness (Noftle & Robins, 2007) and character strengths such as persistence and prudence

(Lounsbury et al., 2009) are most strongly correlated to academic achievement, even when IQ is controlled for.

Personality Traits

The trait theory within personality psychology, where individuals and their unique qualities are distinguished based on descriptions of different universal traits, is a common perspective on human personality (Costa & McCrae, 1992a). Generally, a trait is understood as "a particular quality in your personality" (Oxford Learner's Dictionaries, 2014b). The more established technical definition of a personality trait is that it resembles the differences between individual's frequency and intensity of thinking, behaving and feeling in certain ways (Fleeson & Gallagher, 2009; McAdams & Pals, 2006). Even though, different researchers emphasize different aspects in defining traits. McCrae and Costa (1999) for example, focuses on the genotypical bases of traits, including cognitions and affects seen as covert expressions of the traits, whereas Goldberg (1993) focuses on the phenotypical bases of traits, being overt observable behaviours. There are even so, a considerable agreement that traits can be defined as patterns of behaviour, motivation, emotion and cognition which are relatively stable in an individual (Pytlik Zillig, Hemenover & Dienstibier, 2002; McCrae and Costa, 1999) and not specific to a certain kind of social milieu or culture (DeYoung, 2010; McCrae and Costa, 1999). Within personality psychology there are also lower levels which one can analyse personality with; characteristic adaptations and life stories. Characteristic adaptations have the function of filling in specific details in the individuality of humans for example, values, goals and coping strategies that are able to change over life time. Life stories have the function of integrating a person's meaning in life, time and culture, through narratives for example stories of life, which reconstructs the past and imagines the future that also change over time, thus reflecting the development of personality (McAdams & Pals, 2006).

The Five Factor model. FFM (Costa & McCrae, 1992a; Goldberg, 1993; John & Srivastava, 1999) has gained a widespread acceptance regarding the science of personality traits (McAdams & Pals, 2006; DeYoung & Gray, 2009). FFM (also called the Big Five which will be used interchangeably throughout this thesis) is as hierarchical model of personality traits with five basic factors as mentioned earlier (Costa &McCrae, 1992a). Moreover, there is considerable agreement among theories that specific functions are associated with the Big Five, extraversion is sensitive to reward and positive affect; neuroticism manifests to be sensitive to punishment and negative affect; agreeableness is the tendency to act altruistic vs. exploiting others; conscientiousness is the ability to top-down regulate behaviour in order to pursue non-immediate goals and to follow rules; openness manifests the tendency to explore, detect and enjoy abstract and sensory information (DeYoung, 2010). Each domain includes more specific personality traits referred to as facets, for instance assertiveness belongs to the factor extraversion and self-discipline to the factor conscientiousness (Costa & McCrae, 1992a). Furthermore, Costa and McCrae (1992a) suggest the five factors are: 1) stable dispositions that are visible in patterns of behaviour, 2) found in both personality questionnaires and lexical studies of description of traits, 3) universal and 4) heritable, thus biologically grounded. See Table 1 for definition of all factors and facets. Additionally, there are suggestions that the five factors are divided into two higher metatraits, where neuroticism, agreeableness and conscientiousness are said to belong to the metatrait of stability, whereas extraversion and openness are said to belong to the metatrait plasticity (DeYoung, 2010).

Table 1

Definition of Big Five Factors and Facets

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1. **Extraversion:** implies an energetic approach toward the social and material world.
- Warmth – outgoing
- Gregariousness – sociable
- Assertiveness – forceful
- Activity – energetic
- Excitement seeking – adventurous
- Positive emotions – enthusiastic

2. **Agreeableness:** contrasts a prosaically and communal orientation toward others with antagonism.
- Trust – forgiving
- Straightforwardness – not demanding
- Altruism – warm
- Compliance – not stubborn
- Modesty – not show-off
- Tender-mindedness – sympathetic

3. **Conscientiousness:** describes socially prescribed impulse control that facilitates task-and goal-directed behaviour.
- Competence – efficient
- Order – organized
- Dutifulness – not careless
- Achievement striving – thorough
- Self-discipline – not lazy
- Deliberation – not impulsive

4. **Neuroticism:** contrasts emotional stability and even-temperedness with negative emotionality.
- Anxiety – tense
- Hostility – irritable
- Depression – not contented
- Self-consciousness – shy
- Impulsiveness – moody
- Vulnerability – not self-confident

5. **Openness:** describes the breadth, depth, originality, and complexity of an individual's mental and experiential life.
- Fantasy – imaginative
- Aesthetics – artistic
- Feelings – excitable
- Actions – wide interests
- Ideas – curious
- Values – unconventional

Note. Factors are numbered 1-6 and in bolded text. Based on John and Srivastava (1999).

There are several ways to measure the Big Five. NEO Personality Inventory –

Revised (NEO-PI-R; Costa & McCrae, 1992b) is a long version with 240 items, 60 items per

factor. Internal consistency has shown to be high in all the scales; neuroticism = .92,

extraversion = .89, openness = .87, agreeableness = .86 and conscientiousness = .90. As well

as a good six year test-retest reliability; neuroticism = .83, extraversion = .82, openness = .83,

agreeableness = .63 and conscientiousness = .79 (Costa & McCrae, 1992b). The NEO Five

Factor Inventory (NEO-FFI; Costa & McCrae, 1992b) is a shorter version with 60 items, 10

items per factor with an internal consistency of; neuroticism = .87, extraversion = .82,

openness = .76, agreeableness = .75 and conscientiousness = .82 (John et al., 2008). An even

shorter version is the Big Five Inventory (BFI; John, Donahue & Kentle, 1991; Benet-

Martinez & John, 1998; John et al., 2008) with 44 items, including eight to ten items per

facet. The BFI will be described in the method part, since it is used in this study.

Additionally, in a recent study the most commonly expressed Big Five trait among Swedish

adolescents were from the most common to the least; extraversion, agreeableness, openness,

conscientiousness and neuroticism (Kjell, Nima, Sikström, Archer & Garcia, 2013).

The FFM of today has its origins both within the lexical hypothesis (with the premise

that every important description of individual differences is integrated in the natural language

at some point in the evolution of language) and within personality questionnaires (McCrae &

John, 1992). Some defining researchers that have contributed to the existing FFM are Galton

(1884, as cited in Goldberg, 1993), Allport (1937), Cattell (1943), Tupes and Christal (1992),

Eysenck (1960), Norman (1963), Goldberg (1982), and Costa and McCrae (1992a).

Noteworthy, all researchers in personality psychology have not yet accepted the FFM to be

the universal model of personality traits (Block, 1995; Eysenck, 1992).

Character strengths. In the spirit of personality psychology and more specific, trait theory, Peterson and Seligman (2004) have developed a measure and classification called the Values in Action Inventory of Strengths. VIA-IS gives the field of personality psychology a common vocabulary for positive traits, called character strengths. The character strengths are individual differences which are stable and general but also shaped by different situations (Peterson & Seligman, 2004). The author's emphasizes the importance of an equal focus on strengths and weaknesses, creating the best things in life as well as fixing what is wrong, healing the wounds of the distressed and fulfilling the lives of normal people, and therefore developed the VIA-IS classification of positive traits (Peterson & Seligman, 2004).

The traits included in the final classification of character strengths meet the research guided criterions decided by Peterson & Seligman (2004). First, character strengths are universal and they are recognized in various cultures across the world. Second, character strengths are fulfilling, thus contributing to the good life for individuals. Following that, the fulfilling act/usage of strengths is in itself morally valued, and not valued for the tangible outcome it may produce. Further, when using one's strengths it does not diminish others but elevate others witnessing it, causing admiration rather than jealousy. Furthermore, it is stable and general across time, thus able to be measured. This also makes it distinct from other character strengths. Following this, the distinctiveness of character strengths is clearly expressed by some individuals causing character strengths to have paragons. Further, this is strikingly seen in some children being prodigies. Selective absence is another criterion, meaning that character strengths are totally absent in some individuals. The last but not least criterion is the existence of institutions for which sustain and cultivate character strengths, by

Table 2

The Values in Action Classification of Character Strengths; Virtues and Strengths

1. **Wisdom and knowledge:** cognitive strengths that entail the acquisition and use of knowledge

- Creativity [originality, ingenuity]: thinking of novel and productive ways to conceptualize and do things
- Curiosity [interest, novelty-seeking]: taking an interest in ongoing experience for its own sake
- Open-mindedness [judgment, critical thinking]: thinking things through and examining them from all sides
- Love of learning: mastering new skills, topics, and bodies of knowledge
- Perspective [wisdom]: being able to provide wise counsel to others

2. **Courage:** emotional strengths that involve the exercise of will to accomplish goals in the face of opposition

- Bravery [valour]: not shrinking from threat, challenge, difficulty, or pain
- Persistence [perseverance, industriousness]: finishing what one starts; taking pleasure in completing tasks
- Integrity [authenticity, honesty]: speaking the truth but more broadly presenting oneself in a genuine way
- Zest [vitality, enthusiasm, vigour, energy]: approaching life with excitement and energy

3. **Humanity:** interpersonal strengths that involve ''tending and befriending'' others

- Love: valuing close relations with others; being close to people
- Kindness [generosity, nurturance, care, compassion, altruistic love]: doing favours and good deeds for others
- Social intelligence [emotional intelligence]: being aware of the motives and feelings of self and others

4. **Justice:** civic strengths that underlie healthy community life

- Teamwork [social responsibility, loyalty, citizenship]: working well as member of a group or team
- Fairness: treating all people the same according to notions of fairness and justice
- Leadership: organizing group activities and seeing that they happen

5. **Temperance:** strengths that protect against excess

- Forgiveness [mercy]: forgiving those who have done wrong; accepting the shortcomings of others
- Humility [modesty]: letting one's accomplishments speak for themselves; not seeking the spotlight
- Prudence: being careful about one's choices; not saying or doing things that might later be regretted
- Self-regulation [self-control]: regulating what one feels and does; being disciplined

6. **Transcendence:** strengths that forge connections to the larger universe and provide meaning

- Appreciation of beauty [awe, wonder]: noticing and appreciating beauty and/or excellence
- Gratitude: being aware of and thankful for the good things that happen; taking time to express thanks
- Hope [optimism, future-mindedness, future orientation]: expecting the best and working to achieve it
- Humour [playfulness]: liking to laugh and joke; bringing smiles to other people; seeing the light side
- Spirituality [religiousness, faith]: having coherent beliefs about the higher purpose and meaning of life

Note. Virtues are indicated by numbers 1-6 and in bolded text. Retrieved from Peterson and Seligman (2004).

social practice and/or rituals. It is noteworthy that not all character strengths fulfill

every criterion (Peterson & Seligman, 2004).

Peterson and Seligman (2004) define and distinguish among three conceptual levels in

their classification of strengths and virtues. The first level of definition is virtues, which are

valued by moral philosophers and religious thinkers. These core virtues include: wisdom,

courage, humanity, justice, temperance and transcendence. The second level is character

strengths, defining the higher virtue with a psychological process or mechanism. One can

display a virtue in different ways. For example, the virtue of courage can be achieved through

character strengths such as bravery, persistence, integrity and zest. These strengths all involve

a will to fulfil goals in face of adversity but they are also distinct from each other (Peterson &

Seligman, 2004). The third level is situational themes, which are specific habits that make

people produce certain character strength in a given situation. These three levels explain that

character strengths are stable as well as capable of change (Peterson & Seligman, 2004). See

Table 2 for definition of all virtues and character strengths.

Assessing character strengths can be done with several different measures. The

original VIA-IS contains 240 items with ten items per character strength. It has an internal

consistency of .83, a four months test-retest reliability of .70, and the scales have alphas

ranging from .75 to .91 (Peterson & Park, 2009; Peterson & Seligman, 2004). Further, there

is a shorter version, VIA 120 which will be described in more detail in the method part since

it is used in this study. A third even shorter version is the VIA 72, which contains three items

per character strengths taken from the original VIA 240. VIA 72 has an internal consistency

of .75 and the scales have alphas ranging from .60 to.87. The validity compared to VIA 240

is .87 (Peterson & Seligman, 2004; Peterson & Park, 2009). Additionally, the most

commonly self-described character strengths in Sweden are fairness, open-mindedness and

curiosity and in United States it is kindness, fairness and authenticity (Park, Peterson &

Seligman, 2006).

The neurobiology of personality traits. Personality neuroscience is a developing

field trying to answer why people differ from each other, in contrast to personality

psychology that during the past century have tried to answer how people differ from each

other on a descriptive level (DeYoung & Gray, 2009). Personality neuroscience further has

one premise; "that the whole person cannot be understood without understanding the brain"

(DeYoung, 2010, p.1). In addition, McAdams and Pals' (2006) definition of personality

psychology describes three different levels which one can analyse personality with; traits,

characteristic adaptations and life stories. It is important to investigate all these levels in order

to understand a person, but the first one is much easier to study with neuroscience because of

its stability across time, and therefore personality neuroscience focuses on traits (DeYoung,

2010). DeYoung (2010) further explains the aim of personality neuroscience as: coming to

understand the biological systems that are in charge of different states (states are at the same

level as characteristic adaptations) associated with certain traits, and the parameters in the

systems that make them function differently in different individuals.

Most of the research on personality traits and neurobiological substrates has been

done on neuroticism and extraversion (Adelstein, et al., 2011), since they are long-standing

traits in personality psychology (DeYoung & Gray, 2009). Therefore, the amount of

neurobiological description in this study is also larger for those two factors. Moreover,

various methods for investigating neurobiology of personality traits have been used in

research. In this thesis a wide spectrum of findings are explained, contributing to a larger

picture of how the variation in individual composition of personality traits correlates to the variation in brain- activity, volume and chemistry. When a broad view is taken, the premise of understanding the brain in order to understand the whole person (DeYoung, 2010) is able to be fulfilled (DeYoung & Gray, 2009).

Personality traits and variance in brain activity. Concerning the correlation between personality traits and brain activity (e.g., regional metabolism, functional connectivity), there are studies showing both positive and negative correlations (Deckersbach et al., 2006; Johnson et al., 1999). When regional cerebral glucose metabolism (rCMRglu) was measured during resting state, findings show a negative correlation between neuroticism and the left insular cortex and the superior temporal gyrus (Deckersbach et al., 2006). Insular activation has been found to associate with how normal individuals understand and value social situations as painful (Jackson, Meltzoff & Decety, 2005) as well as easily sensing changes within the body (Critchley, Elliot, Mathias and Dolan, 2000). In line with this, neuroticism is also considered a personality trait which is recognized as people being more anxious and having more negative emotions than individuals low in neuroticism (McCrae & Costa, 1999). In addition, Davidson (2002) suggests that increased activation in the right frontal lobe is associated with neuroticism and other measures of negative emotionality.

One way to gain knowledge about individual differences in regulating emotions, related to neuroticism and the mechanisms underlying this, is to measure functional connectivity between prefrontal regions and limbic regions (Cremers et al., 2010). The analysis of an emotional-faces-decision-task (participants viewing negative emotional pictures depicting angry, sad and fearful faces) revealed that the amygdala – ACC (anterior cingulate cortex) connectivity had negative associations with neuroticism, indicating a

decreased inhibitory control of negative facial expressions when high in neuroticism. Thus, suggesting that individuals high in neuroticism have decreased control function over the amygdala by ACC. The amygdala – dmPFC (dorsomedial prefrontal cortex) connectivity was positively related to neuroticism, indicating that individuals with high neuroticism refer to the self to a higher degree, when processing faces with negative emotional expressions (Cremers et al., 2010).

Furthermore, neuroticism has been found to be negatively associated to widespread interconnecting fibre tracts, including frontal, occipital, parietal and temporal lobes. This association also included tract responsible for connecting orbitofrontal region with limbic regions, as well as the connecting tracts between the frontal lobes and thalamic nuclei, and the corpus callosum. This widespread association suggests that general processes are working rather than specific regional processes, to account for individual differences in neuroticism (Bjørnebekk et al., 2013), which is partly in line with previous findings (Xu & Potenza, 2012). Neuroticism also had a significant, but positive association to mean and radial diffusivity in several interconnecting tracts, such as corpus callosum, tracts between the medial and lateral surfaces of the frontal lobes, occipital lobes, and longer fibres connecting occipital, temporal and parietal lobes. This suggests that biological mechanism in relation to diffusion in the brain may be a candidate responsible for individual differences in neuroticism, noted by the authors to be a simplification of the underlying processes of personality (Bjørnebekk et al., 2013).

In addition, studies show that functional connectivity contributes to individual differences in personality traits other than neuroticism (Haas et al., 2006; Xu & Potenza, 2012). Openness was found to be positively correlated to white matter interconnecting

several regions of PFC, specifically the dorsolateral PFC in both hemispheres. Openness also correlated positively with white matter integrity connecting most cortical and subcortical regions (Xu & Potenza, 2012). Further, findings indicated that agreeableness was associated to better interconnectivity in PFC, parietal cortex and subcortical structures (Xu & Potenza, 2012). In a study investigating the association between activity and functional connectivity of the anterior cingulate and extraversion, it was found that high extraversion score was associated with increased functional connectivity between the inferior parietal lobule and anterior cingulate. More specifically, this was accounted for by specific facets of extraversion, such as warmth and excitement-seeking. Therefore, suggesting that the individual differences in networks important for affective and cognitive processing are associated with extraversion and some of its lower lever traits (Haas et al., 2006). In contrast, Xu and Potenza (2012) and Bjørnebekk et al. (2013) did not find any associations between extraversion and functional connectivity measures.

Furthermore, extraversion was showed to have a positive correlation with resting metabolism in the left orbitofrontal cortex (OFC; Deckersbach et al., 2006). Similar to the findings by Johnson et al. (1999) where extraversion was associated with lower blood flow in the frontal lobes, which is consistent with the knowledge that the prefrontal regions plays an important role in constraining impulsive behaviours (Davidson, Putnam & Larson, 2000).

Personality traits and variance in brain volume. Brain volume indicates to what extent different regions have different volumes of brain tissue. In investigating individual differences in brain volume in correlation to personality traits, NEO-PI-R and magnetic resonance imaging was used (DeYoung et al., 2010), to test hypotheses from DeYoung and Gray's (2009) Biological Model of Personality, which suggest that specific tendencies to

behave, think and feel stem from reoccurring functions of different brain systems. DeYoung

et al. (2010) found correlations between four of the five factors in the Big Five model and

regional brain volume. Findings of negative associations between neuroticism and brain

volume were most clear. They were found in the right dorsomedial PFC and in parts of the

left medial temporal lobe, including posterior hippocampus. Also parts of the basal ganglia

and midbrain, including subthalamic nuclei and globus pallidus were negatively associated

with brain volume in neuroticism, as well as a part of the right precentral gyrus. Further,

neuroticism was found to be positively associated with regions in bilateral mid-cingulate

cortex continuing into the white matter in the cingulate gyrus, as well as into the caudate in

the left hemisphere. Positive associations were also found in a region in the cerebellum and

the middle temporal gyrus. DeYoung et al. (2010) states that these findings are consistent

with the view of neuroticism as a personality trait sensitive for punishment and threat, where

these variations in brain volume are suggested to control that. More recently, neuroticism has

also been found to be negatively correlated to total brain volume, showed by reduced

arealization (the process of subdividing the neocortex into several functional areas; Alfano &

Studer, 2013) in several areas, including right caudal and rostral middle frontal areas, the

frontal pole, anterior cingulate, parts of the orbitofrontal area, superior temporal lobe and

supramarginal area in the parietal lobe. Mostly contributing to this were the facets of anxiety,

depression and vulnerability to stress (Bjørnebekk et al., 2013).

Concerning extraversion, DeYoung et al. (2010) found one positive association

between brain volume and extraversion, in the medial OFC, which is in line with findings

showing that extraversion is associated with increased brain volume in OFC (Omura,

Constable & Canli, 2005). This area is suggested as a substrate to extraversion since it is

involved in coding the value of the reward of presented stimuli (Depue & Collins, 1999).

More recent, individuals high in extraversion were found to be associated with thinner cortex

in left ventromedial prefrontal regions, also called inferior frontal gyrus (IFG) corresponding

to Broca's area (Dronkers, Plaisant, Iba-Zizen & Cabanis, 2007), where excitement-seeking

was the facet mostly contributing. For this reason, the authors tentatively suggest that thinner

cortex in Broca's area in extroverts reflect a structural association to have more boldness to

speak and not inhibit their verbal impulses, compared to introverts (Bjørnebekk et al., 2013).

In the study by DeYoung et al. (2010), brain volumes in most of the middle frontal

gyrus in left lateral PFC, extending from near the frontal pole to the posterior part of lateral

PFC, showed a positive association with conscientiousness. Working memory and the

execution of action are behaviours which the middle frontal gyrus is heavily involved in, thus

the results reflects the notion that conscientiousness being a trait important for effective self-

regulation (DeYoung et al., 2010). An ability previously connected to academic achievement

(Noftle & Robins, 2007; Lounsbury et al., 2009). Negative associations between

conscientiousness and brain volume have been found, showed by arealization in the left

hemisphere including caudal parts of superior temporal and supramarginal regions which

were mainly accounted for by the facets order, achievement-striving and self-discipline

(Bjørnebekk et al., 2013). Even though one can suggest that superior temporal cortices

regulates the behaviours accounted for by conscientiousness, the authors (Bjørnebekk et al.,

2013) emphasizes that these findings should be interpreted with caution since they are

additional to earlier findings (e.g., DeYoung et al., 2010).

Concerning the association between brain volume and agreeableness, DeYoung et al.

(2010) found positive associations in fusiform gyrus and the retrospinal region of posterior

cingulate cortex. A negative association was found in the superior temporal sulcus and

adjacent superior temporal sulcus. Both findings are in line with the view that agreeableness is a personality trait associated with altruistic behaviour and the processing of social information underlying this (DeYoung, 2010).

Personality traits and variance in brain chemistry. As a step forward in the neuroscience of personality biochemical correlates of normal personality were investigated (Ryman et al., 2011), using magnetic resonance spectroscopy and NEO Five Factor Inventory (NEO-FFI). This technique allows researchers to assay neurochemistry while the participant is awake. The metabolites that were measured in this study were N-acetylaspartate (NAA), often linked to neuronal health, viability and high cognitive capacity (Valenzuela et al., 2000); creatine (Cre) which is the brains energy storage, linked to higher mental achievement (Rae, Digney, McEwan & Bates, 2003); and choline-containing compounds (Cho), which increases during the loss and replacement of cellular membrane in affective disorders (Moore & Galloway, 2002). The results suggest that most of the major personality factors, measured by NEO-FFI, relates to variation in neural density, cellularity and energetics in the Default Mode Network (DMN). DMN is activated during resting state, and when people are processing their own thoughts; reflecting on the self, taking perspective, thinking of the future and retrieving autobiographical memories (Buckner, Andrews-Hanna, Schacter, 2008). Ryman et al. (2011) notes that more research is needed to decide what role DMN functioning has in personality.

In the hierarchical model of the Big Five, there are studies describing two higher order metatraits above the five factors. Neuroticism (reversed), conscientiousness and agreeableness form the metatrait Stability which has been linked to serotonin. Whereas, openness and extraversion form the metatrait Plasticity which has been linked to dopamine

(DeYoung, 2010; Yamagata et al., 2006). Serotonin and dopamine are known to have an

impact on several widely distributed brain networks, thus they are plausible contributors to

the broad level of personality structure (DeYoung & Gray, 2009). More specifically low

levels of serotonin have been linked to anxiety, depression, aggression and poor impulse

control that are treated with drugs increasing the function of serotonin (Spoont, 1992), thus

making it possible to expect that it should be positively associated with agreeableness,

conscientiousness and negatively to neuroticism (DeYoung & Gray, 2009). To be

behaviourally and cognitively explorative are representatives of openness and extraversion

respectively, and the plausibility for dopamine to be linked to plasticity mainly relies on the

established role of dopamine in exploratory behaviour and cognitive flexibility (DeYoung &

Gray, 2009).

     Neurobiology of personality traits previously connected to academic achievement.

Recent findings suggest that individual differences in academic achievement can be

associated with the engagement of dorsal ACC in cognitive control. Areas of the medial PFC

are activated when a person is engaged in cognitive control, such as planning, avoiding

reacting on impulses, focusing on exams and studying (Veroude et al., 2013). Veroude et al.

(2013) investigated the correlation between brain activation (through fMRI during a

Go/NoGo task and an emotional and cognitive Stroop Task) and academic performance in a

sample of 26 individuals with the mean age of 18.79 years. The results showed a positive

significant correlation between academic performance and the neural correlates of cognitive

control in the Stroop task. The authors suggest that a potential predictor of differences in

educational outcomes is the link between academic performance and dorsal ACC which was

found in this study. Indicating that students with good grades had more activation in ACC, to

a greater extent during cognitive inhibition, when compared with the students having less

good grades (Veroude et al., 2013). This is also in line with an earlier study investigating the

individual differences in ERN (error-related negativity) magnitude, in relation to performance

which outcomes depend on cognitive control (Hirsh & Inzlicht, 2010). The authors suggest

that individuals with higher achievement in undergraduate programs, to a larger extent

activate cognitive control mechanisms and monitor their performance when they need to,

than individuals with low achievement. Further that a neural marker such as the ERN can

account for the above mentioned abilities (Hirsh & Inzlicht, 2010). Moreover,

conscientiousness on a broad level is defined as the ability to persist in task- and goal

oriented behaviour, in order to reach non-immediate rewards (John et al., 2008), being similar

to the definition of delay of gratification; the ability to ignore immediate rewards for the sake

of later ones being more valuable (Mischel, Shoda & Rodriguez, 1989). Delay of gratification

has been stated as a cornerstone in academic achievement, because it makes students

complete long-term goals in relation to academic and career achievement (Bembenutty,

2011). In terms of neurobiology delay of gratification has been linked to the distinguished hot

and cool system, originally proposed by Metcalfe and Mischel (1999) suggesting that these

systems control and undermine an individual's self-control. The cool system is regulated by

the top-down prefrontal regions, being involved in cognitive control when one has to delay

reward, whereas the hot system is regulated by limbic regions that are associated with more

instant choices. More specifically the PFC show less activation and the ventral striatum more

activation when inability to delay gratification, whereas the ability to delay gratification show

the reversed activation pattern where PFC show more activation and the ventral striatum less

activation, indication the neurobiology of individual's way to self-regulate (Casey et al.,

2011).

Personality Traits as Predictors of Academic Achievement

Big five and academic achievement. Personality has been related to academic achievement in several studies (e.g., Poropat, 2009; McAbee & Oswald, 2013). More specifically, in explaining educational outcomes, Spengler et al. (2013) have demonstrated the importance of personality traits in predicting academic achievement. In a sample of 898 participants with the mean age of 15.83 years, they found significant relations between conscientiousness and GPA, and significant relations between openness and general achievement test scores. Similarly, Noftle and Robins (2007) found strong correlations between personality traits and academic achievement students ranging from 17 to 31 years. In a study examining more than 10,000 participants, multiple personality measures such as BFI, NEO-PI-R and the HEXACO Personality Inventory (HEXACO-PI; Lee & Ashton, 2004) were used. The factor conscientiousness was strongly associated with higher GPAs, both in college and high school students, being slightly higher in the high school sample. In the college sample, Noftle and Robins (2007) also reported significant correlations between three NEO-PI-R conscientiousness facets: achievement-striving, competence and self-discipline, and GPA. In the high school sample all of the NEO-PI-R conscientiousness facets: competence, order, dutifulness, achievement-striving, self-discipline and deliberation showed significant correlation with GPA. Further, Wagerman and Funder (2007) reports that conscientiousness is associated to academic achievement at both freshman and senior level in college, and that conscientiousness is an important predictor of academic performance.

Recently, another study (Di Giunta et al., 2013) investigated the relationship between conscientiousness, openness, self-esteem, and academic self-efficacy and academic performance in a sample of 426 participants ranging from 14 to 19 years old. They found

conscientiousness and self-esteem to contribute to academic self-efficacy, which indirect had

an effect on senior high school grades.

Additionally, several studies have shown that personality traits predict academic

achievement beyond IQ. Duckworth and Seligman (2005) tested if self-discipline, persistence

and grit (defined as perseverance and passion for long-term goals) would predict GPA to a

greater extent than IQ (in this study IQ was assessed with verbal, quantitative and figural

reasoning skills important for academic learning), in a sample of 198 eight-grade students

with the mean age of 13.4 years. The results show that self-discipline predicted academic

achievement more robustly than did IQ. Also that self-discipline predicted which students

who would gain in academic achievement over the school year, whereas IQ did not. In line

with these findings Komarraju, Karau and Schmeck (2009) report that Big Five traits

appeared to be important predictors of academic achievement. Similarly that specific parts of

personality, such as being gritty, social and emotionally stable influences academic

achievement largely. Komarraju et al. (2009) summarizes that the findings reinforces the

notion that IQ is not the only thing predicting academic achievement as stated by Duckworth

et al. (2007). More specifically Duckworth et al. (2007) investigated the construct of grit. As

such grit overlaps with conscientiousness, but emphasises the long-term stamina instead of

short-term intensity. They found that grit over and beyond IQ (in this study assessed with

SAT scores as a measure of general mental ability) explained the variance in academic

achievement.

Character strengths and academic achievement. Character strengths have been

found to be correlated to academic achievement in several studies. Lounsbury et al. (2009)

conducted a field study with college students, which found sixteen of the VIA strengths to be

significantly and positively correlated with GPA. High magnitude correlations were observed

for the VIA strengths of persistence, open-mindedness, self-regulation, love of learning and

prudence. Further, Park and Peterson (2006) report small but noticeable results concerning

the relation between character strengths and academic achievement. In that study VIA-youth

was developed and used (VIA-IS test designed to be appropriate for youths). Park and

Peterson (2006) found strengths such as persistence, fairness, gratitude, honesty, hope and

perspective to predict end-of-year GPA. Interestingly, this is consistent with earlier findings

showing that academic achievement is predicted by prosocial behaviour over and above

general intelligence (Caprara, Barbaranelli, Patorelli, Bandura & Zimbardo, 2003).

Another study by Weber and Ruch (2012) investigated if character strengths matters

in school, in a sample of 247 participants with the mean age of 11.77 years. More specifically

they looked at the relationship between self-reported strengths and teacher-rated classroom

behaviour. They found persistence, love of learning, prudence, zest, honesty, self-regulation,

hope, gratitude and teamwork, to be important for positive classroom behaviour, persistence,

love of learning and prudence being most strongly associated. In addition they also

demonstrated that the strengths of persistence, love of learning, prudence and self-regulation

were associated with academic success, in the middle and the end of the school year.

Interestingly, certain strengths (persistence, love of learning and prudence) had an indirect

effect on academic success through classroom behaviour. Indicating that student's behaviour

in the classroom matter in relation to academic achievement (Weber & Ruch, 2012), which is

in line with previous studies (Caprara et al. 2003).

Besides, character strengths among youths were studied qualitatively by Steen,

Kachorek and Peterson (2003), by engaging a total number of 459 students with the mean age

of 16 years, in focus groups. These focus groups involved the students discussing different

kind of character strengths, if they make sense to them, how they define and recognize them,

if adolescents own any particular strengths and how these develop during life. The research

question or result was not specifically related to academic achievement, but interesting to

highlight in terms of what students think about character strengths. The researchers

concluded that the opportunity for students to discuss and be listened to was highly valued by

them. Also that the students believed character strengths to exist on a continuum, individuals

having more or less of different strengths but that they also can be learned and developed, life

experience being the most important factor for this. Further they mentioned strengths such as

love, spirituality, love of learning, social intelligence and leadership to be particularly valued.

More recently Shoshani and Slone (2013) investigated the relationship among

character strengths, subjective well-being and school adjustment in a longitudinal study

running over 1.5 years. In a sample of 417 students with the mean age of 12.55 years, it was

demonstrated that the strengths love of learning, open mindedness and perspective as well as

self-regulation, modesty, prudence and forgiveness, correlated positively with GPA.

Hypotheses of the Present Study

Based on the previous findings the present study expects to find positive correlation

between academic achievement and the Big Five factor conscientiousness (hypothesis 1A). It

is also expected to find positive correlations between academic achievement and the

conscientiousness facets order (hypotheses 1B) and self-discipline (hypotheses 1C). The Big

Five measure in this study is the BFI and due to the shortness of the measure it includes only

two facets per each factor. Therefore a positive correlation is only expected for order and

self-discipline and not the other four facets in the conscientiousness factor.

Therefore, based on previous findings, this study expects to find positive correlations between academic achievement and the strengths of persistence (hypotheses 2A), love of learning (hypotheses 2B), self-regulation (hypotheses 2C) and prudence (hypotheses 2D). Persistence and self-regulation are the strengths assessed by VIA that correspond most to conscientiousness (Peterson & Seligman, 2004), measured by Big Five, and thus expected to be positively correlated to academic achievement in this study. Further love of learning is the strength most conceptually linked to learning and academic achievement, and thus also expected to be positively correlated to academic achievement in this study. In addition prudence is found to be correlated with academic achievement in several studies (Lounsbury et al., 2009; Weber & Ruch, 2012; Shoshani &Slone, 2013), thus also expected to be positively correlated with academic achievement in this study.

Method

Participants

Students (N = 90) in the last year of Swedish senior high school were recruited to participate in this study. Information about the study was spread through the student's program manager and email. Thus, the participation was voluntary and 69 participants were female. 64 participants were 18 years old and 26 participants were 19 years old. The participants were enrolled in different education orientations including social- (n = 56), nature- (n = 3), humanistic- (n = 7), economic- (n = 9), and aesthetic- (n = 15) educational program.

Measurements

Big five inventory. BFI assesses the Big Five personality factors (and underlying facets) extraversion (assertiveness, activity), neuroticism (anxiety, depression), conscientiousness (order, self-discipline), agreeableness (altruism, compliance) and openness (aesthetics, ideas) (John et al. 1991; Benet-Martinez & John, 1998; John et al., 2008). It is a 44 item questionnaire, with eight to ten items per domain. The respondents answered on a 5-point Likert scale, ranging from 1 (*disagree strongly*) to 5 (*agree strongly*). A sample item is "I am someone who perseveres until the task is done" (conscientiousness). The BFI scales has an internal consistency of.83 (John et al., 2008), and a three months test-retest reliability of .84 including all scales (Rammstedt & John, 2007). Additionally, in a study investigating the psychometric properties for the Swedish version of BFI, similar internal consistency was found with cronbach's alphas ranging from .73 to .84 (Zakrisson, 2010). Further, the convergent validity correlations between BFI and NEO-FFI have shown to be for neuroticism = .81, extraversion = .73, openness = .72, agreeableness = .76 and for conscientiousness = .80 (John et al., 2008).

Values in action 120. Values in Action 120 (VIA-120) is a classification and measure of 24 ubiquitous character strengths and virtues (Peterson & Seligman, 2004). The test administered in the present study consists of 120 items, five per character strength. The respondents answered on a 5-point Likert scale, ranging from 1 (*not like me at all*) to 5 (*very much like me*). A sample item is "I never quit a task before it is done" (persistence). VIA 120 VIA-120 has an internal consistency of .79, and the scales have alphas ranging from .68 to

.91. The validity compared to the VIA 240 is .93 (Peterson & Seligman, 2004; Peterson &

Park, 2009).

Academic achievement. Since the participants had not gotten their final grades for

the last year, grades from year one and two in Swedish senior high school were used in the

statistical analysis, including courses in Swedish 1 and 2, English 1 and 2, Maths 1 and 2,

History, Sports & Health and Social Sciences. These courses are obligatory for every student

enrolled in Swedish senior high school (Swedish National Agency for Education, 2013a), and

thus shared by all the participants except from a few students missing grades in some courses.

The Swedish grading system is designed as follows: A provides 20 points, B provides 17,5

points, C provides 15 points, D provides 12,5 points E provides 10 points and F provides 0

points (Swedish National Agency for Education, 2012), thus creating an ordinal scale.

Therefore academic achievement is operationalized as the median grade in this study.

Procedure

Written informed consent was collected for all participants prior to the test session.

Participants were gathered in their respective classes, during school time under supervision of

the study assistant. VIA-120 was completed online followed by BFI which was filled in

manually. Participants were instructed to answer as truthfully as possible, and to ask the

study assistant if they had troubles understanding any item. All data were collected between

the 24th of February and 4th of March 2014, each single occasion taking approximately 60

minutes. As the participants had completed the two inventories they left the classroom. The

school administration provided grades for all participants.

Table 3

Descriptive and Correlational Statistics for Character Strengths, BFI factors and BFI facets

Measure	N	M	SD	Corr. MG	Corr. MG Women	Corr. MG Men
Character Strength						
Creativity	90	3,29	0,59	-.046	-.081	.063
Curiosity	90	3,45	0,56	-.030	.069	-.217
Open-mindedness	90	3,81	0,53	.371**	.469**	-.070
Love of learning	90	2,85	0,67	.267*	.332**	-.012
Perspective	90	3,88	0,60	.321**	.350**	.236
Bravery	90	3,47	0,57	.031	.040	.082
Persistence	90	3,87	0,62	.237*	.254*	.099
Integrity	90	3,99	0,45	.139	.121	.203
Zest	90	3,22	0,65	.017	.087	-.344
Love	90	3,93	0,73	-.057	-.070	-.236
Kindness	90	4,03	0,52	.003	.001	-.363
Social intelligence	90	4,12	0,50	.020	.026	-.277
Teamwork	90	3,62	0,49	-.227*	-.148	-.468*
Leadership	90	3,71	0,53	-.050	-.039	-.136
Fairness	90	3,90	0,53	.056	.058	-.265
Forgiveness	90	3,38	0,66	.053	.022	.181
Humility	90	3,18	0,64	.036	.104	-.401
Prudence	90	3,74	0,60	.104	.253*	-.281
Self-regulation	90	3,16	0,85	.021	.198	-.134
Appreciation of beauty	90	3,45	0,73	-.099	-.114	-.019
Gratitude	90	3,36	0,65	-.034	-.004	-.026
Hope	90	3,47	0,68	.057	.127	-.073
Humour	90	3,80	0,63	-.155	-.180	-.059
Spirituality	90	2,49	0,87	-.235*	-.308*	-.217
BFI factor						
Extraversion	90	27,64	5,87	.064	.082	-.143
Agreeableness	90	29,78	4,19	.162	.172	-.276
Conscientiousness	88	31,94	7,60	.427**	.473**	-.032
Neuroticism	85	23,49	4,68	.112	.064	-.128
Openness	90	33,77	6,32	.087	.062	.196
BFI facet						
Assertiveness (E)	90	16,89	3,81	.058	.074	.065
Activity (E)	90	6,80	1,79	.081	.106	-.399
Altruism (A)	90	15,38	2,34	.174	.165	-.115
Compliance (A)	90	10,63	2,45	.014	-.021	-.068
Order (C)	88	6,61	1,87	.273*	.408**	-.481*
Self-discipline (C)	90	17,58	5,93	.434**	.448**	.279
Anxiety (N)	89	11,98	3,60	.074	.006	-.214
Depression (N)	87	4,97	1,69	.063	-.022	.270
Aesthetics (O)	90	9,87	3,62	-.006	-.059	.122
Ideas (O)	90	16,92	3,03	.220*	.243*	.135

Note. Corr. MG = Correlation Median Grade. E = extraversion; A = agreeableness; C = conscientiousness;
N = neuroticism; O = openness.
* Correlation is significant at the 0.05 level (two-tailed) with Spearman's rho correlation coefficient
** Correlation is significant at the 0.01 level (two-tailed) with Spearman's rho correlation coefficient

Statistical Analysis

IBM SPSS Statistics Version 20 software was used for analysing the data. Median

grades were the dependant variable, and mean values for VIA and BFI factors and BFI facets

were the independent variables. The BFI raw data was controlled for acquiescence

responding which is the tendency to agree or disagree consistently throughout a questionnaire

(Soto, John, Gosling & Potter, 2008), showing no signs of distortion therefore raw scores

were used in the analysis. Several non-parametric tests were used for the statistical analysis.

Spearman's rank correlation coefficient was used for correlations, Mann-Whitney U-test was

used for analysing sex differences, and Kruskal-Wallis test was used for analysing program

differences. The measures of character strengths and personality traits demonstrated a

satisfactory internal reliability. Cronbach's alpha for VIA was .845, and for BFI .771.

Results

Descriptive statistics for VIA-120 are presented in Table 3. The total median grade

was 14.13 (n = 90; SD = 3.62). In terms of sex differences, females had significantly higher

median grades (n = 69; M = 14.64; SD = 3.83) compared to males median grades (n = 21; M

= 12.44; SD = 2.11), ($U = .001$, $p < .05$). Median grades also differed significantly between

the educational programs; social program (n = 56; M = 13.71; SD = 3.23), nature program (n

= 3; M = 19.17; SD = 1.44), humanistic program (n = 7; M = 17.86; SD = 2.13), economic

program (n = 9; M = 14.72; SD = 3.63) and aesthetic program (n = 15; M = 12.59; SD =

4.08), ($H = .001$, $p < .05$).

In relation to hypothesis 1A, the correlation between median grades and the factor

conscientiousness was found to be significant ($r_s = .427$, $p < .001$), indicating higher median

grades to be associated with higher conscientiousness. A positive correlation between

conscientiousness and median grades was also found for females (r_s = .473, p < .001) but not

for males (r = - .032, p = .895). Further, concerning hypothesis 1B the correlation between

median grades and order was significant (r_s = .273, p = .010), indicating higher median

grades to be associated with the facet order. Similar positive correlations was found for

females (r_s = .408, p = .001) and for males the analysis indicated a significant negative

correlation (r_s = - .481, p = .032). As well as for hypothesis 1C, the correlation between

median grades and self-discipline was significant (r_s = .434, p < .001), indicating higher

median grades to be associated with the facet self-discipline. Similar positive correlations

was found for females (r_s = .448, p < .001) but not for the males (r_s = .279, p = .221).

   Furthermore, in relation to hypothesis 2A, the correlation between median grades and

persistence was found significant (r_s = .237, p = .024), indicating higher median grades to be

associated with persistence. Similar positive correlations was found for females (r_s = .254, p

= .035) but not for the males (r_s = .099, p = .669). Also regarding hypothesis 2B, the

correlation between median grades and love of learning was found significant (r_s = .267, p =

.011), indicating higher median grades to be associated with love of learning. Similar positive

correlations was found for females (r_s = .332, p = .005) but not for the males (r_s = - .012, p =

.958). Furthermore, contradictory to the expected and in relation to hypothesis 2C, the

correlation between median grades and self-regulation was not found significant (r_s = .021, p

= .842). This was also the case for the females (r_s = .198, p = .103) and for the males (r_s = -

.134, p = .563). As well as for hypothesis 2D, the correlation between median grades and

prudence was not significant (r_s = .104, p = .329). Though, it was significant for females (r =

.253, p = .036) but not for males (r_s = - .281, p = .217).

In addition, according to the beforehand stated hypotheses, positive significant

correlations were found between the character strength open-mindedness and median grades

(r_s = .371, p <.000), were females accounted for the significance (r_s = .469, p < .000) and

males showed a negative, non-significant correlation (r_s = -.070, p = .763). Further, additional

significant correlations were found between the character strength perspective and median

grades (r_s = .321, p = .002). The correlation was found significant for females (r_s = .350, p <

.003), but not for males (r_s = .236, p = .303). Furthermore, the character strength of teamwork

showed a significant negative correlation with median grades (r_s = -.227, p = .032), being

significant for males (r_s = -.468, p = .032) but not for females (r_s = -.148, p = .224). Another

negative correlation was found between the character strength spirituality and median grades

(r_s = -.235, p = .026), being significant for females (r_s = -.308, p = .010) but not for males (r_s

= -.217, p = .344).

Furthermore, in addition to the beforehand stated hypotheses concerning the BFI

facets, another significant positive correlation was found between ideas and median grades (r_s

= .220, p = .037). This correlation was found significant for females (r_s = .243, p = .044), but

not for males (r_s = .135, p = .560).

Discussion

The empirical part of this thesis was to investigate the relation between personality

traits and academic achievement of students at a medium-sized high school in Sweden. The

results of the current study indicate positive correlations between academic achievement and

the personality trait conscientiousness and its conceptually underlying facets order and self-

discipline. The results also indicate a positive correlation between academic achievement and

the character strengths of persistence, love of learning, perspective and open-mindedness, and

a negative correlation with spirituality and teamwork. Hence, the results contribute to the accumulated source of knowledge about factors effecting academic achievement, which have been stated as important for the field of learning and education (O'Connor & Paunonen, 2007). Additionally, in the light of previous studies mainly conducted in other countries than Sweden, these results indicate that this relation can be accounted for in Sweden as well.

As expected, a positive correlation between median grades and conscientiousness was found which is in line with previous findings (Poropat, 2009; McAbee & Oswald, 2013). This applied only for the females in this study, and the male correlation was negative but not significant, which is in line with earlier findings, where females high in conscientiousness were found to have higher average grades than males (Rosander, 2013). Connected to this is the expectation to find positive correlations between the facets of conscientiousness and median grades, and these hypotheses were confirmed. More specifically, order correlated positively for females in line with earlier findings (Rosander, 2013) but negatively for males, indicating that the higher grades the males in this study had, the less organized they rated themselves to be. Self-discipline had a significant correlation for females, indicating that self-discipline is important for academic achievement and in line with earlier findings (Duckworth, 2007; Komarraju, 2009), even though this was not the case for males in this study.

Furthermore, the hypotheses that specific character strengths and academic achievement would be positively correlated were partly supported. More specifically persistence was found to be positively correlated with median grades, which is in line with previous studies (Lounsbury et al., 2009; Park and Peterson, 2009) as well as with the claim that persistence is one of the character strengths that is most similar to conscientiousness

(Peterson & Seligman, 2004). If one compares the items measuring persistence: "I do not give up"; "One can trust what I promise"; "I finish what I start" (Peterson & Seligman, 2004), with the items measuring conscientiousness: "I am someone who: does a thorough job, does things efficiently, and is a reliable worker" (John et al., 1991), they are relatively similar to one another. The correlation was positively significant for females and non-significant for males in this study, which continues to underline that the sex differences in this study also account for the character strengths. Moreover, the expectation to find a positive correlation between love of learning and median grades was confirmed, which is in line with findings in earlier studies (Lounsbury et al., 2009; Weber and Ruch, 2012). The link between love of learning and academic achievement is conceptually quite clear, which also is confirmed by the results in the present study though only for females and not for males, which is similar to the findings regarding sex differences mentioned above. In addition, love of learning showed to be especially valued by adolescents in the qualitative study by Steen et al. (2003).

In relation to self-regulation which was hypothesized to have a positive correlation with median grades, it was not confirmed in this study, which is contradictory to earlier findings (Lounsbury et al., 2009). Self-regulation is one of the character strengths that usually correspond to conscientiousness in BFI (Peterson & Seligman, 2004), and one possible explanation for the results in the present study can be the differences in the items measuring these traits. The VIA items for self-regulation for example, focusing on the ability to maintain a diet, not eating sweets placed in front of oneself, being a meticulous person and never wishing for things that are bad in the long run even if they feel good at the moment (Peterson & Seligman, 2004). The BFI factor conscientiousness includes the following: doing a thorough job, being organized and a reliable worker, finishing a task, being efficient, planning and sticking to the plan and not being careless, lazy or distracted easily (John et al.,

1991), which is more similar to the character strength of persistence mentioned above.

Furthermore, prudence was also expected to have a positive correlation to median grades, but was not confirmed in this study. The results regarding self-regulation and prudence, and the additional findings regarding perspective and open-mindedness, all indicate that character strengths are correlated to academic achievement but in another direction than expected. This is in line with earlier research that has shown small but noticeable correlations between open-mindedness and perspective with academic achievement (Lounsbury et al., 2009; Weber and Ruch, 2012). Furthermore, this association provides more reasons to believe that character strengths are associated with academic achievement, and more specifically that the ability to think through things and be critical, and to provide advice to others are important traits to encompass in terms of high achievement in school. The strength of perspective can especially be linked to the suggestion that prosocial behaviour is an important predictor of academic achievement (Caprara et al., 2003).

Another additional finding correlated ideas and median grades. This correlation was significant for females but not for males. Ideas are an underlying facet to the factor openness, and in previous research the findings regarding openness correlations to academic achievement sometimes have been both positive (O'Connor & Paunonen, 2007) and sometimes negative (Rosander, 2013). As mentioned in the beginning, academic achievement is mostly operationalized with GPA (Richardson et al., 2012), but studies using for instance test scores for academic achievement show results where openness has positive correlations to academic achievement. In the study by Noftle and Robins (2007), openness was correlated to academic achievement measured by verbal test scores, while conscientiousness showed no correlations to verbal test scores but strong correlations to academic achievement measured

with GPA. This indicates that how academic achievement is operationalized is crucial to notice for adequate comparison of different findings.

The most striking finding in this study is the differences between females and males in correlations between personality traits and academic achievement. Although the hypotheses contained no specification regarding differences between the sexes one of the two significant correlations for males in this study was accounted for by a negative correlation with order, and the other one by a negative correlation with teamwork. Thus, indicating that the better males in the present study work as a participant in a group, the lower grades they have. The results also indicated females to have higher median grades than males, and the correlation between personality traits and median grades could be seen in several personality traits, both in priori and additional personality traits and character strengths. One interesting finding is the negative correlation between the extraversion facet activity and median grades accounted for by males, even though not significant in this study, previous studies have found negative correlations between extraversion and academic achievement (O'Connor & Paunonen, 2007). On the one hand, this indicates that females have personality traits that are more appropriate for academic achievement, but on the other hand, this indicates that the school setting is formed to provide benefits to individuals being in a specific way.

Additionally, as stated as a premise for the field of personality neuroscience, the understanding of the whole person cannot be complete without understanding the brain (DeYoung, 2010). Therefore, this thesis has explained the neurobiology underlying personality traits and human functioning which is of interest for the understanding of what impacts academic achievement. Different studies have been put forward showing how individual differences in personality can be accounted for by variance in brain-, activity,

volume and chemistry. More specifically brain activity findings indicate that neuroticism is associated with increased activation in the right frontal lobe (Davidson, 2002). Further, that the connectivity pattern in ACC – amgydala and dmPFC – amygdala indicates individuals high in neuroticism to have less inhibitory control over and stronger self-reference to negative facial expressions (Cremers et al., 2010). Moreover, in the light of variance in brain activity, research show that extraversion is related to resting metabolism (Deckersbach et al., 2006) and lower blood flow (Johnson et al., 1999) in OFC, being in line with knowledge that prefrontal regions has an important role in regulating impulsive behaviour (Davidson et al., 2000). The findings concerning openness, conscientiousness and agreeableness in relation to variance in brain activity is scarcer than concerning extraversion and neuroticism, indicating future research to keep on investigating the variance in brain activity of these traits in order to gain a more complete knowledge about the underlying mechanism linked to specific traits.

In relation to brain volume, neuroticism is associated with variance in brain volume controlling for the sensitivity to punishment and reward (DeYoung et al., 2010) and extraversion is associated with increased brain volume in OFC (Omura et al., 2005; DeYoung et al., 2010) suggested as a underlying mechanism for valuing the reward of present stimuli (Depeu & Collins, 1999). This could possibly be linked to the findings where extraversion occasionally is negatively correlated to academic achievement (O'Connor & Paunonen, 2007), being only a speculation, this might indicate that students high in extraversion is more likely to not inhibit their immediate impulses and thus, not paying attention to long term goals in relation to educational demands. Another interesting finding concerning extraversion being more explanatory in terms of overt behaviour is the suggestion by Bjørnebekk et al. (2013) that the thinner cortex in Broca's area in extroverts are a structural mechanism for their way to be more outgoing and bold in speech, not inhibiting verbal impulses.

Furthermore, in the association between brain volume and conscientiousness, areas important for self-regulating behaviour such as the middle frontal gyrus are found to be positively associated with conscientiousness (DeYoung et al., 2010). This can be linked to the association that prefrontal regions are found to be more activated in succeeding to delay gratification (Casey et al., 2011). Similarly as for brain activity, the findings connecting agreeableness and openness to variance in brain volume are scarce, thus indicating further possible research areas.

Additionally, and interestingly in light of this thesis investigating personality traits important for academic achievement, is the recent findings correlating activation in the dorsal anterior cingulate cortex with cognitive control suggested to be a potential predictor for the variance in academic achievement in individuals (Veroude et al., 2013). Moreover, conscientiousness being linked to delay of gratification indicates that different systems are in charge for different types of behaviour, where the top-down prefrontal regions are suggested to be responsible for the choices individual's take when delaying the reward for later, and more immediate choices are regulated by the subcortical limbic structures (Casey et al., 2011). As for future research, it would be interesting to examine the possible effect of an intervention targeting delay of gratification in relation to cognitive and emotional functioning, in order to increase student's ability to focus on long-term goals thereby possibly enhancing academic achievement. Not mentioned or included in this study are the motivational aspects of learning and education, which also are in interest when investigating what factors enable and effect academic achievement (Rosander, 2013).

DeYoung & Gray (2009) suggests that a broad array of methods should be used in the search for neurobiology markers of personality to contribute to the understanding of the brain

in order to understand the whole person. Thus, an alternative way of examining the

neurobiology of personality traits might have been to investigate studies using other

personality measures. For instance the Behavioral Activation and Behavioral inhibition

Scales by Carver and White (1994) or the recent developed Affective Neuroscience

Personality Questionnaire by Davis and Panksepp (2011). Including more interesting

variables in future studies still remains, so that the neurobiology of personality traits

hopefully will be of greater knowledge in the future.

Limitations and Future Research

No specification of the participant's socioeconomic status was collected or analysed

in this study. It is recommended to future studies to include such measure in order to take into

account possible impacting variables on academic achievement. Likewise a recommendation

is done for measures of intelligence, which was not included in this study and thus limiting

the chance to control for intelligence and the breadth of the analysis. It can be problematic to

not include a measure such as IQ since it is known to be a variable predicting and influencing

cognitive performance to a great extent (Busato et al., 2000). Furthermore concerning the

concept of IQ, the studies that have been referred to in this thesis all use different measures of

IQ, however a similar theme is that they assess general intelligence (See DiFabio & Busoni,

2007; Busato et al., 2000; Rosander, 2013; Duckworth et al, 2007; Duckworth & Seligman,

2005; Leeson et al., 2008). Therefore, one the one hand these studies limit the equivalence

concerning IQ but on the one hand show convergent results that IQ is an ability influencing

academic achievement.

Further, concerning the sampling of the participants, only those students willing to

take part and interested in the experiment choose to participate in the study, which affect the

diversity of the sample, thus limiting the ecological validity of the study. Consequently,

interpretations should be done carefully, limiting the analysis to the sample of which the

study included. It is also important to mention the design of the present study was

correlational, thus there are no possibilities to make statements about causality. The results of

the present study should be seen as an indication for further research, suggesting for example,

longitudinal studies investigating the effects of interventions targeting for instance,

conscientiousness, persistence, self-discipline and other relevant traits and behaviours that

have been found to be important for academic achievement. It is also important to note that

more specific analyses could have been done. That in order to find more detailed results

concerning the relation between personality traits and achievement in different courses in

school, since the present operationalization (median grades) is too broad for specific abilities

to be seen in the results. For example a correlation between mathematics and personality

traits would probably be different from a correlation between sports & health and personality

traits.

Moreover, in terms of the evident difference between females and males, it was not in

the scope of this study to investigate sex differences in relation to personality traits and

academic achievement. This is of course an important issue, and thus a future area of

investigation. In this situation it is also tempting to put forth arguments concerning the

differences between females and males, for example are the importance of academic

achievement and how it matters different between females and males? If this is the cause to

the differences between the sexes in this study, the results cannot answer. But the question

gives reason to investigate it further. In a recent investigation concerning men and equality

from the Swedish Government, one conclusion to be one of the most important in order to

improve academic achievement for both men and women, is that the equivalence between

different school needs to be strengthen and the gap of knowledge that also exist between

schools actively needs to be counteracted (SOU, 2014:6).

Furthermore, the grading systems are different in Sweden compared to for example

USA or UK. One interesting question concerning this is if the measures of grades truly are

objective in Sweden. Teachers are not allowed to let the way students behave or are

motivated guide the grade on a course. On the one hand, teachers thus take the performance

of presentations and tests into account, but on the other hand, teacher cannot keep away from

being influenced by how students behave and act in the school. According to the author of

this thesis it is questionable to take for granted that the measures of grades are truly objective.

This may lead to that motivated, ambitious and out-going students earn higher grades than

their less motivated, but still achieving peers.

Conclusion

The main aim of this thesis was to describe the neurobiology underlying personality

traits, and to investigate the relationship between academic achievement and personality

traits. In the first part, the neurobiology of personality traits was described in order to extend

the understanding of what variables effect academic achievement. Various research methods

for investigating individual differences in personality such as variance in brain- activity,

volume and chemistry have been put forward, shedding light on the underlying mechanism

that contribute to the function of different traits (and lower level facets) such as neuroticism

(anxiety and depression), extraversion (assertiveness and activity), conscientiousness (order

and self-discipline), agreeableness (altruism and compliance) and openness (aesthetics and

ideas). The knowledge for all the factors is incomplete and suggestions have been stated in

order to widen the understanding of the neurobiology of personality traits, which is important

because personality traits are said to predict important outcomes and behaviours of an individual's life (Xu & Potenza, 2012).

One such important outcome is academic achievement, which was investigated in the second part of the thesis through the implementation of a study in a medium sized high school in Sweden, with a sample (N = 90) of senior students in the age range of 18–19 years. The results confirmed priori hypothesis concerning the positive correlation between personality traits such as conscientiousness, self-discipline and order, as well as for additional facets such as ideas, with academic achievement. Further the results confirmed priori hypothesis concerning the positive correlations between character strengths such as persistence and love of learning, as well as for additional character strengths such as perspective and open-mindedness, with academic achievement. Moreover, being a study conducted in Sweden the results confirm that these relationships can be accounted for even here. Furthermore, in connecting academic achievement to the neurobiology of personality traits, specific findings regarding the neural mechanisms of traits important for academic achievement have been described. The success and failure for delay of gratification have for instance been associated with increased prefrontal activity and increased limbic activity, respectively. Consequently, the results of the study and the theoretical discussion extend existing knowledge about what factors influence academic achievement, which learning and education can learn from (O'Connor & Paunonen, 2007).

Furthermore, suggestions for future research have also been made concerning sex differences when it comes to investigating correlations between personality traits and academic achievement. As well as to make it possible to keep cultural and scientific innovation up to date, which in a broad sense is a necessary role for academic achievement (Hirsh & Inzlicht, 2010).

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