THE INTERFACE OF INTELLIGENCE AND PERSONALITY

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Faculty of Science
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for the degree of Doctor of Philosophy
For my parents

and my sister
Acknowledgments

I would like to thank my father, for giving me the means to study abroad, but mostly because it was his intelligence that triggered my interest in this fascinating area. I would like to thank my flat-mates, Maria, Alexia and Smaroula, for making the years of my PhD studies truly unforgettable. I would like to thank Tomas, for his support, and especially for his opposing views, which always resulted in the most interesting debates.

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Abstract

This thesis concerns the interface of intelligence and personality. It contains six Chapters and eleven independent but related studies.

Chapter 1 is a review of the literature in this area. This presents the major models of personality and intelligence, the findings on the interface of the two constructs, and the major findings on how both are related to occupational performance.

Chapter 2 consists of two studies, investigating the empirical links between g and the Big 5 personality traits. Results indicate positive links of g with Openness, and negative links with Neuroticism, Conscientiousness and Extraversion.

Chapter 3 consists of three studies, which further investigate the major findings of Chapter 2, proposing explanations on how the observed relationships may have developed. Study 3 indicated that the relationship between Neuroticism and intelligence is mediated by state anxiety. Study 4 attested to a link between gf and Openness, indicating that it does not exclusively correlate with gc. Studies 4 and 5 revealed that Conscientiousness is more highly correlated with gf than with gc, which along with the sub-factor level analysis of Conscientiousness, indicated that gf may affect its development.

Chapter 4 consists of three studies, investigating the relationship between intelligence and personality measures commonly used in occupational settings. Results indicated that similar patterns of results emerge irrespective of the inventories used, which can be linked to the Big 5 correlates of intelligence, thus attesting to the robustness of the relationship between intelligence and personality.

Chapter 5 consists of three studies, investigating the relationship of intelligence and personality with job performance. Results revealed a link between intelligence and simulated and self-rated job performance, but not with salary or managerial level. Job performance was positively linked with measures of Conscientiousness, Extraversion and Agreeableness and negatively linked with measures of Neuroticism and Openness, though results were not consistent across measures of job performance.

Chapter 6 presents a summary of the findings of the thesis, discussing their implications and their contribution to the current literature. This Chapter also considers the limitations of the conducted studies, suggesting ideas for future research.
Note:

Study 1 has been published in the *European Journal of Personality* (2003), 17, 79-94.

Study 2 is in press in *Personality and Individual Differences*.

Study 5 is in press in *Personality and Individual Differences*.

Study 6 has been published in *Social Behaviour and Personality* (2003), 31, 577-584.

Study 7 is in press in *Individual Differences Research*.

Currently another four papers are under editorial review, in *Learning and Individual Differences, Journal of Affective Disorders, European Journal of Psychological Assessment* and *Personality and Individual Differences*. 
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Chapter 1: Introduction

Two main avenues that psychologists have explored in their attempt to understand human behaviour, are intelligence and personality. Attempts have been made to define these constructs and reveal their structure, to explain their development and comprehend their effect on various life outcomes. Although personality and intelligence have traditionally been kept apart and seen to be unrelated in structure and functioning, recent studies have established links between them (Ackerman & Heggestad, 1997; Kyllonen, 1997; Austin, Deary, Whiteman, Fowkes, Padersen, Rabbitt, Bent, & McInnes, 2002), indicating that a comprehensive understanding of the development of human behaviour will require the investigation of the interface between the two constructs.

This review will summarize the studies on the relationship between intelligence and personality, revealing the major findings as well as the inconsistencies in the present literature. As a starting point, the definitions and theories describing the two constructs will be outlined. The aim will not be to provide a complete review of the theories that have been proposed, but to focus on the major and most influential ones, in order to provide a basis for the understanding of the relationship between personality and intelligence. Studies investigating the interface of the two constructs will be divided in the ones that look at intelligence in relation to personality conceptualized by the Five-Factor Model (Costa & McCrae, 1985), and in relation to personality conceptualized by Jung’s (1921) theory of personality types.

One of the major areas in which research on intelligence and personality can be applied, is the Industrial/Organizational field of psychology. Research has shown that
psychometric tests, and more precisely intelligence and personality tests, are valid predictors of job performance (Barrick & Mount, 1991; Gottfredson, 1997; Salgado, 1997; Tan & Libby, 1997; Graham, 1999; Judge & Ilies, 2002), and that failure to employ them during employee selection can lead to substantial economic losses (Schmidt, 1988). This research will therefore also investigate the relationship between measures of personality and intelligence and job performance. Hence this review will summarize the findings of the effects of personality and intelligence on occupational performance, revealing the areas that warrant further research.

1.1. Intelligence

The concept of intelligence is so old that it is apparent even in one of the first examples of European literature, the Odyssey, in which Homer described Odysseus as "polymixanos", which is a synonym to the contemporary Greek word for 'intelligent'. Although the word 'intelligence' is used in our everyday language, researchers have not yet reached a consensus about how to define or measure intelligence. Intelligence has been defined as "the ability to carry out abstract thinking" (Terman, 1916, cited in Sternberg, 2000), "the capacity for knowledge, and knowledge possessed" (Henmon, 1929, p.195), "that faculty of mind by which order is perceived in a situation previously considered disordered" (R.W. Young, cited in Kurzweil, 1999), "the ability to deal with complexity" (Gottfredson, 2002), and even as "what is measured by intelligence tests" (Boring, 1923). However, as Macintosh (1998) noted, "new definitions are the end product of scientific research, not its starting point" (p.2).

One of the first attempts to actually measure intelligence was made by Sir Francis Galton (1822-1911), who established a laboratory in the South Kensington Museum of London
in 1882, in which he administered tests measuring auditory and visual sensory
discrimination abilities and reaction times to specific stimuli. However, mostly due to
methodological problems, his findings were not promising. In 1904, the French Ministry
of Public Instruction asked Alfred Binet (1857-1911) to develop techniques in order to
identify children whose lack of success in normal classrooms suggested the need for
some form of special education. In 1905 Binet and Simon produced the Binet-Simon
scale, the first intelligence test, which consisted of 30 short tasks related to everyday
problems of life (e.g. comparing lengths and weights, counting coins, naming objects in a
picture, filling in the missing words in sentences). This was a turning point in
psychology. It lead to the development of theories of intelligence, as well as of tests
measuring it, which were found to correlate with important criteria such as academic
performance (Thurstone, 1919, Thorndike, 1921; Goh & Moore, 1987; Elshout &
Veehman, 1992; Busato, Prins, Elshout & Hamaker, 2000; Furnham & Chamorro-
Premuzic, in press), job performance (Graham, 1999; Gottfredson, 2002) and life
outcomes such as marital choice (Brand, 1993) crime (Mednick, Moffitt, Gabrielli, &
Hutchings, 1986) mental health and even death rate (Stankov, Boyle & Cattell, 1995).

1.1.1. Models of intelligence

1.1.1.1. Spearman – General intelligence (g)

One of the most influential attempts to describe the structure of human abilities was made
by Charles Spearman (1904), who analyzed the relation between measures of sensory-
discrimination ability using factor analysis\(^1\). Spearman discovered that scores on all

\(^1\) Factor analysis is a statistical technique used to determine the minimum number of underlying dimensions
necessary to explain a pattern of correlations among measurements
mental ability tests were positively inter-correlated, and suggested that there is a common intellectual ability which accounts for the positive manifold of these correlations, which he labeled 'g', for general intelligence (Brody, 1992). This lead him to the 'two factor' theory of intelligence, which proposes that the variance on a particular intelligence measure can be partitioned into a component attributable to g, which is required for performance in mental tests of all kinds, and to a specific source of variance, 's', which is required for performance on the specific intelligence measure.

Some critics of intelligence research maintain that the notion of g is illusory, that no such global mental capacity exists, and that apparent intelligence is really just a by-product of one's opportunities to learn skills and information valued in a particular cultural context (Gottfredson, 1998). However, the fact that g is not specific to any particular domain of knowledge or mental skill, suggests that g is independent of cultural content (Gottfredson, 2002). Consensus on the existence of g has currently increased to the extent of classifying the theories that neglect it as "pseudo-scientific" or "semi-popular" (Deary, 2001).

Family, twin and adoption studies have furthermore shown that g is highly heritable (Bouchard & McGue, 1981; Bouchard, Lykken, McGue, Segal & Tellegen, 1990; Boomsma, 1993). As Gottfredson (1998) claimed, "the reality is that Mother Nature is no egalitarian. People are in fact unequal in intellectual potential-and they are born that way, just as they are born with different potentials for height, physical attractiveness, artistic flair, athletic prowess and other traits" (p. 24). The biological influence on g is also evident by the positive correlations between g and brain size (Wickett, Vernon & Lee, 2000) and by studies that have observed a neural basis of g through positron emission
Finally, studies have further found $g$ to be related to higher nerve conduction velocity (Vernon & Mori, 1992) and to lower glucose metabolic rates (Haier, Siegel, Nuechterlein, Hazlett, Wu, Paek, Browning & Buchsbaum, 1988).

1.1.1.2. Cattell – The $gf$-gc theory

Raymond Cattell (1963, 1971, 1987) suggested that there are three related but distinct components of $g$, 'fluid intelligence' ($gf$), 'crystallized intelligence' ($gc$) and the short-term memory and recall' factor ($gsar$). Attention has been focused on the first two components of Cattell's model, which will be described here in further detail.

Fluid intelligence can be defined as our "on-the-spot reasoning ability, a skill not basically dependent on our experience" (Belsky, 1990). It involves things like reaction times, quick thinking, reasoning, seeing relationships, approaching new problems, and is considered to be biologically based (Brody, 1992). Researchers have advocated that $gf$ is at its peak when the central nervous system (CNS) is at its physiological peak (Belsky, 1990). It has also been found that performance on tests measuring $gf$ is closely associated with working memory capacity and with the ability to control attention, and these functions are largely mediated by forebrain structures (Ackerman et al., 1999). Tests like the Ravens Progressive Matrices, the Norwegian matrices, the Belgian Shapes test, the Jenkins test, and the Horn test are examples of tests that attempt to measure fluid intelligence. These tests try to emphasize problem solving and to minimize reliance on specific skills or familiarity with words and symbols. It should be noted here that $gf$ is understood by some researchers as $g$ (Gustafsson, 1984; Undheim & Gustafson, 1987; Gustafsson, 1988; Stankov, 2000).
Crystallized intelligence can be defined as "the extent to which a person has absorbed the content of culture" (Belsky, 1990). It is the accumulation of information, facts, figures, skills and knowledge, over time. Crystallized intelligence is believed to be influenced by education and cultural exposures (Brody, 1992). Tests like the Wechsler-Binet and purely verbal tests measure gc. Questions on these tests measure verbal knowledge, information about the humanities, social and physical sciences, the ability to follow instructions and to define problems (Horn, 1988). In sum, scores on gf measures indicate an individual’s potential for learning, while scores on gc measures indicate the amount of learning accumulated. In most data sets, correlations between gf and gc range between .50 and .70 (Ackerman, Kyllonen & Roberts, 1999). The gf-gc theory has become one of the most widely accepted psychometric paradigms of intelligence (Stankov et al. 1995), and will be used in this review as the basis to investigate the relationship between personality and intelligence.

1.1.1.3. Vernon and Carroll - Hierarchical Approaches

Probably the most widely accepted factorial descriptions of intelligence are the hierarchical approaches, proposed by Phillip Vernon (1965, 1979) and John Carroll (1993). Vernon (1965) suggested that intelligence can be described as comprising of abilities at varying levels of generality. At the highest level of generality is g, as defined by Spearman (1904). At the next level are ‘major group’ factors, such as verbal-educational ability and practical-mechanical ability. At the next level are ‘minor group’ factors, which can obtained by subdividing the major group factors, and at the lowest level, the bottom of the hierarchy, are specific factors of the kind identified by Spearman. Vernon therefore inserted two further levels between Spearman’s g and s factors.
John Carroll (1993) reviewed over 450 ability matrices and developed a three-stratum model of cognitive ability, similar to Vernon's (1965). According to this model, which is presented in Figure 1.1, g exists in Stratum III, at the top of the hierarchy, underlying all levels of intellectual ability. Stratum II consists of eight somewhat specialized abilities that occur in broad domains of intelligent behaviour, gf, gc, general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speediness, and processing speed. Stratum I consists of very specialized skills that reflect the acquisition of specific types of knowledge, grouped under the second-stratum factors. As Carroll acknowledged, his hierarchical analysis is closely related to the gf-gc model put forward by Cattell (1971). Recent research has provided support for the three-stratum model of intelligence (Bickley, Keith & Wolfe, 1995; Hunt, 2002).

Figure 1.1: The Three-Stratum model (Carroll, 1993)
1.1.1.4. Gardner- Multiple intelligences

A currently popular theory among educationalists, rather than psychologists, was proposed by Howard Gardner (1983), who argued that the format of a single intelligence rules out many kinds of intelligent performance that matter in everyday life, like giving an extemporaneous talk (linguistic intelligence), or being able to find one's way in a new town (spatial intelligence). Gardner (1983) suggested that evidence from gifted individuals, savants, neuro-psychology, experts and virtuosos, and diverse cultures supports at least seven completely independent types of intelligence: linguistic, logical-mathematical, spatial, musical, kinesthetic, interpersonal and intrapersonal. He later added to these three more types of intelligence, naturalist, spiritual and existential (Gardner, 1999).

Although this theory of Multiple Intelligences captured the attention of many researchers, educators and authors, it has been argued that Gardner's intelligences tap personality traits, motor skills or cognitive styles rather than mental aptitudes (Morgan, 1996). As Matthews, Davies, Westerman and Stammers (2000) suggested, "so far as cognitive abilities are concerned, the data are inconsistent with Gardner et al.'s (1996) view that there are several entirely independent abilities" (p.244).

The present review of the models of intelligence is exemplary rather than exhaustive. Of the models described here, the focus of the thesis will be on intelligence as conceptualized by g, and the gf-gc theory of intelligence. This is because these are two of the most influential attempts to describe the structure of human abilities (Jensen, 1998; Robinson, 1999; Stankov, 2000), but also because previous research on the interface of intelligence and personality is based on these two models of intelligence (Ackerman &
Heggestad, 1997; Kyllonen, 1997). The following section will describe individual differences in intelligence, as these must be taken into account in order to accurately assess how intelligence and personality are related.

1.1.2. Individual differences in intelligence

Researchers have investigated individual differences in intelligence, searching for traits or relatively stable characteristics, along which people differ (Eysenck & Eysenck, 1985; Matthews et al., 2000). After the publication of ‘The Bell Curve’ (Herrnstein & Murray, 1994), confusion arose regarding individual differences in intelligence. This prompted 50 experts on the field to jointly publish a statement in the Wall Street Journal in 1994, specifying which individual differences in intelligence were actually supported by empirical research. This review will focus on the two main areas of individual differences that have been investigated in relation to intelligence, namely sex and age.

1.1.2.1. Sex differences

In the research of sex-related differences in cognitive ability, there is a general consensus that males and females do not differ in general intelligence (Hyde & Linn, 1988; APA Public Affairs Office, 1997; Colom, Juan-Espinosa, Abad, & Garcia, 2000; Loehlin, 2000; Matthews et al., 2000). It could be argued that no sex differences are observed because a criterion for the construction of IQ tests is lack of sex bias. However, no sex differences were observed even before such item balancing was used (Terman, 1916). Lynn (1994, 1998, 1999) has argued that the lack of sex differences in intelligence is inconsistent with the fact that males have larger brains than females (Ankney, 1992; Rushton, 1992) and that brain size correlates with IQ by around $r = .35$ (Lynn, 1999). He proposed that males actually have an advantage of 4 IQ points over females, which was
supported by large data sets on the Wechsler overall IQ tests (Lynn, 1994). However, it has been argued that the male superiority that Lynn observed does not reflect actual general intelligence because the test items used should have been weighted according to their loading on g, and also because data sets using different intelligence measures did not support this finding (Mackintosh, 1998).

There do however seem to be sex differences in the variance of IQ scores, with males showing greater variability (Feingold, 1992) and more importantly, researchers have found significant sex differences in specific abilities (Matthews et al., 2000). The most consistent findings on sex differences in specific cognitive abilities are that males outperform females on tests measuring spatial abilities, whereas females outperform males on tests measuring verbal abilities (Matarazzo, 1972; Maccoby & Jacklin, 1974, 1978; Willerman, 1979), although it has recently been suggested that the female superiority in verbal ability has been diminishing (Stumpf & Jackson, 1994). Researchers have also consistently found a male advantage on mathematical reasoning ability, mostly among highly talented individuals (Benbow & Stanley, 1983; Lubinski & Benbow, 1992; Mills, Ablard & Stumpf, 1993; Stumpf, Tissot & Mills, 1993). Born, Bleichrodt and van der Flier (1987) conducted a cross-cultural meta-analysis, in which they found a male superiority on reasoning ability and a female superiority on perceptual speed and memory. These findings were supported by Stumpf and Jackson (1994), who noted however, that although the findings were statistically significant, they were relatively small in magnitude.
1.1.2.2. Age differences

In the study of age-related differences in cognitive ability, although some researchers argue for the maintenance of intelligence across the entire life span (Schaie, 1983; Schaie & Hertzog, 1986), the general consensus is that scores on intelligence tests tend to decline with age, the extent of the decline depending on the nature of the test (Matthews et al., 2000). The tests that show the greatest decline are those measuring fluid intelligence, while scores on tests measuring crystallized intelligence are generally maintained into old age (Schwartzman, Gold, Andres, Arbuckle & Chaikelson, 1987; Horn, 1991; Rabbitt, 1993; Avolio & Waldman, 1994; Stankov et al., 1995; Baltes & Lindenberger, 1997; Kaufman, 2001).

Stankov (1994) reported correlations between fluid abilities and age ranging from $r = -.30$ to $r = -.70$. Among these abilities are working memory, speed of information processing, perceptual-organization and the capacity to handle mental operations that involve abstract reasoning. Ryan, Sattler and Lopez (2000) reported that fluid abilities peak at the age of 16 or 17, and start to decline between 45 and 54 years of age. Conversely, crystallized abilities peak within the age range of 45 to 54 years, and begin to decline during the eighth decade of life. There are however factors which diminish the rate of intellectual decline, such as good health (no cardiovascular or other chronic disease), high socio-economic status, high level of education, complex and intellectually stimulating occupation, flexible personality style in mid-life and high cognitive status of spouse (Schaie, 1989, 1994). It has further been proposed that individuals with higher initial level of intelligence suffer a milder decline in verbal intelligence than individuals with lower initial level of intelligence, however the effect of age on non-verbal intelligence
1.2. Personality

Personality theory developed within the context of individual differences research, in order to develop an inclusive description of persons (Barratt, 1995). Guilford (1959) defined personality as an individual’s “unique pattern of traits”, with a trait being “any distinguishable, relatively enduring way in which one individual differs form others”. In the first Annual Review of Psychology, Sears (1950) suggested that there are three main perspectives for viewing personality theory, structure, dynamics and development. This review will focus on the structure of personality, describing two of the most prominent models, the ‘Five-Factor’ model (Costa & McCrae, 1985) and the ‘Four-factor’ model, which is based on Jung’s (1921) theory of personality types.

1.2.1. The ‘Four-factor’ model of psychological types

In 1921 Jung published his theory of psychological types. He believed that there are two basic functions which humans use in their lives, how they take in information (perceive things) and how they process that information (judge things). Within these two categories, there are two opposite ways of functioning; one can perceive information via the senses or via intuition, and one can make judgments based on objective logic or on subjective feelings. Jung (1921) further noted that these four mental processes can be directed either at the external world of people or things (extraverted attitude) or at the
internal world of subjective experience (introverted attitude). This theory can be pictorially presented in Figure 1.2.

Figure 1.2: The ‘Four-Factor’ model of psychological types (adopted from Myers & McCaulley, 1985)

Katharine Briggs and her daughter Isabel Briggs Myers developed the Myers-Briggs Type Indicator (MBTI) as an objective measure of Jung’s (1921) theory of psychological types. The MBTI has been applied to many practical settings, including academic advising and career counseling (Provost & Anchors, 1987), organizational behaviour (Bridges, 1992) and leadership (McCaulley, 1990). Devito (1985) has described it as “probably the most widely used instrument for non-psychiatric populations in the area of clinical, counseling and personality testing” (p.1030). This test measures four internally consistent and relatively uncorrelated personality dimensions, Extraversion-Introversion
(EI), Sensing-Intuition (SN), Thinking-Feeling (TF) and Judging-Perceiving (JP) (Myers & McCaulley, 1985).

Perceiving individuals directly receive information, often without evaluation, and are curious and open to new events and changes. Judging individuals organize and process information, and are concerned with planning and decision-making. Sensing individuals perceive information directly through their senses, they tend to focus on the facts of a given situation. Intuitive individuals go beyond the information provided by their senses to discover possibilities, which may not be directly obvious from sensory data. Thinking individuals judge information by logically analyzing it in terms of the strict principles of cause and effect, they approach life in a rational way, searching for logical relationships between events. Feeling individuals judge information by identifying the emotional value that is attached to objects or events, they are more concerned by what they feel about a person or an event, than what they can learn about it through logical analysis. Extraverts direct their mental processes towards the external world, they enjoy spending time in the company of other people and enjoy translating their ideas and interests into overt behaviour and action. Finally, Introverts like to spend time with their own thoughts and focus their perception and judgment upon concepts and ideas (Myers & McCaulley, 1985; Myers, McCaulley, Quenk & Hammer, 1998). Sample items for each MBTI dimension are presented in Table 1.1.
Table 1.1: MBTI dimensions with sample items (Form G)

<table>
<thead>
<tr>
<th>Part I</th>
<th>Which answer comes closest to telling how you usually feel or act?</th>
</tr>
</thead>
<tbody>
<tr>
<td>EI</td>
<td>Are you usually: (a) a good mixer, or (b) rather quiet and reserved?</td>
</tr>
<tr>
<td>SN</td>
<td>If you were a teacher, would you rather teach: (a) fact courses, or (b) courses involving theory?</td>
</tr>
<tr>
<td>TF</td>
<td>Do you more often let: (a) your heart rule your head, or (b) your head rule your heart?</td>
</tr>
<tr>
<td>JP</td>
<td>Does following a schedule: (a) appeal to you, or (b) cramp you?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part II</th>
<th>Which word in each pair appeals to you more?</th>
</tr>
</thead>
<tbody>
<tr>
<td>EI</td>
<td>(a) reserved, (b) talkative</td>
</tr>
<tr>
<td>SN</td>
<td>(a) statement, (b) concept</td>
</tr>
<tr>
<td>TF</td>
<td>(a) convincing, (b) touching</td>
</tr>
<tr>
<td>JP</td>
<td>(a) systematic, (b) casual</td>
</tr>
</tbody>
</table>

Each of the four dimensions is dichotomized at a fixed zero point so the test shows on which end of the scale a person is for each trait, and numeric scores merely show the strength of one's preference. Thus it is the dominant score that determines the typological label. Psychological type is given by a four-letter code (e.g. ESTP) and there are 16 types in total. However, this has lead to criticisms of the MBTI on the basis that there is no bi-modal distribution of preference scores in reality (Furnham, 1996a). The MBTI has also been criticized in that there is no support for the typological theory on which it is based (Sticker & Ross, 1964, Hicks, 1984) and that it has low construct validity (Saggino, Cooper & Kline, 2001). Despite these criticisms, the MBTI is amongst the most commonly used instruments in personality assessment (McCrae & Costa, 1989), which is the reason for which it will be investigated, in relation to intelligence as well as to job performance.
1.2.2. The Five-Factor model of personality

One of the most prominent models in contemporary psychology is the Five Factor Model (FFM) of personality, which was proposed by Costa and McCrae (1985). This model was developed using factor-analyses of ratings of the terms people use to describe personality characteristics. According to the model, there are five higher-order, orthogonal dimensions of personality, Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness. Each of the five personality dimensions is represented by six, more specific scales, that measure facets of the dimension. Costa and McCrae (1985) developed the NEO-Personality Inventory in order to measure the 'Big 5' personality factors, and their facet scales. Sample items of the revised version of the NEO-PI, for the 30 facet scales, are presented in Table 1.2.

*Neuroticism* reflects a tendency to experience negative emotions, like anxiety and depression (Busato et al., 2000). The six facets of Neuroticism, according to Costa & McCrae (1992) are anxiety, anger-hostility, depression, self-consciousness, impulsiveness and vulnerability. High scorers tend to be sensitive, emotional, worrying, moody, frequently depressed, often sleep badly and may suffer from various psychosomatic disorders (Eysenck & Eysenck, 1975). Low scorers tend to be secure, hardy and generally relaxed even under stressful conditions. It has been proposed that individual differences in Neuroticism have a biological basis (Eysenck, 1967), more specifically that they are due to differences in the functioning of the limbic system (Stough, Donaldson, Scarlata & Ciorciari, 2001).
Table 1.2: NEO PI-R facets with sample items (Costa & McCrae, 1992)

<table>
<thead>
<tr>
<th>Neuroticism facets</th>
<th>Sample Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1: anxiety</td>
<td>&quot;I am not a worrier.&quot;</td>
</tr>
<tr>
<td>N2: angry hostility</td>
<td>&quot;I often get angry at the way people treat me.&quot;</td>
</tr>
<tr>
<td>N3: depression</td>
<td>&quot;I rarely feel lonely or blue.&quot;</td>
</tr>
<tr>
<td>N4: self-consciousness</td>
<td>&quot;In dealing with other people, I always dread making a social blunder.&quot;</td>
</tr>
<tr>
<td>N5: impulsiveness</td>
<td>&quot;I rarely overindulge in anything.&quot;</td>
</tr>
<tr>
<td>N6: vulnerability</td>
<td>&quot;I often feel helpless and want someone else to solve my problems.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extraversion facets</th>
<th>Sample Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1: warmth</td>
<td>&quot;I really like most people I meet.&quot;</td>
</tr>
<tr>
<td>E2: gregariousness</td>
<td>&quot;I shy away from the crowds of people.&quot;</td>
</tr>
<tr>
<td>E3: assertiveness</td>
<td>&quot;I am dominant, forceful, and assertive.&quot;</td>
</tr>
<tr>
<td>E4: activity</td>
<td>&quot;I have a leisurely style in work and play.&quot;</td>
</tr>
<tr>
<td>E5: excitement-seeking</td>
<td>&quot;I often crave excitement.&quot;</td>
</tr>
<tr>
<td>E6: positive emotions</td>
<td>&quot;I have never literally jumped for joy.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Openness facets</th>
<th>Sample Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1: fantasy</td>
<td>&quot;I have a very active imagination.&quot;</td>
</tr>
<tr>
<td>O2: aesthetics</td>
<td>&quot;Aesthetic and artistic concerns aren’t very important to her.&quot;</td>
</tr>
<tr>
<td>O3: feelings</td>
<td>&quot;Without strong emotions, life would be uninteresting to me.&quot;</td>
</tr>
<tr>
<td>O4: actions</td>
<td>&quot;I’m pretty set in my ways.&quot;</td>
</tr>
<tr>
<td>O5: ideas</td>
<td>&quot;I often enjoy playing with theories or abstract ideas.&quot;</td>
</tr>
<tr>
<td>O6: values</td>
<td>&quot;I believe letting students hear controversial speakers can only confuse and mislead them.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Agreeableness facets</th>
<th>Sample Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1: trust</td>
<td>&quot;I tend to be cynical and skeptical of others’ intentions.&quot;</td>
</tr>
<tr>
<td>A2: straightforwardness</td>
<td>&quot;I am not crafty or sly.&quot;</td>
</tr>
<tr>
<td>A3: altruism</td>
<td>&quot;Some people think I am selfish and egotistical.&quot;</td>
</tr>
<tr>
<td>A4: compliance</td>
<td>&quot;I would rather cooperate with others than compete with them.&quot;</td>
</tr>
<tr>
<td>A5: modesty</td>
<td>&quot;I don’t mind bragging about my talents and accomplishments.&quot;</td>
</tr>
<tr>
<td>A6: tender-mindedness</td>
<td>&quot;I think political leaders need to be more aware of the human side of their policies.&quot;</td>
</tr>
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<table>
<thead>
<tr>
<th>Conscientiousness facets</th>
<th>Sample Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1: competence</td>
<td>&quot;I am known for my prudence and common sense.&quot;</td>
</tr>
<tr>
<td>C2: order</td>
<td>&quot;I would rather keep my options open than plan everything in advance.&quot;</td>
</tr>
<tr>
<td>C3: dutifulness</td>
<td>&quot;I try to perform all the tasks assigned to me conscientiously.&quot;</td>
</tr>
<tr>
<td>C4: achievement striving</td>
<td>&quot;I am easy-going and lackadaisical.&quot;</td>
</tr>
<tr>
<td>C5: self-discipline</td>
<td>&quot;I am pretty good about pacing myself so as to get things done on time.&quot;</td>
</tr>
<tr>
<td>C6: deliberation</td>
<td>&quot;Over the years I have done some pretty stupid things.&quot;</td>
</tr>
</tbody>
</table>
Extraversion reflects a tendency to experience positive emotions and to be sociable and dominant (Busato et al., 2000). The six facets of Extraversion are warmth, gregariousness, assertiveness, activity, excitement-seeking and positive emotions. High scorers tend to be sociable, friendly, self-confident, optimistic, energetic, aggressive, enthusiastic and adventurous. They like excitement and stimulation and tend to be cheerful in disposition. Low scorers tend to be reserved, shy and even-paced, but not necessarily un-friendly or pessimistic. It has been proposed that Extraversion is in part genetically influenced (Eysenck, 1982; Pedersen, Plomin, McClearn & Fridberg, 1988; Bookman, Taylor, Adams, Kittler, 2002), determined by activity in the reticular formation-cortex arousal loop.

Openness to experience reflects a tendency to engage in intellectual activities, to experience varied sensations, and to be curious about both inner and outer worlds (Costa & McCrae, 1992). The facets of Openness are fantasy, aesthetics, feelings, actions, ideas and values. High scorers tend to be imaginative, artistic, creative, idealistic, spontaneous, talkative, adventurous, curious and insightful. Low scorers are down-to-earth, less interested in art and more practical in nature, mild, conservative and cautious. Recent findings, which are based on EEGs and twin studies, suggest that Openness is partly biologically based (Bergeman, Chipuer, Plomin, Pedersen, McClearn, Nesselroade, Costa & McCrae, 1993; Stough et al., 2001).

Agreeableness reflects how we tend to interact with others. High scorers on this trait are kind, gentle, trusting, forgiving, warm and altruistic, they are sympathetic towards others and eager to help them. Low scorers are demanding, selfish, stubborn and aggressive, they are skeptical of others' intentions and competitive rather than co-operative. The six
facets of Agreeableness are trust, straightforwardness, altruism, compliance, modesty and tender-mindedness. Research has shown only modest effects of genetic influence on Agreeableness (Bergeman et al., 1993).

Finally, Conscientiousness reflects how organized and persistent one is in pursuing their goals. The facets of Conscientiousness are competence, order, dutifulness, achievement-striving, self-discipline and deliberation. High scorers are efficient, self-confident, thorough, organized, ambitious, determined and persistent. Low scorers are careless, distractible, lazy, impulsive and impatient, they are not necessarily lacking in moral principles, but are less exacting in applying them. Research has shown only modest genetic influence and psychophysiological correlates of Conscientiousness (Bergeman et al., 1993; Stough et al., 2001).

The FFM has been linked by researchers to the 'three-factor model' of personality, proposed by Eysenck and Eysenck (1985). According to this model, which has been described as one of the most sophisticated trait personality models (Furnham, 1999a), there are three higher-order, orthogonal traits of personality, Extraversion, Neuroticism and Psychoticism. Eysenck (1991, 1992) suggested that these personality factors are biologically based, with the physiological basis being located in the cortico-reticular loop and the viscero-cortical loop that connects the cerebral cortex with the visceral brain (Matthews & Deary, 1998). McCrae and Costa (1985) showed that the Extraversion and Neuroticism factors of the NEO-PI were similar to Eysenck's Extraversion and Neuroticism factors, and that Psychoticism could be essentially covered by their Conscientiousness and Agreeableness factors. It has however been suggested that the two models differ due to the fact that they have different aims (Saggino, 2000). The three-
factor model aims at identifying those dimensions of personality, which are grounded on biological processes, whereas the aim of the FFM is "the classification of all major sources of individual differences in personality" (McCrae & Costa, 1985, p.588). Critics of the FFM argue that the factor-analytic technique, by which the model was developed, is a purely empirical and atheoretical method (Block, 1995). However, this set of five factors has been recovered not only from the analysis of more than 15,000 trait adjectives in several languages, but also from almost every major personality inventory (Goldberg, 1990). Furthermore, studies have shown that this structure has generalized across cultures (Borkenau & Ostendorf, 1990; John & Srivastave, 1999), and evidence indicates moderate heritability of the traits (Loehlin, 1992).

1.3. The relationship between Personality and Intelligence

Psychologists have researched intelligence and personality for over a century now, in an attempt to develop models of human behaviour (Saklofske & Zeidner, 1995). In the history of research of personality and intelligence, most researchers have treated the two constructs as independent (Barratt, 1995; Saklofske & Zeidner, 1995; Zeidner & Matthews, 2000). This differentiation between the two constructs is based on a number of criteria. One basic criterion concerns the nature of the traits, in that intelligence is unidirectional, i.e. there is either "little of" or "much of", whereas personality is bi-directional, i.e. it is usually midpoints instead of extreme values that are considered optimal (Cronbach, 1949). Furthermore, intelligence aims to measure maximal performance, which implies that an individual cannot portray an improved self-image, whereas personality aims to measure an individual’s typical performance, and is assessed
by subjective measures, which may be susceptible to voluntary modification of the outcome.

Despite the tradition to differentiate between personality and intelligence, the artificiality of the distinction has been recognized by many of the key figures of differential psychology (Austin, Deary & Gibson, 1997; Zeidner & Matthews, 2000; Collis & Messick, 2001; Ackerman & Beier, 2003). It has been suggested that intelligence and personality processes are bound to interact, and are never utilized in isolation from one another (Maciel, Heckhausen & Baltes, 1994). Thus Ackerman (in press) argued that the effort to measure intelligence as maximum performance by minimizing environmental and situational effects is an attempt to separate what is practically inseparable in everyday situations.

Cattell’s (1971) 16 Personality Factor model of individual differences also incorporates the relationship between cognitive (ability) and non-cognitive (personality and motivation) dimensions in order to explain human behaviour. He thus proposed that there may be causal and reciprocal relationships between personality and intelligence. The second personality factor of his model, concrete vs. abstract reasoning, seems to be a self-report measure of intelligence. High scorers are described as more intelligence, bright, of higher mental capacity and fast learners, whereas low scorers are described as less intelligence, unable to handle abstract problems and of lower mental capacity (Conn & Rieke, 1994). Many researchers have thereafter attempted to show how the constructs of intelligence and personality are conceptually and empirically related (Matthews, 1986; Hembree, 1988; Goff & Ackerman, 1992; Zeidner, 1995; Ackerman & Heggestad, 1997;
In an attempt to explain the empirical findings on the interface between personality and intelligence on theoretical grounds, Ackerman (1996) developed the PPIK theory (Intelligence-as-Process, Personality, Interests, intelligence-as-Knowledge). According to this theory, individuals start off with differing levels of intelligence-as-process. This concept is similar to gf, with a focus on abilities that are based on substantially de-contextualized processes, such as working memory and abstract reasoning. This form of intelligence interacts with the development of personality and interest variables, causing individuals to devote greater or lesser amounts of cognitive effort in the acquisition of domain-specific knowledge. The PPIK theory, which has been supported by later studies (Ackerman & Heggestad, 1997; Rholfus & Ackerman, 1999; Ackerman, 2000; Ackerman & Beier, 2003; Ackerman, Bowen, Beier, & Kanfer, in press), therefore provides a framework by which correlations between personality factors and gf and gc can be explained.

It is obvious that in order to develop a comprehensive description of human behaviour, the interface between intelligence and personality must also be investigated, as they may interact with respect to their manifestation and development. Attempts to reveal the links between intelligence and personality come from two different approaches, the psychometric and the cognitive science approach. This review will be in the tradition of the psychometric approach, which investigates structure rather than process. This can be achieved by modeling the correlational relationships between the two constructs, and by performing longitudinal studies in order to test causal models.
1.3.1. Intelligence and the Big 5

The first attempts that were made to investigate the interface of intelligence and personality were unfruitful (Lorge, 1940; Wechsler, 1950), mainly because at the time there was no general consensus about which factors underlie the two constructs. However, the recent consensus of researchers on the Five-Factor Model as a structure of personality, and the general acceptance of g and of the gf-gc theory, have set the grounds to base research on valid and reliable measures, and to perform studies which are easily replicable.

1.3.1.1. Openness to Experience

The personality factor that has been most consistently correlated with intelligence, is Openness to Experience (Ackerman & Heggestad, 1997; Zeidner & Matthews, 2000; Demetriou, Kyriakides & Avramidou, 2003). Openness is the personality factor that is conceptually the closest to intelligence, as it represents the tendency to engage in intellectual activities and to experience new sensations and ideas (Busato et al., 2000). Some researchers have indeed preferred to refer to Openness as Intellect (Digman & Takemoto-Chock, 1981), Culture (Goldberg, 1990), or Inquiring Intellect (Fiske, 1949) interpreting this personality trait in terms of introspective reflection and intellectual knowledge. Eysenck (1992) and Kline (2001) suggested that Openness appears to lie on a border between intelligence and personality, and Brand (1994) further argued that about 40% of the ‘true’ variance of Openness in the general population could be attributed to g.

Researchers however also support the differentiation between Openness and intelligence, mainly due to the unavoidable differences in measurement, as Openness measures typical performance whereas intelligence measures maximal performance (Cronbach, 1949). It
should also be noted that Openness includes facets, like 'feelings', which cannot be easily linked conceptually to intelligence. In general, findings support a moderate overlap between Openness and intelligence, as correlations are of the magnitude of $r = .30$ (Austin et al., 2002), $r = .33$ (Ackerman & Heggestad, 1997) and $r = .45$ (Kyllonen, 1997).

The suggestion that Openness is conceptually linked to intelligence, by representing the tendency to engage in intellectual activities (Busato et al., 2000), can also be supported by research on self-estimations of intelligence. Self-estimated intelligence has been found to correlate with psychometrically measured IQ by about $r = .30$ (Borkenau & Liebler, 1993; Paulhus, Lysy & Yik, 1998; Furnham, 2001; Furnham, Kidwai & Thomas, 2001, Furnham & Thomas, 2002; Chamorro-Premuzic, Furnham & Moutafi, in press). Furthermore, Chamorro-Premuzic, Moutafi and Furnham (under review) looked at the relationships between Openness, self-estimated intelligence and gf, and found that all the correlations between these variables were significant. They thus proposed that Openness may be linked to intelligence by being a self-report measure of it.

Many researchers however advocate that Openness specifically correlates with gc (Ackerman & Goff, 1994; Zeidner & Matthews, 2000; Bates & Shieles, 2003). This has been explained in that Open individuals, being more intellectually curious and behaviourally flexible (McCrae, 1993) are more motivated to engage in intellectual activities, which causes them to expand their gc. Correlations between Openness and gc are of the magnitude of $r = .40$ (Goff & Ackerman, 1992). Evidence for the suggestion that Openness specifically correlates with gc has been provided by Jackson (1984), who found this trait to be moderately correlated with a gc sub-test, but only weakly correlated
with a gf sub-test of the Multidimensional Aptitude Battery. This finding was later replicated by Ashton, Lee, Vernon and Jang (2000). Similarly, Kyllonen (1997) found Openness to correlate by $r = .58$ with verbal intelligence, which is a measure of gc, and only by $r = .29$ with quantitative ability, which is a measure of gf.

Further evidence supporting the correlation between Openness and gc has been provided by research on Typical Intellectual Engagement (TIE), a concept proposed by Goff and Ackerman (1992). TIE is a self-report measure of typical intellectual performance, as opposed to maximal performance, which is measured by IQ tests. This construct measures an individual’s desire to engage and understand the world, their interest in a wide variety of things, and their preference for a complete understanding of a complex topic or problem. Evidence shows that TIE, which is highly correlated with Openness ($r = .67$) (Ackerman, 1996), is more highly correlated with gc than gf (Goff & Ackerman, 1992). It was therefore suggested that the relationship between Openness and gc may be mediated by TIE, in that typical engagement with the environment and the culture in an intellectual context may lead to the development of gc.

1.3.1.2. Neuroticism

Another factor of the Big 5 which has been consistently found to correlate with intelligence is Neuroticism, the correlation being negative, indicating that Neurotic individuals tend to score lower on intelligence tests (Zeidner & Matthews, 2000). Among the first studies which reported a negative correlation between intelligence and Neuroticism was an early study by Callard and Goodfellow (1962), and their finding has been replicated many times since then (Furnham et al., 1998a; Dobson, 2000). In a large meta-analysis of 135 studies, performed by Ackerman and Heggestad (1997),
Neuroticism was reported to modestly negatively correlate with g, with a magnitude of $r = -.15$, and Kyllonen (1997) reported a correlation of $r = -.23$ with g and $r = -.20$ with verbal ability.

It has been suggested that Neuroticism is negatively correlated with intelligence mostly due to its anxiety component, although two more components, angry hostility and depression have also been found to be negatively related to intelligence (Hembree, 1988; Matthews, 1986; Zeidner, 1995; Rindermann & Neubauer, 2001). The negative effect of anxiety on intellectual functioning is believed to originate from the working memory system. That is, high-anxiety individuals engage in significantly more task-irrelevant processing (worry) than low-anxiety individuals (Eysenck, 1979). Support for this claim was provided by Leon and Revelle (1985) who reported a deleterious effect of state anxiety on cognitive ability performance, and by Sarason (1980), who reported that state anxiety can impair intellectual functioning in a variety of contexts, from IQ test scores to school achievement. Ackerman and Heggestad (1997) also found a correlation of $r = -.33$ between g and self-report measures of test anxiety. This evidence however implies that it is state anxiety that mediates the relationship between Neuroticism and intelligence test performance, instead of trait anxiety mediating the relationship between Neuroticism and intelligence. Further support for this suggestion comes from studies that found no significant correlation between intelligence and trait anxiety (Leith, 1972; Matarazzo, 1972; Leon & Revelle, 1985), although a significant correlation has also been reported in some studies (Samuel, 1980; Tapasak, Roodin & Vaught, 1978).

It has been proposed that test anxiety consists of two conceptually distinct components, worry and emotionality (Liebert & Morris, 1967). Oostdam and Meijer (2003) recently
suggested that test anxiety also comprises of a third component, lack of self-confidence, although this finding has not yet been replicated. The worry component of test anxiety is a cognitive concern over performance and its consequences, whereas the emotionality component is the physiological changes with unpleasant feelings of unease, nervousness and tension. Research has shown that it is the worry rather than the emotionality component of test anxiety that is primarily associated with decrement of performance (Spielberger, Gonzalez, Taylor, Algaze & Anton, 1978; Dobson, 2000).

The apparent negative relationship between anxiety and intelligence does not necessarily imply that individuals who have state anxiety perform less well on the ability tests due to their anxiety. It could be that individuals with lower intelligence, being aware of their likelihood to perform poorly, become more anxious under test conditions (Mueller, 1992). It has also been proposed that individuals with high anxiety may avoid activities that lead to intellectual growth, due to their beliefs of lack of self-efficacy (Cattell, 1971), this however should be evident by a stronger correlation between anxiety and ge over gf, as the latter is more biologically based. Even though there is no conclusive explanation as to how Neuroticism affects intellectual performance, there seem to be sufficient empirical evidence supporting the claim that such a relationship exists (Ackerman & Heggestad, 1997; Kyllonen, 1997; Furnham, et al. 1998a; Zeidner & Matthews, 2000).

1.3.1.3. Extraversion

Many researchers have agreed that there is a link between intelligence and Extraversion, however, there is considerable disagreement about what exactly the relationship is (Roberts, 2002). In a study of adolescents, Lynn, Hampson and Magee (1982) found correlations between intelligence and Extraversion of r = .21 for males and r = .19 for
females. In their meta-analysis, Ackerman and Heggestad (1997) reported a smaller, though still significant correlation between g and Extraversion ($r = .08$). A negative correlation ($r = -.19$) however has also been reported by Furnham et al. (1998) and by Roberts (2002), for a verbal intelligence test. As Revelle, Amaral and Turriff (1976) noted, the link between intelligence and Extraversion is dependent upon the test type and the test conditions, which could account for these controversial findings.

According to Zeidner (1995), Introverts have an advantage in tasks related to superior associative learning ability (verbal skills) whereas Extraverts have an advantage in tasks related to the ready acquisition of automatic motor sequences (performance tasks), although the replicability of these results has been questioned (Saklofske & Kostura, 1990). Introverts, however, have been found to do better on problem-solving tasks, which require insight and reflection (Matthews, 1992), whereas Extraverts have been found to do better on short and speeded tasks (Rawlings & Carnie, 1989). Eysenck (1994) also suggested that Extraversion is related to speed of working, based on his finding that Extraverts tend to spend less time in taking a test than Introverts. Similarly, Doucet and Stelmack (1997) and Wickett and Vernon (1999) reported that Extraverts had faster movement times in a simple reaction time task than Introverts. These findings are in line with the arousal theory (Eysenck, 1967, 1994), which states that the resting level of cortical arousal for Introverts is higher to that of Extraverts. According to this theory, increased stimulation is required for maximal performance in Extraverts (Bates & Rock, 2004).

Based on the arousal theory, Stough, Brebner, Nettlebeck, Cooper, Bates and Mangan (1996) proposed that very high or very low levels of arousal damage performance,
whereas the optimal level is an intermediate level of arousal. They did indeed find that Ambiverts (moderate extraverts) outperformed both Extraverts and Introverts in the verbal as well as the performance sub-scales of the Wechsler Adult Intelligence Scale-Revised, and proposed that the relationship between Extraversion and intelligence is quadratic instead of linear. Roberts (2002) however failed to replicate these results, explaining that the optimum level of arousal may differ from test to test.

Findings on the relationship between Extraversion and intelligence seem to imply that Extraversion is related to intelligence test performance rather than to intelligence per se. This suggestion has been supported by Robinson (1985), who claimed that Extraversion is associated with intellectual styles and intelligence profiles and not with actual ability.

1.3.1.4. Agreeableness and Conscientiousness

Out of the Big 5 personality factors, Conscientiousness and Agreeableness seem to be the least related to ability. Ackerman and Heggestad (1997) reported a near zero correlation \( r = .01 \) between \( g \) and Agreeableness, a finding which was supported by Kyllonen (1997). Austin et al. (2002) however did find a significant negative, although modest, relationship between Agreeableness and general ability in one data set. This personality factor has also been negatively linked to creativity (King, Walker & Broyles, 1996), which in turn is linked to intelligence (Sternberg & Lubart, 2003). The scarcity of findings however supporting this relationship is not surprising, as Agreeableness, which is related to being kind, gentle, trusting, warm and altruistic, seems the personality factor that is conceptually the most independent from intelligence.

Perhaps more surprising is the near zero correlation, reported by Ackerman & Heggestad (1997), between \( g \) and Conscientiousness \( r = .02 \). Conscientiousness is the personality
factor that has most consistently been found to correlate to academic and job performance (Barrick & Mount, 1993; Rothstein, Paunonen, Rush & King, 1994; De Raad, 1996; Blickle, 1996; Chamorro-Premuzic & Furnham, 2003a,b). Consequently, it could be expected to correlate with intelligence, as the latter has been consistently linked to both academic (Elshout & Veeneman, 1992; Neisser, Boodoo, Bouchard, Broykin, Brody, Ceci, Halpern, Loehlin, Perloff, Sternberg, & Urbina, 1996; Sternberg & Kaufman, 1998; Rinderbaum & Nauber, 2001) and job performance (Varsa & Valutis, 1993; Gottfredson, 1997; Tan & Libby, 1997; Graham, 1999). Interestingly, Furnham (1999b) reported a negative correlation between Conscientiousness and creativity, which may suggest that it is negatively related to gf. Evidence in support of this suggestion has recently been provided by Demetriou et al. (2003) and by Furnham et al. (under review).

1.3.2. Intelligence and the ‘Big 4’

Although there is a great deal of empirical work on the MBTI (Edwards, Lanning & Hooker, 2002), and it is one of the most frequently used personality tests in the occupational community, research looking at the relationship between the MBTI personality dimensions and intelligence is scarce. Of the MBTI personality dimensions, the one that has most consistently been found to correlate with intelligence is SN (Hengstler, Reichard, Uhl & Goldman, 1981; Pratt, Uhl, Roberts & De Lucia, 1981; Schurr, Ruble, & Henriksen, 1988, Schurr, Ruble, Henriksen & Alcorn, 1989; Schurr, Henriksen, Alcorn & Dillard, 1994). This is not surprising, as the MBTI expanded analysis report identifies the Intuitive Type with adjectives such as intellectual, abstract, imaginative, theoretical and original (Saunders, 1989). Sensing individuals tend to emphasize immediate experiences and practicality, whereas Intuitive individuals tend to
perceive possibilities and relationships via insight (Myers & McCaulley, 1985). Kaufman, McLean and Lincoln (1996) inferred from this that Intuition denotes a higher level of intelligence than Sensing. This suggestion was in line with Myers and McCaulley (1985), who found in a sample of students that individuals who scored higher on the Intuition pole also scored higher on the California Test of Mental Maturity. Further, Kaufman et al. (1996) found that Intuitive individuals achieved higher scores than Sensing individuals on the general intelligence measure of the Kaufman Adolescent and Adult Intelligence Test (KAIT).

The other MBTI dimension that has been found to correlate with intelligence is JP. Judging individuals are concerned with decision-making, planning and organizing, and Perceiving individuals are curious, adaptable and open to new events and changes (Myers & McCauley, 1985). As Kaufman et al. (1996) suggested, both types of the JP dimension seem especially equipped to score highly on intelligence tests, especially those measuring gf. Indeed, they found that Judging and Perceiving individuals did not differ on the g measure of the KAIT, indicating that extreme scorers on either end of the JP dimension score higher in intelligence tests. Edwards et al. (2002) on the other hand reported that Judging, and not Perceiving, (as well as Intuition) predicts performance on a social cognitive task, tapping information-processing effort. This however would be expected to tap on interpersonal intelligence, as proposed by Gardner (1983), instead of on g. Schurr et al. (1988) further found that JP and SN together accounted for 8% of the variance of the mathematical component of the Scholastic Aptitude Test (SAT).

The TF and the El are the dimensions that have been found to be least correlated with intelligence, although it has been proposed that both dimensions have some theoretical
relationship to intelligence (Kaufman et al., 1996). Thinking individuals are characterized by making logical connections and applying the principles of cause and effect, whereas Feeling individuals stress personal and group values and subjective interpretations (Myers & McCaulley, 1985). Thinking individuals were therefore expected to score higher than Feeling individuals on the KAIT, however Kaufman et al. (1996) failed to support this hypothesis. Similarly, although Introverts were expected to score higher on the KAIT than Extraverts due to their emphasis in the inner world of ideas and concepts, which would aid the development of gc, findings did not support this hypothesis (Kaufman et al., 1996). However, Schurr et al. (1988) reported that EI, SN and JP together accounted for 21% of the variance in the verbal component of the SAT.

It is apparent that although several studies have provided evidence for links between the constructs of intelligence and personality, the nature and magnitude of many of these relationships are yet unclear, and warrant further research in order to be established. This thesis therefore aims to clarify how the constructs of intelligence and personality are related, and also to propose possible explanations for why these relationships may have occurred. Within this line of research, the effect of both intelligence and personality in the applied field of occupational performance will also be investigated. The following section will thus review the literature on the relationship between intelligence, personality and job performance.

1.4. Intelligence as a predictor of performance

Past research has shown that intelligence as measured by IQ tests is the single most effective predictor of individual performance at school and on the job (Gottfredson, 1997;
Kuncel, Hezlett & Ones, 2003). It also predicts many other aspects of well-being, including a person’s chances of divorcing, dropping out of high school, being unemployed or having illegitimate children (Jensen, 1980; Schmidt & Hunter, 1981; Cattell, 1982; Cronbach, 1990), as well as mortality by vehicular accidents, for men aged 20 to 44 (O’Toole, 1990) and death by suicide (O’Toole & Stankov, 1992). This review will summarize the research on intelligence as a predictor of job performance.

1.4.1. Intelligence and job performance

Research has shown that employment tests are valid predictors for virtually all jobs and that failure to employ them during employee selection can lead to substantial economic losses (Schmidt, 1988). Intelligence, and more specifically general mental ability, has been found to be the best predictor of job performance across a variety of jobs (Hunter, 1983, 1986; Schmidt, Hunter, Outerbridge & Stephen, 1988; Borman, White, Pulakos & Oppler, 1991; Varsa & Valutis, 1993; Gottfredson, 1997; Tan & Libby, 1997; Graham, 1999; Gottfredson, 2002). General intelligence has further been found to correlate with occupational status and with income, which are extrinsic measures of job performance (Burt, 1943; Jencks, 1972, 1979; Gottfredson, 1986, 1997; Herrnstein & Murray, 1994; Jensen, 1998, Mackintosch, 1998), and with performance in assessment center exercises (Spector, Schneider, Vance & Hezlett, 2000).

It has been proposed that one way by which intelligence influences job performance is by affecting job knowledge, which subsequently affects job performance (Hunter, 1983; Carretta & Ree, 1997). This is because intelligence is the “capacity for knowledge” (Henmon, 1929). In line with this suggestion, intelligence has been found to be a better predictor of the acquisition of subsequent job knowledge, compared to prior job
knowledge (Carreta & Doub, 1998). Intelligence further affects occupational performance by facilitating the acquisition of skills (Ackerman, 1988) that enhance performance, by facilitating the effect of job training, and by providing the means to cope with changing demands of the job (Ree & Carreta, 1998).

Researchers investigated whether specific abilities of high congruence to the job could predict job performance over and above general mental ability, but found that they only added little increment validity to an equation that already contained g as a predictor (Ree & Earles, 1991; Besetsny, Earles & Ree, 1993; Graham, 1999). Hattrup and Jackson (1996) thus concluded that specific abilities “have little value for building theories about ability-performance relationships” (p. 532).

Recently, researchers have investigated whether 'practical intelligence', which is the ability that individuals use to find the best fit between themselves and the demands of their environment, is a better predictor of success than g (Sternberg, Wagner, Williams & Horwath, 1995; Sternberg, Forsythe, Hedlund, Horvath, Wagner, Williams, Snook & Grigorenko, 2000). However, these studies base their findings on very small (N < 60) and unrepresentative samples. Furthermore, Taub, Hayes, Cunningham, and Sivo (2001) who tried to replicate these findings with a larger sample failed to do so, and reported that in accordance with the general consensus, g was found to be the best predictor of success.

The nature of the relationship between ability and performance has been found to be linear (Hawk, 1970; Coward & Sackett, 1990). It has however been reported that this relationship can be moderated by factors like task difficulty, task consistency (Nettelbeck, Chesire & Lally, 1979) and task complexity (Salgado, Anderson, Moscoso, Bertua, De Fruyt & Rolland, 2003). Specifically, correlations between intelligence and
rated job proficiency have been found to be generally higher for higher status jobs than for ones of lower status (Hunter & Hunter, 1984) and for jobs of higher complexity (Hunter, 1983). Farrell and McDaniel (2001) also found that for jobs with high task consistency, g best predicted early performance whereas factors like psychomotor ability best predicted later performance. In contrast, for jobs with low task consistency, g was the best predictor above all factors.

The above findings yield a reasonably consistent picture, that IQ tests do predict up to an extent how well people perform their job. It is however less clear what that extent is. Jensen (1980) reported correlations ranging from .32 to .38 between intelligence and actual job performance, and Hunter and Hunter (1984) reported correlations ranging from .25 to .60 between intelligence and rated job performance. Schmitt, Gooding, Noe and Kirsch (1984) on the other hand reported a more modest predictive validity of .25 in their meta-analytic study. However, even if the correlations are modest, intelligence remains the best predictor of job performance, compared to biographical data, references, educational level, college grades and interviews (Hunter & Hunter, 1984; Gottfredson, 2002).

1.5. Personality and Job Performance

The value of personality as a predictor of job performance has been found to be quite low in relation to other predictors (Guion & Gottier, 1965; Hunter & Hunter, 1984; Schmitt, et al., 1984; Robertson & Kinder, 1993). Blinkhorn and Johnson (1990) claimed that “there is precious little evidence that even the best personality tests predict performance”. Schmitt et al. (1984) conducted a meta-analysis of validation studies of personality
measures and concluded that the average correlation between personality measures and performance rating criteria was quite modest ($r = .21$).

Several reasons have been proposed to explain the low validity of personality measures as predictors of job performance, among which are the unreliability of personality and performance measures used (Furnham, 1992), criterion insufficiency and contamination, and the lack of consideration of personality-situation effects (Jackson & Corr, 1998). Furthermore, the lack of a common personality framework, for organizing the traits used as predictors, made it difficult to compare findings. With the increasing confidence in the robustness of the five-factor model however, researchers begun to adopt this in their investigations of the relationship between personality and job performance. This changed the earlier pessimistic conclusions to a widespread faith within the occupational community in the utility of personality assessment for selection and development (Fletcher, 1991; Jackson & Corr, 1998; Hogan & Holland, 2003). Indeed, five later meta-analyses performed by Barrick and Mount (1991), Tett, Jackson and Rothstein (1991), Salgado (1997), Judge, Heller and Mount (2002) and Judge and Ilies (2002) provided grounds for optimism for the use of personality tests in measuring employee selection and productivity.

1.5.1. The Big 5 and Job performance

Studies looking at the relationship of the Big 5 personality factors and job performance show that Conscientiousness and Neuroticism are the factors that are most consistently correlated with job performance (Barrick, Mount & Judge, 1999; Judge & Ilies, 2002). This indicates that individuals who are calm, self-confident, and resilient (Emotionally...
Stable), and dependable and disciplined (Conscientious) tend to perform better on their job.

Conscientiousness and its facets have been found to predict job performance in a number of studies, and it has been claimed that this personality factor is one of the most valid predictors of performance for most jobs, second only to general intelligence (Behling, 1998). Conscientiousness has been correlated with salary (Orpen, 1983, Barrick & Mount, 1991), promotions (Howard & Bray, 1994; Jones & Whitemore, 1995), employment status (De Fruyt & Mervielde, 1999), and with supervisor ratings of performance in the military (Hough, Eton, Dunnette, Kamp & McCloy, 1990). Also dependability, which is a facet of Conscientiousness, has been found to be a predictor of supervisor and peer ratings (Borman et al., 1991). Judge, Higgins, Thoresen and Barrick (1999) further found Conscientiousness to be correlated with job performance directly, i.e. with job status and income, but also indirectly, i.e. with job satisfaction. As Mount, Barrick and Strauss (1999) noted, Conscientiousness is an important correlate of job performance across numerous jobs and diverse criterion types. This makes intuitive sense, as individuals who are dependable, thorough, organized and hardworking are expected to perform better on their job.

A number of recent studies however have also proposed that certain sub-factors of Conscientiousness may be detrimental for specific occupations. Moon (2001) measured performance as de-escalation of commitment in a losing situation, and found Achievement Striving to be detrimental for performance, while Duty had a beneficial effect, with the broad measure of Conscientiousness being unrelated to performance. Job performance has also been negatively correlated with Achievement Striving (Hough,
1992) and with Dependability (Hough, Ones & Viswesvaran, 1998) for certain occupations, such as for health care workers. It has further been proposed that Conscientiousness may result in one performing less tasks as well as taking longer to complete them, which may be detrimental for certain jobs, such as for successful management (Driskell, Hogan, Salas & Hoskins, 1994; Robertson, Baron, Gibbons, MacIver & Nyfield, 2000).

The relationship between Neuroticism and job performance has most extensively been examined by looking at measures of facets of Neuroticism. Low Neuroticism, as measured by self-acceptance and self-confidence, has been correlated with salary (Rawls & Rawls, 1968; Harrell, 1969) and occupational status (Melamed, 1996a, 1996b). Also optimism, self-confidence and self-assurance, have been correlated with managerial advancement, executive pay and job success (Howard & Bray, 1988; Goldberg, 1990; Mount & Barrick, 1995).

Neuroticism as a trait has been directly linked to performance, measured by assessment center exercises (Spector et al., 2000), and indirectly linked to performance, as it has been consistently negatively correlated with job satisfaction (Smith, Organ & Near, 1983; Furnham & Zacherl, 1986; Tokar & Subich, 1997). Neuroticism has also been negatively correlated with occupational success in trainee pilots, especially when the Neurotic individuals were also Introverted (Jessup & Jessup, 1971; Bartram & Dale, 1982). This is not surprising, as flying can be very stressful, since a single mistake can be fatal. Therefore, Neurotics who are susceptible to stress are likely to perform less well to more stable individuals (Eysenck & Eysenck, 1985). The negative relationship between Neuroticism and job performance has further been established by a recent meta-analysis
performed by Salgado (1997). It appears that individuals who are calm, secure, well-adjusted and low in anxiety, tend to perform better on their job. It has however been proposed that Neuroticism is not a negative predictor of performance in all occupations. Goetz and Goetz (1973) for example found that creative painters and sculptors tend on average to be Neurotic Introverts.

Another Big 5 factor, which has frequently been linked to job performance, is Extraversion (Judge et al., 1999). Extraversion has been found to be a valid predictor of salary, of job level (Melamed, 1996a, 1996b) and of managerial potential (Craik, Ware, Kamp, O’Reilly, Staw & Zedeck, 2002). Characteristics of Extraversion, like dominance and sociability have been related to salary, job title and managerial promotions (Rawls & Rawls, 1968; Caspi, Elder & Bem, 1987, Howard & Bray, 1994). Friendliness has also been modestly correlated to job performance, measured by supervisor and peer ratings (Borman, White & Dorsey, 1995). Extraversion can further be indirectly linked to job performance, as it has been consistently correlated with job satisfaction (Furnham & Zacherl, 1986; Watson & Slack, 1993; Tokar & Subich, 1997; Watson & Clark, 1997).

There are however inconsistencies in the correlation between Extraversion and job performance. Barrick and Mount (1991) and Hurtz and Donovan (2000) found Extraversion to be positively correlated with job performance as a sales representative, whereas Stewart and Carson (1995) found Extraversion to be negatively correlated with performance in service jobs. It should be noted that these studies used different measures for job performance, which could account for the inconsistencies observed. It has however been suggested that Introverts are better at handling routine work activities than Extraverts (Cooper & Payne, 1967).
Openness and Agreeableness are the factors which have the least consistently been found to be related to job performance. Judge et al. (1999) suggested that characteristics of Open individuals, like flexibility, creativity and intellectual orientation make it possible for them to perform better on their job. Openness has indeed been found to be a valid predictor of training proficiency (Barrick & Mount, 1991; Barrick, Mount & Judge, 2001) and of effectiveness (Judge & Bono, 2000), and Open individuals have been found to perform better in customer service jobs (Hurtz & Donovan, 2000) and in jobs that require creative behaviour (George & Zhou, 2001). Openness is also linked to a tendency to learn from experiences, which has been identified as a key trait of successful managers (Montaglioni & Giacalone, 1998). However, as Judge et al. (1999) noted, Openness also has characteristics which could be detrimental for performance in certain jobs, for example Open individuals could be unsatisfied in conventional jobs. Indeed, Openness has been found to be negatively correlated with performance of rugby referees (Jackson & Corr, 1998). This has been explained in that rugby referees need to maintain discipline and to ensure that rules are followed, which are conditions that Open individuals might find difficult to follow. Openness has further been indirectly linked to job performance, by negatively correlating with job satisfaction in a European sample (Boudreau et al., 2001).

Similarly it has been proposed that Agreeableness is also a factor that consists of characteristics which could be both beneficial and detrimental for job performance. Judge et al. (1999) suggested that the cooperative nature of Agreeable individuals makes it possible for them to perform better in many occupations compared to individuals low on Agreeableness. Agreeableness has been found to positively correlate with overall job
performance (Tett et al., 1991), with performance as measured by interpersonal facilitation (Hurtz & Donovan, 2000), and to be a valid predictor of performance in the military (Hough et al., 1990). It appears that being likeable, cooperative and good-natured, has a positive impact on job performance. On the other hand, Agreeable individuals with high altruism could sacrifice their success for pleasing others. Accordingly, Agreeableness has been found to negatively correlate with management potential (Howard & Bray, 1988), with extrinsic measures of executive career success and with salary (Boudreau et al., 2001).

1.5.2. The 'Big 4' and Job Performance

The relationship between personality and job performance has also been investigated, though to a lesser extent, by looking at the relationship of the four MBTI dimensions and measures of job performance. The El dimension has been found to modestly correlated with job performance, as measured by self-reported income (Rice & Lindecamp, 1989). El can also be indirectly linked to job performance, as it has been found to correlate with job satisfaction, with Extraverts being more satisfied than Introverts, irrespective of their occupation (Rahim, 1981). It has however been proposed that the correlation between EI and job performance may be culture specific. Furnham and Stringfield (1993) found that EI was positively correlated with team-work, commitment and potential for European managers, whereas it was negatively correlated with decision making and achieving key results for Chinese managers.

With respect to the SN dimension, it has been proposed that Sensing individuals should perform better at innovative projects, and have indeed been found to be more venturesome than Intuitives (Henderson & Nutt, 1980). However, it has also been
suggested that culture may be a moderating factor of the relationship between SN and job performance, as the correlation has been found to be positive for Chinese managers and negative for European managers (Furnham & Stringfield, 1993).

Myers (1962) argued that both the JP and the TF dimensions should be correlated with managerial performance, with an advantage of Judging and Thinking over Perceiving and Feeling. JP can also be indirectly linked to job performance, as it has been found to correlate with job satisfaction, with Judging types being more satisfied than Perceiving types, irrespective of their occupation (Rahim, 1981). The TF dimension has been found to be modestly linked to success in small retailers, with Thinking being more successful than Feeling individuals (Rice & Lindecamp, 1989). Furthermore, it has been suggested that Feeling should perform better than Thinking individuals at jobs requiring innovation (Henderson & Nutt, 1980).

Researchers seem to be much closer to reaching a consensus on the relationship between intelligence and job performance than on the relationship between personality and job performance. Research on the Big 5 correlates of performance warrants further investigation due to the inconsistencies in many findings, whereas research on the ‘Big 4’ correlates of performance warrants further investigation due to the scarcity of the studies. Intelligence however should also be investigated as a predictor of job performance along with personality, in order to take into account their interface.
6. Aims of thesis

The present research has two aims. The main aim is to investigate the relationship between two major constructs in the study of individual differences, intelligence and personality. The investigation of this interface would lead to a more comprehensive description of human behaviour, than the traditional view, which in general looks at intelligence and personality as independent constructs. Although recent studies have found significant correlations between the two constructs, they have not yet reached a consensus on which personality factors are related to measures of intelligence (Ackerman & Heggestad, 1997; Kyllonen, 1997, Zeidner & Matthews, 2000; Austin et al., 2002). Furthermore, the correlations observed have not yet been explained, in terms of how the relationships developed, though one important attempt was made from Ackerman (1996) in his PPIK theory.

The relationship between personality and intelligence will be investigated by looking directly at the relationship between personality dimensions and IQ measures. The choice of the measures used will be based on the major theories that were summarized in this review. Intelligence will therefore be measured as g, as this is “probably the best measured and most studied human trait in all of psychology” (p. 25) (Gottfredson, 2002), but also as gf and gc, as the gf-gc theory is one of the most widely accepted psychometric paradigm of intelligence (Stankov et al. 1995).

Personality will be measured on the basis of both the Five-Factor model and the ‘Four-Factor’ model. The former will be used as it is one of the most prominent personality models in contemporary psychology (Devito, 1985; Panayiotou, Kokkinos & Spanoudis, 2004), and it is also the model that has been mostly used to look at personality-
intelligence interactions. This would therefore yield findings that are not only interesting in the academic field of psychology, but that are also easily comparable with previous studies. The 'Four-Factor' model will be used, as it is one of the most widely used instruments in the area of clinical, counseling and personality testing (Devito, 1985; Kennedy & Kennedy, 2004). Therefore an understanding of how Jung's personality dimensions are linked to intelligence would on the one hand extend our understanding of human behaviour, and on the other hand it would reveal links that would have applications in I/O psychology.

The second aim of this research is to investigate how both intelligence and personality predict occupational performance. The investigation of the relationship between intelligence and job performance will be expected to replicate the well-documented finding that intelligence predicts performance on the job (Varsa & Valutis, 1993; Gottfredson, 1997; Tan & Libby, 1997; Graham, 1999; Gottfredson, 2002). The main reason for looking at intelligence is to investigate how in combination with personality, they predict performance on the job. Within this framework, the effect of two demographic factors, sex and age, will also be looked at with respect to intelligence. This is because individual differences in intelligence with respect to sex and age can have important economical and political implications in the occupational field, since IQ tests are among the most frequently utilized psychometric tests in making decisions on recruitment and promotions.

The investigation of the relationship between personality and job performance has two purposes. The first is to clarify the relationship between the Big 5 factors and measures of job performance, as there are inconsistent findings in the present literature (Barrick &
Mount, 1991; Tett et al., 1991; Salgado, 1997; Moon, 2001). The second purpose stems from the fact that most research has been focused on the Big 5 factors, and the NEO Personality Inventory, whereas occupational psychologists often utilize other inventories to assess personality. An investigation of how personality dimensions, measured by inventories commonly used in the I/O field, relate to occupational performance would therefore be important not only in the academic field, but also in the applied field of organizational psychology.

The hypotheses that will be investigated are explicitly formulated in the chapters that follow. The second chapter will investigate the relationship between general intelligence and the Big 5 and 'Big 4' dimensions of personality, attempting to clarify the empirical links between these factors. Chapter three will extend the findings of the second chapter that are related to the Five-Factor model, and propose explanations of how the observed relationships may have developed.

This chapter will focus on three topics which have been the least researched or which have yielded inconsistent or unclear findings. The first topic is regarding the relationship between Neuroticism and intelligence, the purpose of the research being to clarify whether trait Neuroticism is related to psychometric intelligence per se, or whether the observed relationship is actually mediated by state anxiety, indicating that Neuroticism is actually related to intelligence test performance. The second topic is regarding the relationship between Openness, Conscientiousness and fluid intelligence. The aim is to explain these relationships, by looking at which facets of these personality traits are related to gf. The relationship between Openness and gf is investigated in view of the suggestion that this personality trait specifically correlates with gc (Brand, 1994). The
relationship between Conscientiousness and gf is investigated due to the findings of the second chapter, which revealed a negative link between Conscientiousness and gf, a finding that has been overlooked in previous studies. The third topic of the chapter will further explain the relationship between Conscientiousness and intelligence.

Chapter four will investigate the relationship of general intelligence and specific abilities with personality measures that are commonly used in occupational settings. The main aim is to extend the scarce research on the relationship between intelligence and the MBTI dimensions (Kaufman et al., 1996). In order to achieve this, the relationship between the MBTI dimensions and the Big 5 factors will also be examined, so that findings on intelligence and the MBTI dimensions can be linked to findings on intelligence and the Big 5 factors. Within this line of research, two other inventories that are commonly used in occupational settings (the Fundamental Interpersonal Relations Orientation-Behaviour Scale and the California Psychological Inventory-434) will also be investigated as to how they are related to fluid intelligence.

Chapter five will investigate how intelligence, and more importantly how personality variables, are related to job performance. The first part of this chapter will investigate how both the Big 5 and the ‘Big 4’ dimensions are related to job performance as measured by managerial level, and whether demographic factors such as age may moderate these relationships. The second part of the chapter will look at intelligence and personality variables in relation to three measures of job performance, actual, simulated and rated performance. The aim of this is to explain the inconsistencies in the current literature, regarding the relationship between intelligence, personality and job performance.
Finally, Chapter six will summarize the findings of the thesis, discussing their implications and their contribution to the current literature. This Chapter will also consider the limitations of the conducted studies, suggesting ideas for future research.
Chapter 2: The relationship between psychometric intelligence and the Big 5

2.1. Study 1

2.1.1. Introduction

The aim of this study is to investigate the links between intelligence and personality, two major areas in the study of individual differences. Although these links have been investigated for more than three quarters of a century, the first attempts that were made to reveal these were unfruitful (Lorge, 1940; Wechsler, 1950). This was mainly because at the time there was no general consensus about which factors underlie both personality and intelligence. At present, researchers have generally accepted the notion of g (Deary, 2001), and the gf-gc distinction of intelligence (Stankov et al., 1995); and one of the most widely accepted models of personality is the Five-Factor model (Costa & McCrae, 1985a). This has lead researchers to investigate the relationship between intelligence and personality more systematically, revealing that the two constructs are conceptually and empirically related (Matthews, 1986, Zeidner, 1995, Ackerman & Heggestad, 1997, Kyllonen, 1997; Furnham et al., 1998a, Austin et al., 2002).

According to Spearman, g is the general intellectual ability, which accounts for the positive, manifold, observed relations between intelligence tests and between different measures within tests. This has been defined as "the ability to deal with complexity" (Gottfredson, 2002), and several studies have suggested that it is biologically based (Boosma, 1993; Duncan et al., 2000; Wickett et al., 2000). Cattell (1963) proposed that g has two components, fluid intelligence (gf), which is dependent on the efficient
functioning of the central nervous system, and crystallized intelligence (gc), which is dependent on experience and education within a culture.

Within this psychometric framework, the intelligence tests that are used (the Watson-Glaser Critical Thinking Appraisal and the Graduate and Managerial Assessment: Abstract) can be considered as measures of fluid intelligence, as they both measure reasoning ability, which is not dependent on accumulated knowledge. Furthermore a measure of g can be derived by extracting the first un-rotated factor of these two tests through the statistical technique of factor analysis.

The Five Factor Model (FFM), which was proposed by Costa and McCrae (1985), measures five higher-order, orthogonal dimensions of personality (the 'Big 5'), Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness, each of which is composed of six primary factors. This set of factors has been found to generalize across cultures (Borkenau & Ostendorf, 1990). The Big 5 factors are measured in this study by the NEO Personality Inventory-Revised (Costa & McCrae, 1985).

Most of the recent literature that deals with key personality correlates of intelligence focuses on relationships between intelligence and the five factors derived from the FFM (Austin et al., 2002; Goff & Ackerman, 1992; Kyllonen, 1997; Zeidner & Matthews, 2000). The major replicated findings, which are presented in detail in Chapter 1 (section 1.3.1), are that intelligence is positively correlated with Openness to Experience (Ackerman & Heggestad, 1997; Austin et al., 2002; Brand, 1994; Chamorro-Premuzic et al., under review; McCrae, 1994; Zeidner & Matthews, 2000) and negatively correlated with Neuroticism (Ackerman & Heggestad, 1997; Furnham et al., 1998a; Kyllonen,
It has been proposed that Openness specifically correlates with gc (Goff & Ackerman, 1992; Brand, 1994) and that Neuroticism is correlated with intelligence mostly due to its anxiety component (Hembree, 1988; Matthews, 1986; Zeidner, 1995; Rindermann & Neubauer, 2001), indicating that Neuroticism may be more related to intelligence test performance rather than to intelligence per se.

Intelligence has also been found to correlate with Extraversion both positively (Lynn et al., 1982; Ackerman & Heggestad, 1997) and negatively (Furnham et al., 1998a; Austin et al., 2002), indicating that Extraversion may also be related to intelligence test performance rather than to actual intelligence. Conscientiousness has generally been found to be only weakly positively correlated with intelligence (Ackerman & Heggestad, 1997; Kyllonen, 1997), although recent studies have found significant negative correlations between these constructs (Allik & Realo, 1997; Demetriou et al., 2003; Furnham et al., under review). Finally Agreeableness seems to be the personality factor that is least related to ability (Ackerman & Heggestad, 1997; Kyllonen, 1997).

The aim of Study 1 is to investigate the relationship between intelligence and the Big 5 factors with a large data set (N=900), using more than one measure of both intelligence and personality, in an attempt to replicate and consequently establish the most consistent findings so far (Ackerman & Heggestad, 1997; Kyllonen, 1997; Zeidner & Matthews, 2000). Therefore, with respect to the Big 5 factors, the hypotheses are that Openness will be a positive predictor of g (H1) and that Neuroticism will be a negative predictor of g (H2).
This study will also extend research on the interface between personality and intelligence, by investigating how the MBTI personality dimensions are related to intelligence, as research on this relationship is scarce, despite the fact that the MBTI is amongst the most commonly used personality inventories in the occupational community (Devito, 1985; Kennedy & Kennedy, 2004). The MBTI, which was developed to assess Jung's personality types (1921), measures four internally consistent and relatively uncorrelated personality traits, Extraversion-Introversion (EI), Sensing-Intuition (SN), Thinking-Feeling (TF) and Judgment-Perception (JP). The MBTI has been discussed in detail in Chapter 1 (section 1.2.1).

To summarize the findings on the relationship between intelligence and the MBTI dimensions, which are more extensively presented in Chapter 1 (section 1.3.2), the dimension that has most consistently been correlated with intelligence is SN. Researchers have specifically found that Intuitive individuals tend to score more highly on intelligence tests than Sensing individuals (Hengstler et al., 1981; Agor, 1985; Myers & McCaulley, 1985; Schurr et al., 1988; Kaufman et al., 1996). The JP dimension has also been related to intelligence, as Kaufman et al. (1996) argued that both poles are especially equipped to score highly on intelligence tests, especially those measuring fluid intelligence, this finding however has not yet been replicated. Finally, although it has been proposed that both the EI and the TF dimensions can be theoretically linked to intelligence, Kaufman et al. (1996) failed to find evidence supporting this claim.

Out of the eight scales of the MBTI, only the four will be tested as predictors of intelligence, as they are not independent and therefore cannot all be included in a regression model. Only one hypothesis is made, based on the most consistent finding on
the relationship between the MBTI dimensions and intelligence. The hypothesis is that Sensing will be a negative predictor of general intelligence (H3), which would be in line with the finding that Intuition is positively correlated with intelligence (Agor, 1985, Schurr et al., 1988; Kaufman et al., 1996).

Within the framework of investigating personality correlates of intelligence, two demographic factors, sex and age will also be investigated regarding their relationship to intelligence. The most consistent finding on sex related differences in intelligence is that males do not differ from females on measures of general intelligence (APA Public Affairs Office, 1997). However, males tend to score higher on tests measuring visuo-spatial and mathematical ability, whereas females tend to score higher on tests measuring verbal ability (Maccoby & Jacklin, 1978; Hyde & Linn, 1988; Voyer, Voyer & Bryden, 1995). With respect to age, research has shown that there is a decline on tests that measure fluid intelligence with age, whereas crystallized abilities are maintained into old age and may also improve slightly (Matthews et al., 2000).

With respect to the demographic factors, it is hypothesized that there will be no sex differences in general intelligence (H4) in line with the APA Public Affairs Office (1997) and that age will be a negative predictor of the intelligence tests used (H5), as they are considered to be measures of fluid intelligence which is found to decline with age (Matthews et al., 2000).
2.1.2. Method

Participants

A total of 900 participants were recruited in this study. Of these 717 were male and 183 were female. Their age ranged from 23 to 64, with a mean of 42 years. They were all British adults, tested by a business psychology consulting company as part of an assessment exercise.

Materials

The Watson-Glaser Critical Thinking Appraisal (WGCTA; Watson & Glaser, 1980). This is a timed (40 minutes) ability test assessing the ability to define a problem, to select pertinent information for its solution, to recognize stated or unstated assumptions, to formulate and select hypotheses and to draw valid conclusions. The test consists of five subtests. (1) The Inference test consists of three statements, each followed by a number of proposed assumptions. Participants have to discriminate among degrees of truth or falsity of the assumptions based on the given data. (2) The Recognition of Assumptions test consists of five statements, each followed by several proposed assumptions. Participants have to decide for each assumption whether a person, in making the given statement, is really making that assumption. (3) The Deduction test consists of six statements, each followed by several assumptions. Participants have to determine whether certain conclusions necessarily follow from the information given in the statements. (4) The Interpretation test consists of five short paragraphs, each followed by several conclusions. Participants have to decide whether the given conclusions logically follow beyond a reasonable doubt from the information given in the paragraph. (5) The evaluation of arguments test consists of five questions, each followed by several arguments.
Participants have to distinguish between strong and weak arguments. Studies on the WGCTA have provided evidence for the test’s reliability and validity (Watson & Glaser, 1980).

Graduate and Managerial Assessment: Abstract (GMA:A; Blinkhorn 1985). This is a timed (30 minutes) high-level test of abstract reasoning ability, which measures the ability to think conceptually, to discover underlying patterns within a set of information and to switch easily between contexts and level of analysis. It is therefore a measure of gf. The test is made up of 115 questions split into 23 groups of 5 questions. There are two different scoring methods, the Lenient score (GMA-L) which measures the total number of individual questions which are correct, and the Harsh score (GMA-H) in which a mark is assigned for each group of five questions which are answered correctly. The manual provides evidence of the test’s reliability (alpha coefficients ranging from .83 to .92) and validity (correlation of .50 with Raven’s Advanced Progressive Matrices; Blinkhorn, 1985).

The Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1985). This is a 240-item un-timed questionnaire, measuring 30 primary and five super-traits. The super-traits are Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness. Neuroticism includes anxiety (N1), anger-hostility (N2), depression (N3), self-consciousness (N4), impulsiveness (N5) and vulnerability (N6). Extraversion includes warmth (E1), gregariousness (E2), assertiveness (E3), activity (E4), excitement seeking (E5) and positive emotions (E6). Openness includes fantasy (O1), aesthetics (O2), feelings (O3), actions (O4), ideas (O5) and values (O6). Agreeableness includes trust (A1), straightforwardness (A2), altruism (A3), compliance (A4), modesty (A5) and
tender-mindedness (A6). Conscientiousness includes competence (C1), order (C2), dutifulness (C3), achievement-striving (C4), self-discipline (C5) and deliberation (C6). Each item of the test is answered on a five-point Likert scale, the answers ranging from strongly disagree to strongly agree. A considerable amount of research has been done on the NEO PI-R demonstrating high levels of both reliability and validity (Furnham, 1996a).

*Myers-Briggs Type Indicator (MBTI). (Myers & McCauley, 1985).* This is a 94-item untimed questionnaire (administration time is 15-25 minutes), determining preferences on four bi-polar scales: Extraversion-Introversion (EI), Sensing-Intuition (SN), Thinking-Feeling (TF) and Judging-Perceiving (JP). Respondents are classified into one of 16 personality types, based on the highest score they receive on each of the four scales. Research on the MBTI has demonstrated that the inventory has a satisfactory level of both reliability and validity (Carlson, 1985, Furnham & Stringfield, 1993).

**Procedure**

Participants were tested by Kaisen Consulting, a British based management consulting firm run predominantly by chartered psychologists. Participants were from various organizations undergoing an individual assessment or career development center process.

**2.1.3. Results**

The distributions of the intelligence and personality variables were observed, in order to check for any outliers. An outlier was observed in the WGCTA scores. Analyses were
performed both including and excluding this participant. Both analyses yielded the same significant results, therefore the analysis which included all participants is presented here.

**Correlations:** The two ability tests (Watson-Glaser critical thinking appraisal and GMA:A) were correlated by $r = .39$, $p < .001$. Correlations between the two ability tests and the personality factors of the NEO-PI and the MBTI are presented in Table 2.1.1. The WGCTA was most highly correlated with Intuition ($r = .23$), Sensing ($r = -.20$) and Openness ($r = .15$). The GMA:A was most highly correlated with Intuition ($r = .15$), Sensing ($r = -.12$) and Conscientiousness ($r = -.11$).

**Table 2.1.1: Correlations between ability and personality factors**

<table>
<thead>
<tr>
<th></th>
<th>WGCTA</th>
<th>GMA:A</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMA:A</td>
<td>.39***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neuroticism</td>
<td>.00</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-.07*</td>
<td>-.02</td>
<td>-.06</td>
</tr>
<tr>
<td>Openness</td>
<td>.15***</td>
<td>.10**</td>
<td>.15***</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-.01</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-.13***</td>
<td>-.11**</td>
<td>-.14***</td>
</tr>
<tr>
<td>MBTI-Extraversion</td>
<td>-.11***</td>
<td>-.05</td>
<td>-.10***</td>
</tr>
<tr>
<td>MBTI-Introversion</td>
<td>.12***</td>
<td>.05</td>
<td>.10**</td>
</tr>
<tr>
<td>MBTI-Sensing</td>
<td>-.20***</td>
<td>-.12***</td>
<td>-.19***</td>
</tr>
<tr>
<td>MBTI-Intuition</td>
<td>.23***</td>
<td>.15***</td>
<td>.22***</td>
</tr>
<tr>
<td>MBTI-Thinking</td>
<td>-.09**</td>
<td>-.06</td>
<td>-.09**</td>
</tr>
<tr>
<td>MBTI-Feeling</td>
<td>.01</td>
<td>.03</td>
<td>.02</td>
</tr>
<tr>
<td>MBTI-Judging</td>
<td>-.07</td>
<td>-.08**</td>
<td>-.09***</td>
</tr>
<tr>
<td>MBTI-Perceiving</td>
<td>.11***</td>
<td>.10**</td>
<td>.12***</td>
</tr>
<tr>
<td>Sex</td>
<td>-.03</td>
<td>.12***</td>
<td>.05</td>
</tr>
<tr>
<td>Date of Birth</td>
<td>.02</td>
<td>.13***</td>
<td>.12***</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01, ***p<.001, N = 900

**Regressions:** A series of multiple regressions were performed in order to further investigate the relationship between IQ and personality, gender and age. The dependent variables were the WGCTA and the GMA:A. The same independent variables were used
in all regression models, namely the Big 5 personality factors, four of the MBTI factors, gender, and date of birth. The β values for these coefficients are presented in Table 2.1.2.

(a) WGCTA: The Watson-Glaser critical thinking appraisal was used as the dependent variable in four regression models. The first model used the Big 5 factors as the independent variables, and was significant accounting for 5% of the variance in WGCTA scores. Significant predictors were Neuroticism (β = -.08), Extraversion (β = -.17), Openness (β = .22) and Conscientiousness (β = -.12). The second model used the four MBTI factors as the independent variables, and was significant accounting for 6% of the variance. Significant predictors were Extraversion (β = -.15) and Sensing (β = -.23). The third model used the Big 5 and the four MBTI factors as independent variables, and was significant accounting for 8% of the variance. Significant predictors were Neuroticism (β = -.10), Openness (β = .11), Conscientiousness (β = -.16), MBTI Extraversion (β = -.15), Sensing (β = -.17) and Judging (β = .10). The fourth model used the Big 5, the four MBTI factors, gender and date of birth as independent variables, and was significant accounting for 8% of the variance. Significant predictors were Neuroticism (β = -.10), Openness (β = .11), Conscientiousness (β = -.16), MBTI Extraversion (β = -.15), Sensing (β = -.17) and Judging (β = .11).

(b) GMA:A: The GMA:A was used as the dependent variable in four regression models, using the same independent variables as above. The first model was significant accounting for 2% of the variance in GMA:A scores. Significant predictors were Openness (β = .12) and Conscientiousness (β = -.11). The second model was significant due to the fact that the eight MBTI dimensions are not independent, they could not all be included in the regression models. Instead, one of each bipolar dimensions were included, namely Extraversion, Sensing, Thinking and Judging
accounting for 2% of the variance. Significant predictors were Extraversion (\( \beta = -.07 \)) and Sensing (\( \beta = -.11 \)). The third model was significant accounting for 2% of the variance. Conscientiousness was the only significant predictor (\( \beta = -.11 \)). The fourth model was significant accounting for 6% of the variance. Significant predictors were Neuroticism (\( \beta = -.10 \)), Conscientiousness (\( \beta = -.10 \)), MBTI Extraversion (\( \beta = -.11 \)), gender (\( \beta = .08 \)) and date of birth (\( \beta = .18 \)).

(c) General intelligence ('g'): A measure of g was derived by combining scores on the WGCTA and the GMA:A. Correlations between g and personality measures are presented in Table 2.1.1.

Four regression models were tested, using g as the dependent variable and the same independent variables that were used above. The first model was significant accounting for 5% of the variance. Significant predictors of g were Neuroticism (Beta = -.08), Extraversion (\( \beta = -.15 \)), Openness, (\( \beta = .21 \)) and Conscientiousness (\( \beta = -.14 \)). The second model was significant, accounting for 5% of the variance. Significant predictors were Extraversion (\( \beta = -.13 \)) and Sensing (\( \beta = -.20 \)). The third model was significant, accounting for 7% of the variance. Significant predictors were Neuroticism (\( \beta = -.09 \)), Openness (\( \beta = .11 \)), Conscientiousness (\( \beta = -.16 \)), MBTI Extraversion (\( \beta = -.13 \)) and Sensing (\( \beta = -.15 \)). The fourth model was significant, accounting for 9% of the variance. Significant predictors were Neuroticism (\( \beta = -.12 \)), Openness (\( \beta = .10 \)), Conscientiousness (\( \beta = -.16 \)), MBTI Extraversion (\( \beta = -.16 \)), Sensing (\( \beta = -.16 \)), Judging (\( \beta = .08 \)) and date of birth (\( \beta = .15 \)).
Regressions: In order to further investigate the relationship between intelligence and personality, as assessed by the NEO PI-R, a series of multiple regressions were performed, using the two ability measures and the measure of g as dependent variables, and the NEO PI-R sub-factors as independent variables. The β values for these regressions are presented in Table 2.1.3.
WGCTA: Six regression models were used to investigate the relationship between the Big 5 sub-factors and WGCTA. The first model, which used the sub-factors of Neuroticism, was significant accounting for 1% of the variance in WGCTA scores. Significant predictors were Anxiety ($\beta = -.11$) and Vulnerability ($\beta = .13$). The second model, which used the sub-factors of Extraversion as independent variables, was significant accounting for 2% of the variance. Significant predictors were Gregariousness ($\beta = -.10$), Assertiveness ($\beta = -.08$) and Activity ($\beta = .13$). The third model, which used the sub-factors of Openness, was significant accounting for 8% of the variance. Ideas ($\beta = .32$) was a significant predictor of the WGCTA. The fourth model, which used the sub-factors of Agreeableness as independent variables, was significant accounting for 2% of the variance. Significant predictors were Trust ($\beta = .10$), Altruism ($\beta = -.12$) and Modesty ($\beta = -.08$). The fifth model, which used the sub-factors of Conscientiousness, was significant accounting for 3% of the variance. Order was a significant predictor of WGCTA ($\beta = -.19$). The sixth model used all the sub-factors of the Big 5 together as independent variables. The model was accounting for 12% of the variance. Significant predictors were Vulnerability ($\beta = .10$), Activity ($\beta = .11$), Ideas ($\beta = .29$) and Order ($\beta = -.12$).

GMA:A: Six regression models were used to investigate the relationship between the Big 5 sub-factors and GMA:A. The first two models, which used the sub-factors of Neuroticism and Extraversion respectively as independent variables, were not significant. The third model, which used the sub-factors of Openness, was significant accounting for 4% of the variance. Ideas was a significant predictor of GMA:A ($\beta = .24$). The fourth model, which used the sub-factors of Agreeableness, was significant accounting for 2%
of the variance. Significant predictors were Trust ($\beta = .09$) and Modesty ($\beta = -.07$). The fifth model, which used the sub-factors of Conscientiousness, was significant accounting for 1% of the variance. Order was a significant predictor of GMA:A ($\beta = -.10$). The sixth model, which used all the sub-factors of the FFM as independent variables, was significant accounting for 7% of the variance. Significant predictors were Ideas ($\beta = .24$), Trust ($\beta = .09$), Compliance ($\beta = .09$) and Tender-mindedness ($\beta = -.09$).

'g': Six regression models were used to investigate the relationship between the Big 5 sub-factors and g. The first model, which used the sub-factors of Neuroticism, was significant accounting for 1% of the variance. Significant predictors of g were Anxiety ($\beta = -.13$) and Vulnerability ($\beta = .13$). The second model, which used the sub-factors of Extraversion, was significant accounting for 2% of the variance. Significant predictors were Assertiveness ($\beta = -.10$) and Activity ($\beta = .12$). The third model, which used the sub-factors of Openness, was significant accounting for 8% of the variance. Ideas was a significant predictor of g ($\beta = .34$). The fourth model, which used the sub-factors of Agreeableness, was significant accounting for 3% of the variance. Significant predictors were Trust ($\beta = .11$), Straightforwardness ($\beta = .08$), Altruism ($\beta = -.11$) and Modesty ($\beta = -.09$). The fifth model, which used the sub-factors of Conscientiousness, was significant accounting for 3% of the variance. Order was a significant predictor of g ($\beta = -.18$). The sixth model, which used all the sub-factors of the FFM as independent variables, was significant accounting for 14% of the variance. Significant predictors of g were Assertiveness ($\beta = .10$), Aesthetics ($\beta = -.09$), Ideas ($\beta = .32$), Trust ($\beta = .09$) and Order ($\beta = -.10$).
Table 2.1.3: β values for multiple regression coefficients of NEO sub-factors on intelligence measures

<table>
<thead>
<tr>
<th>Sub-factor</th>
<th>WGCTA</th>
<th>GMA:A</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1: Anxiety</td>
<td>-.11*</td>
<td>-.10*</td>
<td>-.13**</td>
</tr>
<tr>
<td>N2: Angry-hostility</td>
<td>-.02</td>
<td>-.02</td>
<td>-.02</td>
</tr>
<tr>
<td>N3: Depression</td>
<td>-.07</td>
<td>-.02</td>
<td>-.06</td>
</tr>
<tr>
<td>N4: Self-consciousness</td>
<td>.06</td>
<td>.04</td>
<td>.06</td>
</tr>
<tr>
<td>N5: Impulsiveness</td>
<td>.04</td>
<td>.05</td>
<td>.06</td>
</tr>
<tr>
<td>N6: Vulnerability</td>
<td>.13**</td>
<td>.09</td>
<td>.13**</td>
</tr>
<tr>
<td>Regression model</td>
<td>F(6,893)=2.49*</td>
<td>F(6,893)=1.57</td>
<td>F(6,893)=2.81*</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>.01</td>
<td>.00</td>
<td>.01</td>
</tr>
<tr>
<td>E1: Warmth</td>
<td>-.04</td>
<td>-.06</td>
<td>-.06</td>
</tr>
<tr>
<td>E2: Gregariousness</td>
<td>-.10*</td>
<td>-.04</td>
<td>-.09</td>
</tr>
<tr>
<td>E3: Assertiveness</td>
<td>-.08*</td>
<td>-.09*</td>
<td>-.10*</td>
</tr>
<tr>
<td>E4: Activity</td>
<td>.13**</td>
<td>.07</td>
<td>.12**</td>
</tr>
<tr>
<td>E5: Excitement seeking</td>
<td>-.02</td>
<td>.05</td>
<td>.02</td>
</tr>
<tr>
<td>E6: Positive emotions</td>
<td>.02</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>Regression model</td>
<td>F(6,893)=3.81**</td>
<td>F(6,893)=1.94</td>
<td>F(6,893)=3.59**</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>.02</td>
<td>.01</td>
<td>.02</td>
</tr>
<tr>
<td>O1: Fantasy</td>
<td>.02</td>
<td>-.01</td>
<td>.00</td>
</tr>
<tr>
<td>O2: Aesthetics</td>
<td>-.06</td>
<td>-.07</td>
<td>-.08</td>
</tr>
<tr>
<td>O3: Feelings</td>
<td>-.05</td>
<td>-.06</td>
<td>-.06</td>
</tr>
<tr>
<td>O4: Actions</td>
<td>-.05</td>
<td>.05</td>
<td>.00</td>
</tr>
<tr>
<td>O5: Ideas</td>
<td>.32***</td>
<td>.24***</td>
<td>.34***</td>
</tr>
<tr>
<td>O6: Values</td>
<td>.02</td>
<td>-.01</td>
<td>.01</td>
</tr>
<tr>
<td>Regression model</td>
<td>F(6,893)=13.11***</td>
<td>F(6,893)=7.74***</td>
<td>F(6,893)=14.63***</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>.08</td>
<td>.04</td>
<td>.08</td>
</tr>
<tr>
<td>A1: Trust</td>
<td>.10**</td>
<td>.09*</td>
<td>.11**</td>
</tr>
<tr>
<td>A2: Straightforwardness</td>
<td>.07</td>
<td>.06</td>
<td>.08*</td>
</tr>
<tr>
<td>A3: Altruism</td>
<td>-.12**</td>
<td>-.06</td>
<td>-.11**</td>
</tr>
<tr>
<td>A4: Compliance</td>
<td>.03</td>
<td>.07</td>
<td>.06</td>
</tr>
<tr>
<td>A5: Modesty</td>
<td>-.08*</td>
<td>-.07*</td>
<td>-.09*</td>
</tr>
<tr>
<td>A6: Tender-mind</td>
<td>-.00</td>
<td>-.06</td>
<td>-.04</td>
</tr>
<tr>
<td>Regression model</td>
<td>F(6,893)=3.93***</td>
<td>F(6,893)=3.27***</td>
<td>F(6,893)=4.86***</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>.02</td>
<td>.02</td>
<td>.03</td>
</tr>
<tr>
<td>C1: Competence</td>
<td>.06</td>
<td>.02</td>
<td>.05</td>
</tr>
<tr>
<td>C2: Order</td>
<td>-.19***</td>
<td>-.10*</td>
<td>-.18***</td>
</tr>
<tr>
<td>C3: Dutifulness</td>
<td>-.00</td>
<td>.04</td>
<td>.02</td>
</tr>
<tr>
<td>C4: Achievement-striving</td>
<td>.01</td>
<td>-.04</td>
<td>-.02</td>
</tr>
<tr>
<td>C5: Self discipline</td>
<td>-.04</td>
<td>-.01</td>
<td>-.03</td>
</tr>
<tr>
<td>C6: Deliberation</td>
<td>-.01</td>
<td>-.05</td>
<td>-.04</td>
</tr>
<tr>
<td>Regression model</td>
<td>F(6,893)=6.26***</td>
<td>F(6,893)=2.81*</td>
<td>F(6,893)=6.02***</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>.03</td>
<td>.01</td>
<td>.03</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01, ***p<.001

2.1.4. Discussion

The main aim of this study was to investigate personality, sex and age as predictors of intelligence. The first hypothesis (H1) was that Openness would be a positive predictor of
general intelligence, in line with previous findings (Ackerman & Heggestad, 1997, Kyllonen, 1997; Zeidner, 2000). The present findings clearly supported this hypothesis, although the magnitude of the correlations was small. Openness was significantly correlated, and was a significant predictor of g. Furthermore, when the Big 5 were tested as predictors of g on their own, Openness accounted for the highest percentage of unique variance in g. Even though it has been proposed that Openness specifically correlates with gc (Brand, 1994), the present findings show that Openness is also related to g, with a correlation coefficient of .15 and a Beta coefficient ranging from .10 to .21.

The direction of the causal relationship between Openness and g however, is possibly different to that with gc, where it is high Openness which leads an individual to expand their gc. With general intelligence, such an explanation is less plausible since g is considered to be primarily biologically based, and less susceptible to influences of the environment (Brand, 1996; Cattell, 1971). Here it is useful to look at the investigation of the sub-factors of Openness, which revealed that Openness is related to intelligence through Ideas. Ideas\textsuperscript{2} is a sub-factor which represents individuals who are inventive, curious, original, insightful, idealistic, with wide interests (Costa & McCrae, 1985). A possible explanation therefore for the relationship between g and Openness, is that individuals with lower g may become less inventive, curious and have narrower interests, due to their lower ability to handle novel experiences which makes it less rewarding and discouraging to be Open. Also, individuals with higher g may have sought to stimulate and challenge themselves, by exposing themselves to novel experiences, and thus

\textsuperscript{2} Sample items for the Big 5 sub-factors have been presented in Chapter 1 (section 1.2.2)
becoming more curious, inventive and with wider interests, and therefore, in turn, more
Open.

The second hypothesis (H2) was that Neuroticism would be a negative predictor of
general intelligence. This hypothesis was supported, as Neuroticism was found to be a
significant predictor of g, although the correlation between Neuroticism and g was not
significant. This indicates that the relationship between Neuroticism and g is apparent
when other variables, such as other personality or demographic factors, are partialled out.
The investigation of the sub-factors of Neuroticism revealed that it is Anxiety and
Vulnerability that are related to g. It has been suggested that Anxiety causes the working
memory system to function inefficiently; due to task irrelevant processing such as
worrying (Eysenck, 1979). Indeed the present findings are in line with previous research
that has found Anxiety to impair intellectual functioning in several contexts (Sarason,
1980; Hembree, 1988). This explanation implies that the relationship is between
Neuroticism and intelligence test performance, rather than actual general intelligence.
However, it could also be the case that individuals with low g developed Anxiety through
time, due to their inability to cope with circumstances as well as individuals with high g.
Vulnerability was also found to be a significant predictor of g, however, the relationship
was positive. This is a curious finding, as it implies that individuals with high g tend to be
less confident and efficient, which are characteristics of Vulnerability.

The relationship between Extraversion and psychometric intelligence was also
investigated, although no specific hypotheses were made due the fact that previous
research had yielded contradictory findings (Lynn et al., 1982; Furnham, 1998). In the
present study, Extraversion was found to be negatively correlated with the WGCTA, but
not correlated with the GMA:A or g. As a predictor of intelligence, Extraversion was found to be a negative predictor for the WGCTA and g when only the Big 5 were tested as predictors. It has been reported in the past that Introverts tend to do better on problem-solving tasks requiring insight and reflection (Matthews, 1992) whereas Extraverts tend to do better on speeded tasks (Rawlings & Carnie, 1989). The present results are in line with these findings, as the WGCTA, which was negatively related to Extraversion, is a problem-solving task requiring reflection even though it is timed.

Correlations between Conscientiousness and intelligence have been found to be negligible in the past (Ackerman & Heggestad, 1997). However, the present study revealed Conscientiousness to be significantly correlated with the two intelligence measures as well as with g, and to be a significant predictor of these. It should be noted that the regression coefficients were negative, indicating that more Conscientious people scored lower on the intelligence tests. This finding is in line with Demetriou et al. (2003) and Chamorro-Premuzic et al. (under review). A possible explanation for this could be that less intelligent people cope with their relative lack of intelligence by becoming more organized, thorough, persistent and methodical, all of which are characteristics of Conscientiousness. It could also be the case that more intelligent people feel they do not need to put in too much effort as they rely on their intelligence, and thus become less Conscientious. The analysis of the relationship between the sub-factors of Conscientiousness and intelligence provides further evidence for these explanations. In both IQ tests as well as in the measure of general intelligence, it was Order that was a significant predictor, which is a characteristic of people who are organized, thorough, efficient, precise, methodical, but not absent-minded or careless.
Agreeableness seems to be the personality factor least related to intelligence. Statistical analysis showed that it was not significantly correlated, nor a significant predictor for any of the IQ measures used. This is in agreement with Ackerman and Heggestad’s (1997) meta-analysis, who found a near zero correlation between g and Agreeableness. It should be noted that the analysis of the sub-factors of Agreeableness did reveal significant predictors of intelligence, however these were both positive and negative, therefore canceling each other out when the factor of Agreeableness was tested as a predictor. This means that by focusing on the higher-level traits of personality, during the investigation of the relationship between intelligence and personality, one may miss explanatory relationships that exist between intelligence and “mid-level” personality traits. The present investigation revealed that the sub-factors of the Big 5 accounted for 5, 7 and 9% more of the variance in IQ scores than the super-factors, depending on the measure of intelligence. Future research should further investigate weather it is mid-level or higher-level traits of personality that account for highest percentage of the variance in intelligence scores.

The analysis of the MBTI also revealed some interesting relationships between intelligence and personality. The third hypothesis (H3) expected Sensing to be a negative predictor of g, as previous research has shown that Intuition is positively correlated with intelligence, and Sensing is the opposite end of the same dimension. The results supported this hypothesis, in line with previous research (Agor, 1985; Kaufman et al. 1996). Furthermore, Intuition itself was found to have the highest correlation among the eight MBTI dimensions and the two intelligence measures, as well as g. The sign of the
 coefficient was positive, indicating that more Intuitive types score higher on intelligence measures.

The present investigation revealed one more MBTI dimension which was a significant (negative) predictor of intelligence, Extraversion. This finding is in agreement with the finding that NEO PI-R Extraversion is a significant negative predictor of intelligence, as the two dimensions are highly correlated (McCrae & Costa, 1989), although they are not identical. Extraversion as measured by the MBTI refers to a person whose mental processes are directed towards the external world as opposed to Introversion, which refers to an orientation towards the internal world (Myers, 1962). It would be interesting for future research to look at whether the advantage of Extraverts in performance tasks and their disadvantage in tasks related to superior learning ability (Zeidner, 1995) is apparent for Extraversion as measured by the MBTI, which could explain the present finding.

Of the remaining MBTI dimensions, Judging was a significant positive predictor of the WGCTA and of g, although this was only when the Big 5 and the demographic factors were also included as predictors in the regression model. However, what is curious about this finding is that Judging was negatively correlated with intelligence. This indicates that other factors may moderate the relationship between Judging and intelligence. The relationship between the JP dimension and intelligence should be further researched, as Kaufman et al. (1996) suggested that both poles are especially equipped to score highly on IQ tests, i.e. more intelligent individuals tend to have a strong preference for either end of the JP dimension.
Finally, this paper looked at how demographic factors can predict intelligence. The hypothesis (H4) that there would be no sex differences in general intelligence was supported by the results, in line with the APA Public Affairs Office (1997). However, females were found to outperform males on the GMA:A, which is a curious finding as no gender differences have previously been reported on measures of abstract reasoning. The fifth hypothesis (H5), which expected age to be a negative predictor of scores on the two intelligence tests (i.e. date of birth to be a positive predictor) was partly supported, as it was a significant predictor for the GMA:A but not for the WGCTA. These two tests can be considered to be measures of fluid intelligence (as the GMA:A measures abstract reasoning, and the WGCTA measures the ability to define a problem and formulate hypotheses which will lead to valid conclusions) and therefore age was expected to be a negative predictor for both of them. However, the WGCTA is based on verbal comprehension, which is also related to crystallized intelligence, which may account for the insignificance in the results.

In summary, the present findings attest to the relationship between personality and intelligence, even though the two constructs are generally treated as independent. It should however be noted that although significant correlations were observed, these were of a modest magnitude. This study replicated the most consistent findings on this area by using a large data set, and also revealed links between intelligence and personality that have not received much attention (specifically Conscientiousness and EI). It further extended previous research by jointly looking at the relationship between intelligence and the Big 5 as well as Jung’s personality dimensions, and also by not simply looking at correlations between personality and intelligence, but by looking at how well the former
can be used as predictors of the latter. Although personality factors were investigated as predictors of intelligence, this does not imply a causal relationship directed from personality towards intelligence. In fact it has been suggested that in the case of general or fluid intelligence, the causal relationship is most likely from intelligence to personality as these are more biologically based (Brand, 1996). However, it is more useful to investigate predictors of intelligence than personality, as in the applied field of psychology, there is resistance in using IQ tests and not personality tests.
2.2 Study 2

2.2.1. Introduction

The aim of Study 2 was to replicate the results found in Study 1, using a large sample (N = 4859), and different tests of both personality and intelligence. This study aimed to extend the findings in the investigation of the relationship between personality and intelligence, in two ways. The first was by looking at personality correlates of general, fluid but also of crystallized intelligence, which was not investigated in Study 1. In order to achieve this, the intelligence test used is the General Reasoning Test Battery 2 (Budd, 1993a), which includes a measure of gf (abstract reasoning), a measure of gc (verbal reasoning), and g can be derived by factor analyzing the three sub-scales of the test (abstract, verbal and numerical reasoning).

The gf-gc distinction is important in the investigation of the relationship between personality and intelligence, in order to meaningfully understand the basis of this relationship. This is primarily because gf is considered to be biologically based, and independent of our experience (Belsky, 1990) whereas gc is believed to be influenced by education and cultural exposures (Brody, 1992). Therefore, observed correlations with measures of personality, warrant different interpretations when they are regarding gf and when they are regarding gc. Correlations between personality and gf may be interpreted in that they are either due to gf having affected the development of the personality, or that personality affects intelligence test performance. Correlations between personality and gc may also be interpreted in that personality may have affected the development of gc, and are therefore best examined by longitudinal studies.
The second way in which the current findings are extended is by using a personality test hitherto not reported in this specific literature. This would not only extend our understanding of the relationship between the two constructs, but would also provide psychologists in the occupational field, who use this test along with intelligence tests for recruitment and selection, with an understanding of how the measures they use are theoretically interrelated. The Big 5 factors are therefore measured in this study as second-order factors of the 15-Factor Questionnaire (Budd, 1992).

The first hypothesis (H1) is that Openness will be a significant positive predictor of verbal and numerical reasoning, and of general intelligence. This would support Kyllonen (1997), who found Openness to be positively correlated with verbal ability, quantitative ability, and g. The second hypothesis (H2) is that Extraversion will be a significant positive predictor of the three intelligence tests, as they are short and timed tests, which have been found to favor Extraverts (Rawlings & Carnie, 1989). The third hypothesis (H3) is that Neuroticism will be a significant negative predictor of numerical, verbal, abstract and general intelligence, in line with Ackerman and Heggestad (1997) and Kyllonen (1997). The fourth hypothesis (H4) is that Conscientiousness will be a significant negative predictor of general intelligence, replicating the findings of Study 1, and supporting Demetriou et al. (2003) and Chamorro-Premuzic et al. (under review).

2.2.2. Method

Participants

A total of 4859 participants were recruited for this study. Of these, 3944 were male and 903 were female (12 did not specify their gender). Their age ranged from 20 to 63, with a mean of 35.28 and a standard deviation of 8.67. In the statistical analysis of the IQ
measures, participants who scored 3 or below (out of 35) on any IQ test were excluded from the analysis. This meant that in total 4639 participants were included, of which 3765 were male and 865 were female. Their age ranged from 14 to 63 with a mean of 35.23 and a standard deviation of 8.61.

Materials

The General Reasoning Test Battery (GRT2) (Budd, 1993a). This is a timed (28 minutes) ability test, measuring numerical (NR) (25 items), verbal (VR) (35 items) and abstract (AR) (25 items) reasoning. Numerical reasoning measures the ability to use numbers in a logical and efficient way. Verbal reasoning measures basic vocabulary, verbal fluency, and the ability to reason using words. Abstract reasoning measures the ability to understand abstract logical problems, and use new information outside the range of previous experience. Examination of the alpha coefficients for all three sub-tests of the GRT2 showed that they were all above .8, demonstrating a high level of reliability of the test. Furthermore, test-retest coefficients were all above .7. In order to test the validity of the GRT2, its sub-scales and total score were compared to the sub-scales and total score of the Alice Heim reasoning test (AH5). Correlation coefficients ranged from .56 to .76 for the sub-scales, and for the total scores of the two tests it was .82 (N = 81), demonstrating that the GRT2 measures the same trait of reasoning ability which is assessed by the AH5, although the discriminant validity of the sub-scales is not very high. These coefficients are presented in Table 2.2.1.
Table 2.2.1: Reliability and validity coefficients for GRT2 and 15FQ

<table>
<thead>
<tr>
<th></th>
<th>Reliability</th>
<th></th>
<th>Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alpha Coef.</td>
<td>Test-retest coef.</td>
<td>Alice Heim 5</td>
</tr>
<tr>
<td></td>
<td>r</td>
<td>N</td>
<td>r</td>
</tr>
<tr>
<td>NR</td>
<td>.84</td>
<td>135</td>
<td>.78</td>
</tr>
<tr>
<td>VR</td>
<td>.83</td>
<td>135</td>
<td>.79</td>
</tr>
<tr>
<td>AR</td>
<td>.83</td>
<td>135</td>
<td>.74</td>
</tr>
<tr>
<td>Outgoing</td>
<td>.70</td>
<td>618</td>
<td>.80</td>
</tr>
<tr>
<td>Self-sufficient</td>
<td>.67</td>
<td>618</td>
<td>.71</td>
</tr>
<tr>
<td>Socially bold</td>
<td>.64</td>
<td>618</td>
<td>.78</td>
</tr>
<tr>
<td>Enthusiastic</td>
<td>.73</td>
<td>618</td>
<td>.88</td>
</tr>
<tr>
<td>Self-doubting</td>
<td>.72</td>
<td>618</td>
<td>.68</td>
</tr>
<tr>
<td>Stable</td>
<td>.79</td>
<td>618</td>
<td>.85</td>
</tr>
<tr>
<td>Tense driven</td>
<td>.69</td>
<td>618</td>
<td>.80</td>
</tr>
<tr>
<td>Suspicious</td>
<td>.74</td>
<td>618</td>
<td>.76</td>
</tr>
<tr>
<td>Conceptual</td>
<td>.72</td>
<td>618</td>
<td>.70</td>
</tr>
<tr>
<td>Intuitive</td>
<td>.65</td>
<td>618</td>
<td>.87</td>
</tr>
<tr>
<td>Radical</td>
<td>.77</td>
<td>618</td>
<td>.71</td>
</tr>
<tr>
<td>Conscientious</td>
<td>.73</td>
<td>618</td>
<td>.78</td>
</tr>
<tr>
<td>Disciplined</td>
<td>.66</td>
<td>618</td>
<td>.79</td>
</tr>
<tr>
<td>Restrained</td>
<td>.80</td>
<td>618</td>
<td>.79</td>
</tr>
<tr>
<td>Assertive</td>
<td>.66</td>
<td>618</td>
<td>.78</td>
</tr>
</tbody>
</table>

*Fifteen Factor Questionnaire (15FQ) (Budd, 1992). (The 15FQ Technical Manual. Letchworth: Psytech International Ltd.).* This is an un-timed questionnaire, taking approximately 30 minutes to complete, measuring 15 bipolar personality dimensions. The 15FQ was developed in the UK on a large sample of applicants drawn from a wide range of occupational groups, and is used for personnel assessment and selection (Budd, 1992). The items were selected with the criteria that they cover the construct adequately, while maintaining acceptable levels of scale cohesiveness and minimum overlap with other scales. The dimensions measured by the test are Outgoing, Stable, Assertive, Enthusiastic, Conscientious, Socially bold, Intuitive, Suspicious, Conceptual, Restrained, Self-doubting, Radical, Self-sufficient, Disciplined, Tense driven.

Factor analysis has shown that a further five broad underlying characteristics can be derived from the 15FQ, which have been found to favorably compare to the Big 5 factors.
of personality. These are Extraversion (corresponding to NEO Extraversion, \( r = .77 \)), Anxiety (corresponding to NEO Neuroticism, \( r = .71 \)), Tough-mindedness (corresponding to NEO Openness, \( r = .64 \)), Independence (corresponding to NEO Agreeableness, \( r = -.55 \)) and Control (corresponding to NEO Conscientiousness, \( r = .36 \)).

The technical manual provides evidence for the test's reliability and validity (Budd, 1992). All the 15FQ dimensions were found to have reliability coefficients above .64, which compare favorably to the reliability coefficients of the 16PF (Smith, 1994). Long-term data also showed test-retest reliability coefficients ranging from .70 to .88. Evidence for the test's construct validity comes from comparisons between the 15FQ and other personality measures such as the 16PF and the NEO short form, which show that the dimensions of the 15FQ are consistent with similar measures. The Alpha coefficients, the test-retest reliability coefficients and the correlations between the 15FQ factors and their corresponding factors of the 16PF are presented in Table 2.2.1. The validity of the 15FQ has been further supported by looking at the relationship of the 15FQ with a number of tests, including the Myers-Briggs Type Indicator, the Jung Type Indicator, the Professional Personality Questionnaire, the Occupational Personality Profile and the FIRO-B (Budd, 1992).

Procedure

Participants were all job applicants tested by Psytech International as part of an assessment center.
2.2.3. Results

Intelligence measures

Scores on all three intelligence measures were approximately normally distributed with a slight positive skew. Scores on abstract reasoning ranged from 4 to 25 (M = 17.67, SD = 4.67), with 41.5% of the participants responding to all items. Scores on numerical reasoning ranged from 4 to 25 (M = 17.45, SD = 5.31), with 30.4% of the participants responding to all items. Scores on verbal reasoning ranged from 4 to 35 (M = 23.97, SD = 5.43), with 46.2% of the participants responding to all items.

Pearson product moment correlations were computed to investigate the relationship between the three sub-tests of the General Reasoning Test 2 (verbal, numerical and abstract reasoning). These are presented in Table 2.2.2. Partial correlations were also computed, controlling for gender and age, these are presented in brackets.

<table>
<thead>
<tr>
<th></th>
<th>GRT2-VR</th>
<th>GRT2-AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRT2-NR</td>
<td>.58* (.59*)</td>
<td>.61* (.61*)</td>
</tr>
<tr>
<td>GRT2-AR</td>
<td>.53* (.52*)</td>
<td></td>
</tr>
</tbody>
</table>

*p<.001, N = 4639 (N = 4625)

In order to obtain a measure of general intelligence, principal component analysis was performed on the three intelligence tests. This yielded one factor (g), with loadings of .87 (numerical reasoning), .84 (abstract reasoning) and .83 (verbal reasoning).
Personality and intelligence

The relationship between personality and intelligence was investigated by correlation and regression analyses. Pearson product moment correlations between personality factors and the four intelligence measures, and partial correlations, controlling for gender and age are presented in Table 2.2.3.

Table 2.2.3: Correlation and partial correlation coefficients for intelligence measures with personality and demographic factors

<table>
<thead>
<tr>
<th>NR</th>
<th>VR</th>
<th>AR</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outgoing</td>
<td>-0.01</td>
<td>-0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Stable</td>
<td>0.04</td>
<td>0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td>Assertive</td>
<td>0.13*</td>
<td>0.11*</td>
<td>0.09*</td>
</tr>
<tr>
<td>Enthusiastic</td>
<td>0.06*</td>
<td>0.04</td>
<td>0.11*</td>
</tr>
<tr>
<td>Conscientious</td>
<td>-0.17*</td>
<td>-0.18*</td>
<td>-0.23*</td>
</tr>
<tr>
<td>Socially bold</td>
<td>-0.03</td>
<td>-0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Intuitive</td>
<td>0.09*</td>
<td>-0.02</td>
<td>0.08*</td>
</tr>
<tr>
<td>Suspicious</td>
<td>-0.07*</td>
<td>-0.07*</td>
<td>-0.07*</td>
</tr>
<tr>
<td>Conceptual</td>
<td>-0.02</td>
<td>0.00</td>
<td>0.11*</td>
</tr>
<tr>
<td>Restrained</td>
<td>-0.12*</td>
<td>-0.11*</td>
<td>-0.14*</td>
</tr>
<tr>
<td>Self-doubting</td>
<td>-0.08*</td>
<td>-0.06*</td>
<td>-0.05</td>
</tr>
<tr>
<td>Radical</td>
<td>0.04</td>
<td>0.03</td>
<td>0.10*</td>
</tr>
<tr>
<td>Self-sufficient</td>
<td>-0.00</td>
<td>0.06*</td>
<td>0.06*</td>
</tr>
<tr>
<td>Disciplined</td>
<td>-0.15*</td>
<td>-0.18*</td>
<td>-0.21*</td>
</tr>
<tr>
<td>Tense driven</td>
<td>-0.11*</td>
<td>-0.09*</td>
<td>-0.10*</td>
</tr>
<tr>
<td>Anxiety (N)</td>
<td>-0.10*</td>
<td>-0.08*</td>
<td>-0.07*</td>
</tr>
<tr>
<td>Extraversion (E)</td>
<td>-0.01</td>
<td>-0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Tough-Minded (O)</td>
<td>-0.04</td>
<td>0.00</td>
<td>0.12*</td>
</tr>
<tr>
<td>Independence (A)</td>
<td>-0.08*</td>
<td>0.06*</td>
<td>0.12*</td>
</tr>
<tr>
<td>Control (C)</td>
<td>-0.20*</td>
<td>-0.21*</td>
<td>-0.26*</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.04</td>
<td>0.03</td>
<td>-0.04</td>
</tr>
<tr>
<td>Age</td>
<td>-0.35*</td>
<td>-0.13*</td>
<td>-0.35*</td>
</tr>
</tbody>
</table>

*p<.001, N = 4639 (r), N = 4625 (r partial)

A series of multiple regressions were performed in order to investigate the relationship between IQ and personality, taking into account the variance in IQ scores accounted for by gender and age. The dependent variables were numerical reasoning (NR), verbal reasoning (VR) abstract reasoning (AR) and g. The same independent variables were used in all regression models, namely the fifteen factors of the 15FQ, gender (coded 1 for...
male and 2 for female), and age. The β values for the coefficients of these models are presented in Table 2.2.4. Due to the large sample size, the .001 was taken as a more appropriate significance level, in order to diminish the probability of making a Type I error.

**Numerical Reasoning:** The model that used NR as the dependent variable was significant, accounting for 11% of the variance in IQ scores. Significant predictors of NR were Assertive, Conscientious (-), Suspicious (-), Self-sufficient, Disciplined (-), gender (-) and age (-).

**Verbal Reasoning:** The model that used VR as the dependent variable was significant, accounting for 12% of the variance in IQ scores. Significant predictors of VR were Assertive, Enthusiastic, Conscientious (-), Suspicious (-), Self-sufficient, Disciplined (-) and age (-).

**Abstract Reasoning:** The model that used AR as the dependent variable was significant, accounting for 19% of the variance in IQ scores. Significant predictors of AR were Assertive, Conscientious (-), Intuitive (-), Conceptual, Disciplined (-) and age (-).

**General intelligence:** The model that used g as the dependent variable was significant accounting for 16% of the variance in IQ scores. Significant predictors of g were Assertive, Enthusiastic, Conscientious (-), Intuitive (-), Suspicious (-), Self-sufficient, Disciplined (-), Tense driven (-), gender (-) and age (-).
Table 2.2.4: β coefficients for multiple regressions of 15FQ and demographic factors on intelligence measures

<table>
<thead>
<tr>
<th></th>
<th>GRT2-NR</th>
<th>GRT2-VR</th>
<th>GRT2-AR</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outgoing</td>
<td>-.01</td>
<td>-.05</td>
<td>-.06</td>
<td>-.05</td>
</tr>
<tr>
<td>Stable</td>
<td>.03</td>
<td>.00</td>
<td>-.01</td>
<td>.01</td>
</tr>
<tr>
<td>Assertive</td>
<td>.12*</td>
<td>.10*</td>
<td>.08*</td>
<td>.12*</td>
</tr>
<tr>
<td>Enthusiastic</td>
<td>.05</td>
<td>.08*</td>
<td>.06</td>
<td>.08*</td>
</tr>
<tr>
<td>Conscientious</td>
<td>-.13*</td>
<td>-.16*</td>
<td>-.12*</td>
<td>-.16*</td>
</tr>
<tr>
<td>Socially bold</td>
<td>-.05</td>
<td>-.03</td>
<td>-.03</td>
<td>-.04</td>
</tr>
<tr>
<td>Intuitive</td>
<td>-.06</td>
<td>.01</td>
<td>-.14*</td>
<td>-.07*</td>
</tr>
<tr>
<td>Suspicious</td>
<td>-.07*</td>
<td>-.09*</td>
<td>-.04</td>
<td>-.08*</td>
</tr>
<tr>
<td>Conceptual</td>
<td>-.01</td>
<td>.05</td>
<td>.10*</td>
<td>.05</td>
</tr>
<tr>
<td>Self-doubting</td>
<td>-.00</td>
<td>-.03</td>
<td>-.01</td>
<td>-.02</td>
</tr>
<tr>
<td>Radical</td>
<td>.03</td>
<td>.05</td>
<td>.00</td>
<td>.04</td>
</tr>
<tr>
<td>Self-sufficient</td>
<td>-.04</td>
<td>-.02</td>
<td>-.05</td>
<td>-.04</td>
</tr>
<tr>
<td>Disciplined</td>
<td>.08*</td>
<td>.10*</td>
<td>.06</td>
<td>.10*</td>
</tr>
<tr>
<td>Tense driven</td>
<td>-.12*</td>
<td>-.09*</td>
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<td>-.12*</td>
</tr>
<tr>
<td>Gender</td>
<td>-.05</td>
<td>-.07</td>
<td>-.06</td>
<td>-.07*</td>
</tr>
<tr>
<td>Age</td>
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<td>.02</td>
<td>-.04</td>
<td>-.07*</td>
</tr>
<tr>
<td>Regression</td>
<td>-.15*</td>
<td>-.17*</td>
<td>-.39*</td>
<td>-.27*</td>
</tr>
</tbody>
</table>

Adj. R²: .11 .12 .19 .16

*p<.001

Second-order factors of the 15FQ

It has been established by factor analysis that the 15FQ dimensions can be summarized in five broad dimensions of personality (Budd, 1992), which correspond to each of the five dimensions the Five Factor Model. Correlations between the Big 5 and their corresponding dimensions are given in the method section. These second order factors were computed for this sample using the following formulae, provided by the manual of the 15FQ (Budd, 1992):

- Anxiety (Neuroticism) = (Suspicious + Self-doubting + Tense driven - Stable) / 4
- Extraversion (Extraversion) = (Outgoing + Enthusiastic + Socially bold - Self-sufficient) / 4
- Tough Minded (Openness) = (Intuitive + Conceptual + Radical) / 3
• Independence (Agreeableness) = (Assertive + Suspicious - Restrained + Radical + Enthusiastic) / 5

• Control (Conscientiousness) = (Conscientious + Restrained + Disciplined) / 3

Principal Component Analysis: In order to investigate the validity of the second order factors, principal component analysis with varimax rotation was performed on the fifteen personality factors of the 15FQ. Five components were extracted, accounting for 68% of the variance. The rotated component matrix is presented in Table 2.2.5.

Table 2.2.5: Rotated component matrix for second order factors of 15FQ

<table>
<thead>
<tr>
<th></th>
<th>Extraversion (E)</th>
<th>Anxiety (N)</th>
<th>Tough-minded (O)</th>
<th>Control (C)</th>
<th>Independence (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outgoing</td>
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<td>.00</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Self-sufficient</td>
<td>-.80</td>
<td>.16</td>
<td>.00</td>
<td>.00</td>
<td>.15</td>
</tr>
<tr>
<td>Socially bold</td>
<td>.72</td>
<td>-.13</td>
<td>.23</td>
<td>.11</td>
<td>.35</td>
</tr>
<tr>
<td>Enthusiastic</td>
<td>.68</td>
<td>.00</td>
<td>.22</td>
<td>-.15</td>
<td>.45</td>
</tr>
<tr>
<td>Self-doubting</td>
<td>-.10</td>
<td>.82</td>
<td>.00</td>
<td>.13</td>
<td>.20</td>
</tr>
<tr>
<td>Stable</td>
<td>.15</td>
<td>-.79</td>
<td>.00</td>
<td>.29</td>
<td>.11</td>
</tr>
<tr>
<td>Tense driven</td>
<td>-.00</td>
<td>.77</td>
<td>.00</td>
<td>.19</td>
<td>.00</td>
</tr>
<tr>
<td>Suspicious</td>
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<td>.52</td>
<td>.00</td>
<td>.22</td>
<td>.50</td>
</tr>
<tr>
<td>Conceptual</td>
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<td>.83</td>
<td>-.00</td>
<td>.00</td>
</tr>
<tr>
<td>Intuitive</td>
<td>.00</td>
<td>.00</td>
<td>.82</td>
<td>-.00</td>
<td>-.00</td>
</tr>
<tr>
<td>Radical</td>
<td>.00</td>
<td>.00</td>
<td>.55</td>
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<td>.41</td>
</tr>
<tr>
<td>Conscientious</td>
<td>.00</td>
<td>-.00</td>
<td>-.13</td>
<td>.78</td>
<td>.00</td>
</tr>
<tr>
<td>Disciplined</td>
<td>.13</td>
<td>.20</td>
<td>-.21</td>
<td>.73</td>
<td>.00</td>
</tr>
<tr>
<td>Restrained</td>
<td>-.20</td>
<td>.15</td>
<td>.12</td>
<td>.62</td>
<td>-.42</td>
</tr>
<tr>
<td>Assertive</td>
<td>.13</td>
<td>-.15</td>
<td>.00</td>
<td>.00</td>
<td>.81</td>
</tr>
</tbody>
</table>

As can be seen from the Table, Outgoing, Self-sufficient, Socially bold and Enthusiastic load on Extraversion (E), Self-doubting, Stable, Tense driven and Suspicious load on Anxiety (N), Conceptual, Intuitive and Radical load on Tough Minded (O), Conscientious, Disciplined and Restrained load on Control (C), and Enthusiastic, Suspicious, Radical, Restrained and Assertive load on Independence (A). Thus, the factor
analysis yielded the same results that were reported in the manual. The eigenvalues and the variance accounted for by these factors are presented in Table 2.2.6.

Table 2.2.6: Eigenvalues and % of variance accounted for by factor analysis components

<table>
<thead>
<tr>
<th>Component</th>
<th>Eigenvalues</th>
<th>% of Variance</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion (E)</td>
<td>3.59</td>
<td>23.93</td>
<td>23.93</td>
</tr>
<tr>
<td>Anxiety (N)</td>
<td>2.26</td>
<td>15.04</td>
<td>38.97</td>
</tr>
<tr>
<td>Tough-Minded (O)</td>
<td>1.85</td>
<td>12.34</td>
<td>51.31</td>
</tr>
<tr>
<td>Control (C)</td>
<td>1.42</td>
<td>9.43</td>
<td>60.74</td>
</tr>
<tr>
<td>Independence (A)</td>
<td>1.14</td>
<td>7.58</td>
<td>68.32</td>
</tr>
</tbody>
</table>

Pearson product moment correlation coefficients between the five personality factors and the four intelligence measures, and partial correlations, controlling for gender and age are presented in Table 2.2.3. Multiple regressions were performed for each of the dependent variables (NR, VR, AR and g). The independent variables used were the five factors extracted from the factor analysis, gender and age. These results are summarized in Table 2.2.7.

**Numerical Reasoning:** The model that used NR as the dependent variable was significant accounting for 9% of the variance in IQ scores. Significant predictors of NR were Anxiety (-), Independence, Control (-), gender (-) and age (-).

**Verbal Reasoning:** The model that used VR as the dependent variable was significant accounting for 9% of the variance in IQ scores. Significant predictors of VR were Anxiety (-), Tough-minded, Independence, Control (-) and age (-).

**Abstract Reasoning:** The model that used AR as the dependent variable was significant accounting for 17% of the variance in IQ scores. Significant predictors of AR were Anxiety (-), Independence, Control (-), gender (-) and age (-).
General intelligence: The model that used g as the dependent variable was significant accounting for 13% of the variance in IQ scores. Significant predictors of g were Anxiety (-), Independence, Control (-), gender (-) and age (-).

Table 2.2.7: β coefficients for multiple regressions of personality and demographic factors on intelligence measures

<table>
<thead>
<tr>
<th></th>
<th>GRT2-NR β</th>
<th>GRT2-VR β</th>
<th>GRT2-AR β</th>
<th>g β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety (N)</td>
<td>-.08*</td>
<td>-.05</td>
<td>-.07*</td>
<td>-.08*</td>
</tr>
<tr>
<td>Extraversion (E)</td>
<td>-.09*</td>
<td>-.08*</td>
<td>-.08*</td>
<td>-.10*</td>
</tr>
<tr>
<td>Tough-Minded (O)</td>
<td>-.05</td>
<td>.07*</td>
<td>-.04</td>
<td>-.01</td>
</tr>
<tr>
<td>Independence (A)</td>
<td>.06</td>
<td>.02</td>
<td>.05</td>
<td>.05</td>
</tr>
<tr>
<td>Control (C)</td>
<td>-.20*</td>
<td>-.24*</td>
<td>-.17*</td>
<td>-.24*</td>
</tr>
<tr>
<td>Gender</td>
<td>-.16*</td>
<td>.00</td>
<td>-.08*</td>
<td>-.09*</td>
</tr>
<tr>
<td>Age</td>
<td>-.14*</td>
<td>-.16*</td>
<td>-.39*</td>
<td>-.29*</td>
</tr>
</tbody>
</table>

Regression model:
- GRT2-NR: F(7,4621) = 63.81*, Adj. R² = .09
- GRT2-VR: F(7,4621) = 68.79*, Adj. R² = .09
- GRT2-AR: F(7,4621) = 137.35*, Adj. R² = .17
- g: F(7,4621) = 102.76*, Adj. R² = .13

* p < .001

Curve Estimation: Non-linear relationships were also tested for each of the five personality factors (as independent variables), and each of the intelligence measures (as dependent variables). These models were viewed in comparison to linear models in order to estimate whether a non-linear model fitted the data better than a linear one. The curve models that were tested were logarithmic, quadratic and cubic. For Anxiety, Extraversion and Control, the model that best fitted the data of all intelligence tests was the linear model. For Independence, none of the models tested were significant at the .001 significance level. Finally, for Openness, verbal intelligence was best predicted by the linear model, abstract reasoning was not significantly predicted by any model, numerical reasoning was best predicted by a logarithmic model (F(1,4627) = 12.74, p < .001, Adj. R² = .09, Beta = -.05) and g was best predicted by a quadratic model (F(2,4636) = 8.98,
p<.001, Adj. $R^2 = .00$, Beta$_1 = -.23$, Beta$_2 = .26$), although Openness accounted for less than 1% of the variance in NR and g scores.

### 2.2.4. Discussion

The aim of this study was to investigate the extent to which personality factors can predict psychometric intelligence. Together, the primary factors of the 15FQ accounted for 16% of the variance in g, and 11 to 19% of the variance in specific abilities. The second-order factors of the 15FQ accounted for 13% of the variance in g, and 9 to 17% of the variance in specific abilities. A series of hypotheses were tested, with respect to the individual contribution of specific personality factors. The second-order factors of the 15FQ will be referred to in the discussion by their names that correspond to the Five-Factor model, to make comparisons with previous studies clearer.

The first hypothesis (H1), which was that Openness (O) would be a significant positive predictor of verbal, numerical reasoning, and of g, was only partly supported by the results. This hypothesis was based on the findings of Kyllonen (1997), who found O to be positively correlated with numerical reasoning and with g, as well as with verbal reasoning. The present results however showed that O was a significant predictor of verbal reasoning only. It has been proposed that Open individuals are more inclined to engage in intellectual activities, especially those of a verbal nature and cultural nature, which may lead them to develop their verbal reasoning (Zeidner & Matthews, 2000). Based on the suggestion that tests of verbal reasoning are generally believed to measure gc (Horn, 1988), this finding seems to support the suggestion that O specifically correlates with crystallized intelligence (gc) (Geoff & Ackerman, 1992; Brand, 1994).
The second hypothesis (H2), which was that Extraversion (E) would be a significant positive predictor of numerical, verbal and abstract reasoning was not supported by the results. Contrary to expectations, Extraversion was found to be a significant negative predictor of AR, VR, NR and g. The hypothesis proposed here was based on the suggestion that Extraverts have an advantage over Introverts for short and speeded tasks due to their lower resting level of cortical arousal (Rawling & Carnie, 1989). This is because E has been found to mediate the inverted U-shaped relationship between arousal and intelligence, causing Extraverts to perform better under conditions of medium and high arousal (such as completing short and speeded tests), and Introverts to perform better under conditions of low arousal (Bates & Rock, 2004). The hypothesis was therefore made on the assumption that GRT2 is a short and speeded task, as the test comprises of 85 multiple-choice questions, which must be completed in 28 minutes. It could however be argued that although the test is definitely a speeded task, it may not necessarily be considered as a short one. This would mean that Extraverts may outperform Introverts initially, but may then get bored (under-aroused), which would cause them to perform less efficiently. This could be tested by future studies, by administering an IQ test on a pc, which would be programmed to calculate achieved scores at different times, i.e. this would allow comparison of Extraverts’ and Introverts’ performance at time$_1$ versus time$_2$, even though the psychometric properties of the test would not be valid when only a part of the test would be completed.

The third hypothesis (H3) was that Neuroticism (N) would be a significant negative predictor of general intelligence and of all three specific abilities. This hypothesis was partly supported by the results, as Neuroticism was a significant predictor of NR, AR and
g, but failed to reach significance for VR at the .001 significance level. However, all correlations and partial correlations, including those for VR were significant.

It has been proposed that the relationship between N and intelligence is mediated by anxiety (Sarason, 1980; Eysenck & Eysenck, 1985; Zeidner & Matthews, 2000). This is because Neurotic individuals experience higher levels of test (state) anxiety, and anxiety causes individuals to engage in significantly more task-irrelevant processing (worry), which interferes with their performance (Eysenck, 1979). This implies that N is actually more systematically related to intelligence test performance than to intelligence per se. This suggestion cannot actually be argued here, as a measure of state anxiety was not administered in order to test this. However, participants would be expected to experience anxiety, on the basis that their performance on the tests would have major consequences for them, as it would affect their chances to be selected or promoted.

It would perhaps be advisable for organizations that use intelligence tests for any form of selection, to also administer a questionnaire measuring anxiety. This is because if N is negatively linked to intelligence test performance due to state anxiety, IQ tests will underestimate the intelligence of Neurotics. This will be so for IQ tests administered mostly under any context, as conditions of testing are generally believed to induce state anxiety (Dobson, 2000), but especially if the results of the tests will have consequences on the testees, as this will elevate state anxiety further. The relationship between Neuroticism and intelligence, should be tested by future studies by experimentally manipulating participants' state anxiety. This would be essential in order to establish whether Neuroticism is directly related to intelligence per se, or whether it is related to intelligence test performance, with state anxiety mediating this relationship.
The fourth hypothesis (H4), which was that Conscientiousness (C) would be a negative predictor of g was clearly supported by the results, although the size of the correlation was modest. C was further a significant negative predictor of numerical, verbal as well as abstract reasoning, and Pearson product moment and partial correlations were also significant for all IQ measures. These results are in line with Study 1 and with recent studies, which have reported a negative link between C and intelligence (Allik & Realo, 1997; Demetriou et al., 2003; Furnham et al., in press). The negative relationship between intelligence and C has been explained in that this trait may be adaptive. This is in the sense that relatively low g may lead to the development of C as a compensatory effect, or that high g may discourage its development, as g may be sufficient to cope with situations that would otherwise be efficiently dealt with by utilizing characteristics of C. For example in order to complete an assignment, an individual low on g would need to be organized, methodical and persistent (which are characteristics of C), but an individual high on g may have the ability to accomplish the same task with less effort and less organization.

The fact that individuals high on g may not develop C as much as individuals low on g has important implications in the occupational field. This is because C has been found to be the best predictor of occupational performance (amongst personality variables) (Barrick & Mount, 1991; Barrick et al., 1999; Salgado, 1997). It is therefore important for parents, or teachers who recognize that they are dealing with an individual of high g, to try to encourage the development of characteristics of C.

In summary, significant predictors of g were Conscientiousness (negative), Extraversion (negative), Neuroticism (negative), age (negative) and sex (indicating an advantage of
males), although the size of the Beta coefficients was modest. Together, personality and demographic factors accounted for 13 to 16% of the variance in general intelligence scores. The present findings, along with the findings of Study 1, attest to the significant, albeit small relationship between the constructs of personality and intelligence, indicating the importance of investigating their relationship, instead of investigating them as independent constructs. The present study also indicates the importance of investigating the relationship of personality variables in relation to specific types of intelligence. Although several factors were significant predictors of all measures of intelligence (Conscientiousness, Assertive, Conscientious, Disciplined), others were predictors only of specific types of intelligence. For example Self-sufficient and Suspicious were predictors of NR and VR but not of AR, while Conceptual and Intuitive were predictors of AR but not of NR or VR. The finding that personality variables differentially correlate with specific types of intelligence should caution researchers to specify the types of intelligence they are measuring when investigating their relationship with personality, as it will affect their findings.

Although this study was based on a large sample and of a wide age range, there is however a limitation which should be considered. The Big 5 personality factors, which are discussed above, were not measured by the NEO PI-R, but were derived by the primary factors of the 15FQ. Although previous research has provided evidence of high correlations between the second order factors of the 15FQ and the Big 5 factors, they are still not identical. However, most of the results replicated previous research findings which used the Big 5 factors as assessed by the NEO PI-R, therefore using the second order factors of the 15FQ does not seem to be an important limitation. Furthermore, using
a different test, which measures the same factors, is a way to provide further support for previous research and moreover the primary factors of the 15FQ are conceptually very close to the 16PF (Budd, 1992), which has thus far not been explored with respect to its relationship to intelligence.

The investigation of the relationship between intelligence and personality is important, not only for extending the research on individual differences, but also because it has important implications in the applied field of psychology. Both personality and intelligence are individually used as predictors of different types of performance, such as academic and job performance (Salgado, 1997; Carretta & Doub, 1998; Hunton, Wier & Stone, 2000; Barrick et al., 2001). Therefore the understanding of the underlying relationship between these two constructs can be used to improve their predictive validity, and shows that it would be most useful to use both measures in conjunction instead of either individually.
Chapter 3: Explaining the major findings on the interface between intelligence and the Big 5

3.1. General Introduction

Chapter 2 consisted of two studies that investigated the interface of intelligence and personality, by looking at correlations between the two constructs. Studies in this chapter therefore investigated possible explanations for how the two constructs are linked. The aim of Chapter 3 is to investigate why these constructs are linked, in an attempt to explain the processes by which these relationships developed. Chapter 3 will therefore focus on the major findings of Chapter 2, and on the main replicated findings of previous literature on this topic, which look at Big 5 correlates of intelligence. The most consistent findings within this line of research are that intelligence is negatively correlated with Neuroticism (Ackerman & Heggestad, 1997, Furnham et al., 1998a; Kyllonen, 1997; Zeidner & Matthews, 2000) and Conscientiousness (Demetriou et al., 2003; Furnham et al., in press) and positively correlated with Openness to Experience (Brand, 1994; McCrae, 1994; Ackerman & Heggestad, 1997; Zeidner & Matthews, 2000; Austin et al., 2002; Chamorro-Premuzic et al., under review).

Study 3 is an investigation of the relationship between intelligence and Neuroticism. In order to establish whether Neuroticism is actually related to intelligence per se or to intelligence test performance, this study investigates whether it is trait Neuroticism, or state anxiety that is directly related to IQ scores. Of course it is not possible to obtain a "pure" measure of IQ, and all test scores are proxy measures for it. However, by varying
test conditions, it is possible to investigate the extent to which test conditions influence performance.

Study 4 is an investigation of the relationship between intelligence, Openness and Conscientiousness. Although longitudinal studies are essential in order to establish whether intelligence has influenced the development of these personality traits, some indications of process are available by cross-sectional studies. This study looks at which sub-factors of Openness and Conscientiousness are related to intelligence, in order to investigate whether these are in line with the proposed explanations for the development of these relationships.

Study 5 is an investigation of the negative relationship between Conscientiousness and intelligence. This study investigates the suggestion that the development of Conscientiousness is influenced by gf (see Studies 1 and 2). It is proposed that if it is gf that affects the development of Conscientiousness, this should be obvious by a stronger correlation between Conscientiousness and gf rather than gc. Specific hypotheses for studies 3, 4 and 5 are explicitly presented in their introductions.
3.2. Study 3

3.2.1. Introduction

The aim of Study 3 is to investigate the nature of the negative correlation, found in various studies, between intelligence and Neuroticism. This correlation, which has been reported as early as 1962 by Callard and Goodfellow, is of a magnitude of around $r = -0.15$ (Ackerman & Heggestad, 1997). Many studies have since provided evidence supporting this negative correlation (Kyllonen, 1997; Dobson, 2000), and Study 1 further showed that Neuroticism is a negative predictor of intelligence test scores, in line with Furnham et al. (in press).

Neuroticism reflects a tendency to experience negative emotions, like anxiety and depression (Busato et al., 2000). High scorers tend to be sensitive, emotional, worrying, moody and frequently depressed, whereas low scorers tend to be secure, hardy and generally relaxed even under stressful conditions (Eysenck & Eysenck, 1975). The six sub-facets of Neuroticism are Anxiety, Anger-hostility, Depression, Self-consciousness, Impulsiveness and Vulnerability (Costa & McCrae, 1992). It has been proposed that individual differences in Neuroticism have a biological basis (Eysenck, 1967), originating from differences in the functioning of the limbic system (Stough et al., 2001).

It has been suggested that Neuroticism is negatively correlated with intelligence mostly due its the anxiety component (Zeidner, 1998; Zeidner & Matthews, 2000). It is important here to distinguish between trait and state anxiety. Trait anxiety is an individual’s stable, cross-situation, predisposition to respond with worry, tension and
physiological arousal across a variety of conditions. State anxiety is a transitory emotional state; it is a particular level of anxiety, which is experienced in a particular situation and is associated with heightened activity of the autonomic nervous system (Spielberger, 1972; Zeidner & Matthews, 2000). It is therefore essential to distinguish whether intelligence is directly related to Neuroticism (due to its trait anxiety component), or whether intelligence is instead related to state (test) anxiety, indicating that the relationship between intelligence and Neuroticism is not direct, but is actually mediated by state anxiety affecting intelligence test performance. These two suggestions, of how intelligence is related to Neuroticism, are pictorially represented in Figure 3.2.1.

Figure 3.2.1: Two models representing Neuroticism being directly related to intelligence (Model 1) and the relationship between Neuroticism and intelligence being mediated by test anxiety affecting IQ test performance (Model 2)

Studies on the relationship between intelligence and trait anxiety, which is a component of Neuroticism, have yielded contradictory findings (Matarazzo, 1972). Although some studies have reported a negative correlation between trait anxiety, and intelligence
Findings on the relationship between state anxiety and intelligence have been more consistent, yet still not conclusive. Samuel (1980) for example did not find a significant relationship between state anxiety and IQ. Idzikowski and Baddeley (1983) reported a significant relationship between state anxiety and creativity, but not with logical reasoning. However, the majority of the investigations have reported a deleterious effect of state anxiety on cognitive ability performance (Leon & Revelle, 1985). Support for this claim has been provided by Sarason (1980), who reported that state anxiety can impair intellectual functioning in a variety of contexts, from IQ test scores to school achievement. Eysenck and Eysenck (1985) also reported a number of studies showing a deleterious effect of state anxiety on several measures of performance, such as digit recall and solving anagrams. Ackerman and Heggestad (1997) in their meta-analysis reported a correlation of $r = -0.33$ between g and self-report measures of test anxiety, which is state anxiety due to testing conditions.

It has been proposed that test anxiety consists of two conceptually distinct components, worry, which is a cognitive concern over performance and its consequences, and emotionality, which are physiological changes with unpleasant feelings of unease, nervousness and tension (Liebert & Morris, 1967). Recently, Oostdam and Meijer (2003) suggested that test anxiety comprises also of a third component, lack of self-confidence, although this finding has not yet been replicated. Research has shown that it is the worry rather than the emotionality component of test anxiety that is primarily associated with decrement of performance (Spielberger et al., 1978; Dobson, 2000). It has been suggested...
that the negative effect of state anxiety on intellectual functioning originates from the working memory system. According to Eysenck and Eysenck (1985) "It seems reasonably well established that anxiety reduces the efficiency of short-term storage and long term memory, that it increases attentional selectivity, that it decreases accuracy without affecting performance speed, and that it increases distractibility" (p. 310). That is, high-anxiety individuals engage in significantly more task-irrelevant processing (worry) than low-anxiety individuals, which interferes with their performance (Eysenck, 1979).

The negative relationship between anxiety and intelligence does not necessarily imply that individuals who have test anxiety perform less well on the ability tests due to their anxiety. It could be that individuals with lower intelligence, being aware of their likelihood to perform poorly, become more anxious under test conditions (Muller, 1992). However, as Tobias (1985) noted, this ‘deficit hypothesis’ does not explain the negative correlation between test anxiety and performance for high achieving individuals. Oostdam and Meijer (2003) furthermore directly tested whether the negative correlation between test anxiety and IQ test performance can be explained by the deficit hypothesis, or by the occurrence of task-irrelevant processing, which they referred to as the interfering hypothesis. Their results provided support for the interfering and not for the deficit hypothesis.

The aim of the present study is to investigate the relationship between Neuroticism, test anxiety and intelligence. Previous research has shown that the relationship between Neuroticism and intelligence is mostly due to state anxiety, which mostly affects Neurotic individuals (Zeidner, 1998; Zeidner & Matthews, 2000). In order to investigate
this suggestion, two groups were tested on the Raven’s Progressive Matrices and on the Neuroticism scale of the TPQue5 (the shortened version of a Greek Big 5 measure), one state induced high-anxiety group and one low-anxiety (control group). The high-anxiety group was given information intended to induce state anxiety, and a manipulation check was established. Two self-report measures of test anxiety were used in the high-anxiety group, one prior to completion of the tests, and one after the anxiety-inducing information was given, prior to completion of the IQ test.

The first hypothesis (H1) is that Neuroticism will be positively correlated with the initial level of anxiety (test anxiety) and with the level of anxiety after receiving the anxiety-inducing information (induced anxiety). This tests whether high Neurotics are more stressed under testing conditions, and whether they are more stressed when they receive information, which induces anxiety, than low Neurotics. The second hypothesis (H2) is that the correlation between Neuroticism and intelligence will be higher in the high-anxiety group than in the low-anxiety group. This tests whether state anxiety has a deleterious effect on IQ test performance. The third hypothesis (H3) is that the correlation between intelligence and Neuroticism will not be significant in the high-anxiety group, when test anxiety is controlled for. This investigates whether the relationship, which has been observed between Neuroticism and intelligence is due to test anxiety.

3.2.2. Method

Participants

The participants included in this study were 213 Greek university students. Of these, 113 were included in the high-anxiety group, and 100 were included in the control (low-anxiety) group. The anxiety group consisted of 48 male and 65 female students, their age
ranging from 18 to 45, with a mean of 21.89 and a standard deviation of 4.98. The control group consisted of 24 male and 76 female students, their age ranging from 18 to 53, with a mean of 26.90 and a standard deviation of 9.35.

Materials

Questionnaire. The questionnaire used was a part of the Traits Personality Questionnaire 5 (TPQue5) (Tsaousis & Kerlepis, in press), which is a the shortened version of the TPQue (Tsaousis, 1999), a Greek measure of the Five-Factor Model, measuring the five personality factors proposed by Costa and McCrae (1985). The TPQue5 consists of 101 statements to which the person has to respond on a 5-point Likert scale, according to how much each statement represents them. Each of the five factors is measured by 15 questions, and the remaining questions comprise a lie and a social desirability scale. For the purpose of this study, which only needed a measure of Neuroticism, a questionnaire was composed consisting of the 15 statements of Neuroticism and 15 of the 86 remaining statements, randomly chosen, to avoid the participants' understanding of what the questionnaire was measuring. There was no time limit for completion of the questionnaire.

Raven's Standard Progressive Matrices. (SPM) (Raven, Raven & Court, 2000). This is a 60-item, timed (20 minutes) ability test, measuring eductive ability. Each of the items consists of a box that contains one or several figures, which are related by specific rules. An area of the box is missing and participants have to distinguish the missing part among six or eight similar figures, by deducing the rules of each box. The 60 items are divided into five groups of 12 items, with increasing level of difficulty within each group. The manual reports that studies on a wide range of age groups, cultural groups and clinical as
well as normal populations, provide abundant evidence for the test's reliability and validity (Raven, Raven & Court, 1998).

Procedure

Participants were tested in groups of about twenty individuals during their lecture periods. The high-anxiety group first completed the personality questionnaire followed by the Raven's Progressive Matrices Test, and were told that they would receive their results after 2 weeks. Before they completed the questionnaire, they were asked to write down on a scale from 1 to 10 how anxious they felt at that time, '1' denoting not at all anxious and '10' denoting very anxious. After they completed the personality questionnaire, and while the tests were gathered by the experimenter, the lecturer, who had been instructed by the experimenter in advance, told the students that their final exams (which were after a short time period) would be for the first time with closed instead of open books, and that in order to get an estimate of their understanding of the material, they would be orally examined after the IQ testing. The participants were then handed out the Raven's Progressive Matrices and were asked once again to record on the same scale how anxious they felt at that time. They were then allowed 20 minutes to complete the test. After completion of the test, they were debriefed of the purpose of the experiment and were told that what the lecturer had told them was only part of the experiment.

The control (low-anxiety) group was also tested in smaller groups during their lecture periods. They were asked to give a code name instead of their actual name, so that they would not be anxious about anyone knowing their results. Half the participants were first administered the Raven's Progressive Matrices Test, followed by the TPQue5, and half
were administered the tests in the reversed order. Their Neuroticism score was calculated by taking into account only the questions on Neuroticism that form the short version of the TPQue. The study fulfilled the ethics guidelines of the University.

3.2.3. Results

Induced anxiety (Manipulation check)

The level of anxiety of the participants, after they were informed they were going to take a personality and an intelligence test (test anxiety), ranged from 1 to 10, with a mean of 2.54 and a standard deviation of 1.85. The level of participants’ anxiety, after they were given the information that was intended to produce further anxiety (induced anxiety), ranged from 1 to 10, with a mean of 3.89 and a standard deviation of 2.29. In order to measure whether further anxiety was indeed induced, a paired samples t-test was performed. The t value was significant, \( t(109) = -5.82 \) with an associated probability \( p < .001 \), indicating that participants were more anxious after they received the information.

Intelligence

In order to investigate whether the anxiety group differed from the control group (low-anxiety group) in their intelligence levels, due to the different testing conditions, an independent samples t-test was computed, with intelligence as the dependent variable, and testing condition as the independent variable. The mean IQ for the anxiety group was 45.13 with a standard deviation of 6.76. The mean IQ for the low-anxiety group was 48.38 with a standard deviation of 7.66. The independent samples t-test yielded a \( t(211) = - \)
3.29, which was significant at the .001 significance level, indicating that the low-anxiety group scored significantly higher on the IQ test than the anxiety group.

**Neuroticism and anxiety**

In order to investigate whether Neuroticism is correlated with anxiety under usual testing conditions and under testing conditions of induced anxiety, correlations were computed between Neuroticism, and anxiety levels before and after they received the anxiety-inducing information. These correlations are presented in Table 3.2.1. The correlation between Neuroticism and 'test anxiety' was \( r = .34, p<.001 \). The correlation between Neuroticism and 'induced anxiety' was \( r = .48, p<.001 \).

**Table 3.2.1: Correlations between Neuroticism, fluid intelligence, test anxiety and induced anxiety**

<table>
<thead>
<tr>
<th></th>
<th>Neuroticism</th>
<th>Intelligence</th>
<th>Test Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>-.19*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Anxiety</td>
<td>.34***</td>
<td>-.22*</td>
<td></td>
</tr>
<tr>
<td>Induced Anxiety</td>
<td>.48***</td>
<td>-.11</td>
<td>.32**</td>
</tr>
</tbody>
</table>

\*p<.05, **p<.01, ***p<.001

The correlation between Neuroticism and 'test anxiety' and the correlation between Neuroticism and 'induced anxiety' were tested to investigate whether they were significantly different. The formula used was \( t = (r_{12} - r_{13}) \times \sqrt{(N-1)*(1+r_{23})} / \sqrt{2*[(N-1)/(N-3)]*[(1-r_{12}^2-r_{13}^2-r_{23}^2)+2*r_{12}*r_{13}*r_{23}]+[(r_{12}+r_{13})^2*(1-r_{23})^3]/4]} \), the ratio being distributed as \( t \) on \( N-3 \) df, where \( r_{12} \): correlation of Neuroticism with 'test anxiety', \( r_{13} \): correlation of Neuroticism with 'induced anxiety', \( r_{23} \): correlation of 'test anxiety' with 'induced anxiety', and \( N = 113 \). The \( t \) value was 1.65, with the critical value being 1.66 at the .05 significance level for a one-tailed test.
Intelligence and anxiety

In order to investigate the relationship between intelligence and anxiety under normal testing conditions, and under conditions of induced anxiety, correlations were computed between intelligence and ‘test anxiety’ and ‘induced anxiety’. These correlations are also presented in Table 3.2.1. The correlation between intelligence and ‘test anxiety’ was significant, $r = -.22, p < .05$, but the correlation between intelligence and ‘induced anxiety’ was not significant, $r = -.11, p = .23$.

Neuroticism and intelligence

Correlations were computed in order to investigate the relationship between Neuroticism and intelligence under conditions of low anxiety and under conditions of induced anxiety. The control group was considered to be a condition of low anxiety because participants were required to give a code name, which meant that no one would know their results. The correlation between Neuroticism and intelligence for the low anxiety group was marginally significant ($r = -.18, p = .07$). The correlation between Neuroticism and intelligence for the high-anxiety group was $r = -.19, p < .05$, indicating that individuals high on Neuroticism tended to score lower on the intelligence test.

In order to investigate whether there was a significant difference in the correlations between Neuroticism and intelligence in the high-anxiety and in the low-anxiety group, a one-tailed t-test for two independent correlations was conducted, using Fisher’s (1921) transformation of $t' = .5 \times \ln \left| \frac{1 + r}{1 - r} \right|$. The $z^2$ value was .06, which is lower than the critical value ($1.96$) at the .05 significance level, indicating that the correlations were not significantly different.

3 The $z$ value was calculated by $z = (r_1 - r_2) / \sqrt{\left[ \frac{1}{(N_1 - 3)} + \frac{1}{(N_2 - 3)} \right]}$
Neuroticism, intelligence and test anxiety

In order to test whether the relationship between Neuroticism and intelligence is due to test anxiety, a partial correlation was computed between Neuroticism and intelligence, controlling for level of test anxiety. The partial correlation was not significant, \( r_{\text{partial}} = -.13, p = .20 \). A partial correlation was also computed between Neuroticism and intelligence, controlling for level of 'induced anxiety'. The partial correlation was again not significant, \( r_{\text{partial}} = -.18, p = .07 \). The relationship between Neuroticism, intelligence and test anxiety is represented in Figure 3.2.2⁴.

Figure 3.2.2: The relationship between Neuroticism, test anxiety and intelligence (test performance)

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3.1.4. Discussion

The main focus of this study was to investigate whether the negative correlation between Neuroticism and psychometric intelligence is mediated by state (test) anxiety, which is represented by the second model in Figure 3.2.1. The first hypothesis (H1) was that Neuroticism would be correlated with the level of test anxiety and with level of induced anxiety. It was hypothesized that Neuroticism would be correlated with initial level of anxiety.

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⁴ The arrow between Neuroticism and intelligence is dotted indicating that this relationship is mediated by test anxiety.
anxiety, as the conditions of testing are believed to induce state anxiety (Dobson, 2000). The results supported the first hypothesis, as Neuroticism positively correlated with test anxiety and with anxiety after the anxiety-inducing information. The latter correlation was higher than the former, although these were not significantly different. These results therefore indicate that high Neurotics are more stressed under testing conditions than low Neurotics, and that they tend to be more stressed when they receive information that induces further anxiety. This finding, which has been previously been reported by Eysenck and Eysenck (1985), provides the basis for the suggestion that the relationship between Neuroticism and intelligence could be due to Neurotic individuals experiencing higher levels of anxiety which interfere with their performance on the IQ test. That is trait anxiety influences state anxiety, which affects performance.

Further evidence for this suggestion arises from the finding that the high-anxiety and the low-anxiety group significantly differed in their levels of intelligence, with the low-anxiety group scoring slightly higher. This indicates clearly that anxiety affected performance on the intelligence test. This is based on the assumption that the two groups differed in their levels of intelligence due to the different testing conditions, and not due to actual differences in their intelligence levels. This could actually be tested by future studies, by giving the two groups another test of fluid intelligence on a different day, under identical testing conditions, in order to compare the actual IQ of the two groups. However, there was no reason to expect that there was any difference in the actual levels of intelligence in the two groups, as all participants were university students.

The second hypothesis (H2) was that the correlation between Neuroticism and intelligence would be higher in the high-anxiety group than in the low-anxiety group.
This hypothesis was not supported by the results, as no significant difference was found between the two correlations. However, the correlation between Neuroticism and intelligence was significant in the high-anxiety group, whereas for the low-anxiety group the correlation was not significant. This indicates that the results were in the expected direction, although they were not significantly different. This may be due to the fact that although attempts were made to reduce anxiety in the low-anxiety group, they may not have been sufficient to eliminate test anxiety. This is because although participants were required to give a code name, which would reduce their anxiety of possible consequences of their results, they were however tested under usual testing conditions, which means that they may still have experienced test anxiety. The task of completely eliminating test anxiety for all participants is very difficult if not impossible. However, future research could attempt to further reduce test anxiety by giving participants the un-timed version of a test (which is for example available for the Raven's Progressive Matrices) although this could produce a ceiling effect, which would affect the size of the correlations. Test anxiety could also be reduced by giving participants information on the purpose of the experiment, and by explicitly requesting them not to be anxious.

The third hypothesis (H3) was that the correlation between intelligence and Neuroticism would not be significant, when level of test anxiety was controlled for, thus investigating whether the relationship between Neuroticism and intelligence is mediated by test anxiety. In order for a variable to mediate the relationship between a predictor and a criterion variable, all the correlations between the three variables must be significant, and the correlation between the criterion and the predictor variable must not be significant when the mediator variable is controlled for (Baron & Kenny, 1986). This is what the
third hypothesis examined. The results supported this hypothesis, as the partial
correlation between Neuroticism and intelligence was no longer significant when test
anxiety was partialled out. Furthermore, correlations between Neuroticism and
intelligence, between Neuroticism and test anxiety, and between intelligence and test
anxiety were all significant. These results therefore indicate the relationship between
Neuroticism and intelligence was indeed mediated by test anxiety.

One drawback in this study was that test anxiety was measured by one question, instead
of using a validated multi-item questionnaire. This meant that it would not be possible to
distinguish whether it was the worry, the emotionality or the self-confidence component
of anxiety that affects IQ test performance. However, in order to induce anxiety by giving
the participants false information, it was necessary that the role of anxiety in the
experiment would not be made obvious. This is because it could lead participants to
understand that the information they were given was false, and used simply to induce
anxiety. Therefore a questionnaire measuring anxiety could not be used. Anxiety was
instead measured by a single question on a Likert scale. As a manipulation check, anxiety
was measured after participants were informed they were going to be tested, as well as
after they were given further anxiety-inducing information.

The present findings suggest that the negative correlation usually observed between
intelligence and Neuroticism is because Neurotics become more anxious under testing
conditions, and this anxiety affects their performance on the IQ tests. It is therefore
proposed that Neuroticism is not related to intelligence per se, but to intelligence test
performance, which has been proposed in the past (Eysenck, 1971). This suggestion
implies that IQ tests may underestimate the true intelligence of Neurotic individuals. It
should however be noted that intelligence and Neuroticism are usually measured in order to predict some form of performance (e.g. academic or occupational). On this basis, since anxiety affects the performance of high Neurotics on IQ tests, it may also affect their performance on academic or occupational settings, if conditions are stressful or demanding.
3.3. Study 4

3.3.1. Introduction

The findings of Study 3 suggest that the relationship between Neuroticism and intelligence is mediated by state anxiety, which affects intelligence test performance. This implies that Neuroticism is actually more systematically related to IQ test performance than to intelligence per se. Study 4 will investigate the relationship of fluid intelligence (gf) with Openness and Conscientiousness, as they are the two personality factors that appear to be actually and conceptually related to intelligence and not to intelligence test performance. The studies that have provided evidence for the relationship between intelligence and the super-traits of Openness and Conscientiousness will be outlined below. The aim of this study is to investigate which second-order facets of Openness and Conscientiousness are related to intelligence, so as to explain why the super-traits are linked to intelligence and how these relationships may have developed. Intelligence will be measured by the Graduate and Managerial Assessment: Abstract (GMA:A) (Blinkhorn, 1985), which is a measure of gf, as it measures abstract reasoning.

Openness to Experience

Openness to Experience has been found to correlate with general intelligence, with levels ranging from about \( r = .30 \) (Austin et al., 2002), to \( r = .45 \) (Kyllonen, 1997). Elements of Openness are aesthetic sensitivity, awareness of one’s emotions, vivid imagination, preference for novelty and variety, and intellectual curiosity (Costa & McCrae, 1992; McCrae, 1993; McCrae & Costa, 1997). Some researchers have indeed preferred to refer to Openness as Intellect or Culture, interpreting this personality trait in terms of
introspective reflection and intellectual knowledge (Goldberg, 1994; Johnson, 1994; Saucier, 1994).

It has been proposed that Open individuals, being more intellectually curious and behaviourally flexible, are more motivated to engage in intellectual activities, which causes them to expand their gc. Evidence for this suggestion is that Openness particularly correlates with the crystallized aspects of intelligence (gc) (Jackson, 1984; Brand, 1994; Kyllonen, 1997; Ashton et al., 2000). Goff and Ackerman (1992) further supported this suggestion, by proposing that the relationship between gc and Openness may be mediated by Typical Intellectual Engagement (TIE). This is because TIE, which is highly correlated with Openness (Ackerman & Goff, 1994), is a measure of intellectual motives and interests and of intellectual investment. It is therefore likely to be a determinant knowledge acquisition, and consequently a determinant of gc (Cattell, 1971, 1987; Ackerman, 1996, 1999).

Study 1 however also showed that Openness significantly correlates with gf, in line with Chamorro-Premuzic et al. (under review). Here the suggestion that Openness may have lead to the expansion of gf is not appropriate, as gf is considered to be biologically based, and less susceptible to influences of the environment (Brody, 1992). This relationship may be due to the high correlation between gf and gc, indicating that gc mediates the relationship between gf and Openness. An alternative interpretation of the relationship between Openness and gf, is that individuals with lower gf may become less curious and have narrower interests, due to their lower ability to handle novel experiences, which discourages Openness. Also, individuals with higher gf may have sought to stimulate and challenge themselves, by exposing themselves to novel experiences, and thus becoming
more curious and with wider interests, and therefore, in turn, more Open. This study will attempt to further explain the relationship between Openness and intelligence, by looking at which specific parts of Openness are correlated with gf. This will be investigated by looking at how the sub-factors of Openness correlate with intelligence measures.

The six sub-factors of Openness are Fantasy, Aesthetics, Feelings, Actions, Ideas and Values, according to the Costa and McCrae model (1992). Fantasy involves having a vivid imagination and an active fantasy life, which may contribute to a creative and rich life. Aesthetics refers to an interest and an appreciation of art and beauty, even in the lack of artistic talent or taste. Feelings implies receptivity to one's emotions, and the evaluation that emotions are important in life. Actions refers to the willingness to try different activities, and a preference for novelty over familiarity. Ideas involves intellectual curiosity, and is characterized by an active pursuit of intellectual interests. Finally, Values denotes the readiness to re-examine social, political and religious values.

The first hypothesis (H1) is that trait Openness will be positively correlated with fluid intelligence, in line with previous studies (Austin et al., 2002; Kyllonen, 1997) and with Study 1. The second hypothesis (H2) is that of the sub-factors of Openness, the ones that will significantly (positively) correlate with gf will be Actions and Ideas. This would support the suggestion that intellectual curiosity and behavioural flexibility may have lead Open individuals to expand their gc, which is highly correlated with fluid intelligence (Cattell, 1971) but also the suggestion that fluid intelligence may have affected the development of Openness. Ideas was found to be a positive predictor of general intelligence in Study 1.
Conscientiousness

The other factor that appears to be significantly correlated with intelligence per se, is Conscientiousness. This personality factor is related to persistence, discipline, organization and need for achievement. Studies 1 and 2 however reported that there is a consistent significant negative correlation between Conscientiousness and intelligence, a finding that has also been reported by Allik and Reallo (1997), Demetriou et al. (2003) and Furnham et al. (in press).

The negative relationship between Conscientiousness and intelligence seems inconsistent with the fact that Conscientiousness has been consistently found to positively correlate with job performance (Hough et al., 1990; Barrick & Mount, 1991, Goff & Ackerman, 1992; Blickle, 1996; De Raad, 1996; Barrick et al., 1999; Judge et al., 1999). There also appears to be no specific theoretical explanation for more Conscientious individuals to become less intelligent, or for less Conscientious individuals to become more intelligent.

It has however been suggested that the negative correlation between Conscientiousness and intelligence can be explained by seeing Conscientiousness as being adaptive (see Study 1 and 2). This means that in a competitive educational or work environment, relatively less intelligent individuals may become more Conscientious to cope with their comparative disadvantage in intelligence. It may also be that more intelligent individuals do not become so Conscientious over time, as they are able to rely on their intelligence to accomplish most cognitive tasks. Therefore in a competitive academic environment filled with highly (fluid) intelligent people the comparatively less intelligent may be able to ‘keep up’ by working harder. Hard work, persistence, dutifulness and deliberation may thus develop to compensate for quick-wittedness. This implies that it is intelligence that
affects the development of Conscientiousness and not vice versa. This study attempts to provide further support for this suggestion, by looking at which sub-factors of Conscientiousness are correlated with measures of intelligence.

The sub-factors of Conscientiousness, according to the Costa & McCrae (1992) model, are Competence, Order, Dutifulness, Achievement Striving, Self-Discipline and Deliberation. Competence refers to a sense of being capable, prudent and effective. Order involves being well-organized. Dutifulness is associated with strict adherence to one’s ethical principles and moral obligations. Achievement Striving involves high aspiration levels and working hard to achieve one’s goals. Self-Discipline implies the ability to carry out tasks to completion despite distractions. Finally, Deliberation refers to a tendency of thinking carefully before acting, of being cautious and deliberate.

The third hypothesis (H3) is that trait Conscientiousness will be negatively correlated with intelligence, in line with Studies 1 and 2, and with Demetriou et al. (2003) and Furnham et al. (in press). The fourth hypothesis (H4) is that intelligence will be negatively correlated with Order, Self-Discipline, and Deliberation, which would support the suggestion that Conscientiousness develops in order to compensate for lower levels of intelligence. Order was in fact a negative predictor of general intelligence in Study 1.

3.3.2. Method

Participants

A total of 2658 participants were included in this study. Of these 2155 were male and 503 were female. All participants were tested by a business psychology consulting company, during an assessment exercise.
Materials

Graduate and Managerial Assessment: Abstract (GMA:A; Blinkhorn 1985). See Study 1 (section 2.1.2).

The Revised NEO Personality Inventory (NEO PI-R) (Costa & McCrae, 1985). See Study 1 (section 2.1.2).

Procedure

Participants were employees from ten different companies, and were tested by Kaisen Consulting, a British based management consulting firm, as part of an individual assessment process. All the testers were trained and chartered psychologists.

3.3.3. Results

Correlations: Pearson product moment correlations were computed between fluid intelligence, the Big 5 personality factors and gender. Due to the large sample size, the .001 level was adopted as a more appropriate significance level. These correlation coefficients are presented in Table 3.3.1. GMA:A was significantly correlated with Openness (r = .09, p<.001) and Conscientiousness (r = -.11, p<.001), supporting the first and the third hypotheses. Gender was significantly correlated with the GMA:A (r = .15, p<.001) as well as with four of the five personality factors. Due to the fact that gender was significantly correlated with both intelligence and personality variables, partial correlations were also computed, controlling for gender. These coefficients did not differ to an appreciable extent from the pearson product moment correlation coefficients and are therefore not presented here.
Table 3.3.1: Correlations between fluid intelligence, personality factors, and gender

<table>
<thead>
<tr>
<th></th>
<th>gf</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>-.01</td>
<td>.08*</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-.03</td>
<td>.10*</td>
</tr>
<tr>
<td>Openness</td>
<td>.09*</td>
<td>.20*</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.01</td>
<td>.16*</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-.11*</td>
<td>-.05</td>
</tr>
<tr>
<td>Gender</td>
<td>.15*</td>
<td></td>
</tr>
</tbody>
</table>

*p<.001

Regressions: In order to further investigate the relationship between intelligence and the Big 5 factors, multiple regression were performed, using fluid intelligence as the dependent variable, and the personality factors as independent variables. Again the .001 level of significance was adopted. The regression model was significant F(5,2625) = 15.40, p<.001, with Adjusted R² = .03. Significant predictors of fluid intelligence were Neuroticism (β = -.07), Extraversion (β = -.09), Openness (β = .12) and Conscientiousness (β = -.13). The β-coefficients for these regression models are presented in Table 3.3.2.

Table 3.3.2: Beta values for multiple regression coefficients of Big 5 personality factors on fluid intelligence

<table>
<thead>
<tr>
<th></th>
<th>gf</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>-.07</td>
<td>-3.32*</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-.09</td>
<td>-3.68*</td>
</tr>
<tr>
<td>Openness</td>
<td>.12</td>
<td>5.51*</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.00</td>
<td>.14</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-.13</td>
<td>-5.81*</td>
</tr>
</tbody>
</table>

Regression Model F(5,2625) = 15.40*
Adjusted R² = .03

*p<.001
Openness to Experience

In order to understand the nature of the relationship between Openness and intelligence, the relationship between the sub-factors of Openness with fluid intelligence was investigated.

Correlations: Correlations between the sub-factors of Openness and gf are presented in Table 3.3.3. The GMA:A significantly correlated at the .001 level with Actions (r = .07) and Ideas (r = .20), supporting the second hypothesis.

Table 3.3.3: Correlations between fluid intelligence, Openness and Conscientiousness sub-factors

<table>
<thead>
<tr>
<th></th>
<th>gf</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1: Fantasy</td>
<td>.05</td>
</tr>
<tr>
<td>O2: Aesthetics</td>
<td>.01</td>
</tr>
<tr>
<td>O3: Feelings</td>
<td>-.01</td>
</tr>
<tr>
<td>O4: Actions</td>
<td>.07*</td>
</tr>
<tr>
<td>O5: Ideas</td>
<td>.20*</td>
</tr>
<tr>
<td>O6: Values</td>
<td>.04</td>
</tr>
<tr>
<td>C1: Competence</td>
<td>-.04</td>
</tr>
<tr>
<td>C2: Order</td>
<td>-.15*</td>
</tr>
<tr>
<td>C3: Dutifulness</td>
<td>-.06</td>
</tr>
<tr>
<td>C4: Achievement-striving</td>
<td>-.06</td>
</tr>
<tr>
<td>C5: Self discipline</td>
<td>-.08*</td>
</tr>
<tr>
<td>C6: Deliberation</td>
<td>-.09*</td>
</tr>
</tbody>
</table>

*p<.001

Regressions: In order to further investigate the relationship between gf and the Openness sub-factors, multiple regression was performed, using the GMA:A as the dependent variable, and the six Openness sub-factors as independent variables. The regression model was significant \( F(6,2623) = 23.27, p<.001, \) with Adjusted \( R^2 = .05. \) Significant predictors of gf were Aesthetics (\( \beta = -.10 \)) and Ideas (\( \beta = .25 \)). The \( \beta \) coefficients for this regression model are presented in Table 3.3.4.
### Conscientiousness

In order to understand the nature of the relationship between Conscientiousness and fluid intelligence, the relationship between the sub-factors of Conscientiousness and the GMA:A was investigated.

**Correlations:** Correlations between the sub-factors of Conscientiousness and gf are also presented in Table 3.3.3. The GMA:A significantly correlated at the .001 level with Order ($r = -.15$), Self-Discipline ($r = -.08$) and Deliberation ($r = -.09$), partly supporting the fourth hypothesis.

**Regressions:** In order to further investigate the relationship between intelligence and the Conscientiousness sub-factors, multiple regression was performed, using the GMA:A as
dependent variable, and the six Conscientiousness sub-factors as independent variables. The regression model was significant $F(6,2623) = 10.68, p<.001$, with Adjusted $R^2 = .02$. Order ($\beta = -.13$) was a significant predictor of the GMA:A. The $\beta$ coefficients for this model are presented in Table 3.3.4.

3.3.4. Discussion

The aim of the present study was to investigate how Openness and Conscientiousness are related to fluid intelligence, by looking at the sub-factor level of these personality factors. Results showed that $gf$ was positively correlated with, and predicted by, Openness (positively) and Conscientiousness (negatively), thus supporting the first (H1) and the third (H3) hypotheses, although the size of the correlations was of a small magnitude. Extraversion and Neuroticism were also both negative predictors of $gf$. These findings are in line with previous studies, which have investigated the relationship between the Big 5 factors and measures of intelligence (Lynn et al., 1982; Ackerman & Heggestad, 1997; Kyllonen, 1997; Furnham et al., 1998; Zeidner & Matthews, 2000). It has been proposed that both Neuroticism and Extraversion are actually related to intelligence test performance and not to intelligence per se. The relationship between $gf$ and Neuroticism and Extraversion was therefore not investigated in greater depth in the present study, as the focus was the direct relationship between personality and fluid intelligence.

The finding that Openness was positively correlated with, and a positive predictor of $gf$, is in line with previous studies (McCrae, 1994; Ackerman & Heggestad, 1997; Zeidner & Matthews, 2000; Austin et al., 2002). Although it has been proposed that Openness is specifically correlated with $gc$ (Brand, 1994), studies have shown that it is also related to
gf (Kyllonen, 1997; Chamorro-Premuzic et al., under review), a finding which was also reported in Study 1. This can be interpreted in two ways. One explanation is that Openness is correlated to gf, due to its correlation with gc, and the fact that gf and gc are highly correlated (Cattell, 1971). An alternative explanation is that gf may affect the development of Openness over time. The opposite argument, i.e. that Openness may affect the development of gf is less plausible, as gf is considered to be genetically influenced, based on physiological aspects of an individual, and less susceptible to influences of the environment (Cattell, 1963; Horn & Cattell, 1966; Belsky, 1990; Brody, 1992). The two possible explanations of the relationship between Openness and gf can be considered by looking at how the sub-factors of Openness correlated with gf.

Analysis of the sub-factors of Openness showed that gf was correlated with Actions and Ideas, supporting the second hypothesis (H2). Ideas refers to intellectual curiosity. This trait is seen as an active pursuit of intellectual interests, and as a willingness to consider new, perhaps unconventional ideas. High scorers on this scale enjoy philosophical arguments and brainteasers. Actions refers to willingness to try different activities, and to a preference for novelty and variety over familiarity and routine. Fluid intelligence involves things like reaction times, quick thinking, reasoning, seeing relationships and approaching new problems (Brody, 1992). This means that individuals high on gf have an innate ability to cope more efficiently with novel experiences, and to deal with intellectually stimulating tasks such as brainteasers, which would thus make it rewarding for them to pursue such activities. Similarly, individuals low on gf may in time grow to avoid such activities, due to their low ability to handle them, which would thus make them less rewarding. This argument is in line with Ackerman (1996), who suggested that
interest in a task domain will increase, subsequent to successful attempts at task performance, whereas unsuccessful attempts may result in a decrease in interest for the task domain.

Findings on the relationship between gf and Openness sub-factors seem to support the suggestion that the relationship between gf and Openness may have occurred by gf affecting the development of Openness. This suggestion is in line with the adaptive models proposed by Matthews (1999), according to which the development of non-cognitive traits can be explained as adaptations to different cognitive patterns. On the other hand, it is also plausible that Actions and Ideas are correlated to gf due to their relationship with gc. Under this line of reasoning, the tendency of Open individuals to engage in novel activities and their intellectual curiosity may have caused them to expand their gc. This in turn would lead to a relationship between Openness and gf, as gf and gc are highly correlated (Cattell, 1971).

Future studies could investigate this further, by examining how the sub-factors of Openness are related to gf in comparison to how they are related to gc. The best means however to reach a conclusion on how the relationship between Openness and intelligence developed, is through longitudinal studies, which would record participants' Openness and gf and gc from an early age until the age of around 30, when personality characteristics are believed to have stabilized (Costa, Metter & McCrae, 1994). The fact that the analysis of the sub-factors of Openness provided support for both explanations of how Openness is related to gf implies that both explanations may be true. This means that gf may influence the development of Openness, which in turn may influence the development of gc.
The finding that Conscientiousness was negatively correlated with, and a negative predictor of gf, is in line with previous studies (Demetriou et al., 2003; Furnham et al., in press) and with Studies 1 and 2, which reported Conscientiousness to be negatively correlated with both general and fluid intelligence. These correlations have been interpreted in terms of the possibility that high Conscientiousness may develop as a compensatory trait for poor gf.

Analysis of the sub-factors of Conscientiousness revealed that gf was particularly correlated with Order, Self-Discipline and Deliberation, supporting the fourth hypothesis (H4). Order was furthermore a significant predictor of gf, in line with Study 1, where Order was found to be a significant predictor of general intelligence. These findings imply that individuals low in gf are more well-organized (Order), have the self-discipline to carry out tasks assigned to them despite distractions and boredom (Self-Discipline), and have the tendency to be cautious and deliberate, and to think carefully before acting (Deliberation). These are characteristics that may indeed have developed to compensate for a low gf. As gf is associated with fast thinking, reasoning, and a high working memory capacity (Brody, 1992; Horn & Hofer, 1992), individuals with lower gf would have a disadvantage in dealing with novel situations, in making decisions and in solving problems, compared to individuals high on gf. This disadvantage would become obvious in a competitive environment, like the school, the university, or the work environment. Individuals with a comparatively lower gf might have to compensate for this by working harder, by being well-organized, by having the self-discipline to carry out the tasks assigned to them, i.e. by becoming more Conscientious. Also, individuals high on gf might not develop these characteristics of Conscientiousness, simply because they would
not need to, because their fluid abilities would enable them to deal with situations without being so well organized, self-disciplined or deliberate. In this sense bright individuals might become lazy.

The findings from the analysis of the Conscientiousness sub-factors therefore provide evidence supporting the suggestion that gf affects the development of Conscientiousness.

It would be useful for future studies to attempt to replicate the present results by looking at different personality tests, which include measures of C. By simultaneously looking at more than one measures of C, more conclusive evidence could be obtained, regarding which specific sub-factors of C are related to intelligence, which would further explain the mechanisms leading to the negative relationship between C and intelligence. As it was proposed for Openness, in order to provide conclusive evidence on how the relationship between intelligence and Conscientiousness developed, longitudinal studies would be necessary. Evidence however on whether gf affects the development of Conscientiousness, could also be obtained by cross-sectional studies, by looking at whether Conscientiousness is more highly correlated with gf than with gc.

The present findings attest to the conceptual and empirical relationship between personality and intelligence, indicating the importance of investigating their interface, in order to achieve a better understanding of the psychological variability between individuals. The present study was not a longitudinal study, and therefore the suggestions on how the observed relationships may have developed, cannot be directly proved. It is

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5 There are measures of Conscientiousness in several personality inventories, eg. 16 Personality Factors, 15 Factor Questionnaire, Thematic Apperception Test
however important that the findings are in line with the proposed suggestions and can therefore form the basis, as well as complement future longitudinal studies.
3.4. Study 5

3.4.1. Introduction

The aim of Study 5 is to further investigate the relationship between Conscientiousness (C) and intelligence, extending the findings of Study 4. It was suggested that the relationship between intelligence and C could be explained in that intelligence, and more specifically fluid intelligence, may influence the development of C. If this is the case, then C should be more highly correlated with gf than with gc. It is important here to clarify the distinction between fluid and crystallized intelligence.

This distinction was first proposed by Raymond Cattell (1941, 1963, 1971) in his gf-gc theory, which has been presented in Chapter 1 (section 1.1.1.2). Fluid intelligence is defined as our "on-the-spot reasoning ability, a skill not basically dependent on our experience" (Belsky, 1990, p.125). It involves things like quick thinking, reasoning, seeing relationships between ideas, approaching new problems, and is considered to be biologically based, and less susceptible to influences of the environment (Brody, 1992). According to Cattell (1983), gf tends to increase up to the age of about 16 to 20 and steadily decrease thereafter. Belsky (1990) proposed that this is because gf is associated with the central nervous system (CNS), and is therefore at its peak when the CNS is at its physiological peak.

Crystallized intelligence on the other hand has been defined as "the extent to which a person has absorbed the content of culture" (Belsky, 1990, p.125). It is the accumulation of information, of facts, figures, skills and knowledge, over time, and is usually measured by vocabulary tests. Gc is therefore influenced by education and cultural exposures.
(Brody, 1992), and is at its peak at around the age of 45 to 54 years, beginning to decline during the eighth decade of life.

It is therefore apparent that a relationship between a personality trait and gf may have had a different development to a relationship between a personality trait and gc. This is because gc is by definition influenced by the environment, whereas gf is primarily biologically based. Therefore it is unlikely that an observed relationship between a personality factor and gf has emerged due to that personality factor having affected the development of gf. On the other hand, for an observed relationship between a personality factor and gc, causality may be argued in both directions.

On this basis, it has been proposed that the observed negative correlation between intelligence and Conscientiousness could be explained in that fluid intelligence, affects the development of C (see Study 4). This has been explained in that relatively less intelligent individuals may become more Conscientious to cope with their relative disadvantage, or that more intelligent individuals do not become so Conscientious over time, as they are able to rely on their intelligence to accomplish most cognitive tasks. This suggestion views C as being adaptive, i.e. hard work, persistence, dutifulness and deliberation develop to compensate for quick-wittedness.

The aim of the present study is to provide evidence to support the proposed explanation for the negative relationship between intelligence and C, which views C as being adaptive and compensating. It is hypothesized that if this suggestion is correct, C should be more highly correlated with gf than with gc. This is proposed because since gf is predominantly biologically based, whereas gc is developed through education and cultural exposures, it must be gf which influences the development of personality (which
occurs early in life), as gc will not have fully developed. Furthermore, one would expect more Conscientious individuals (who are more organized, thorough, persistent and methodical) to be more devoted students during school education. This would lead them to develop their gc more than individuals low in C, as gc is developed through education (Brody, 1992). Therefore, the negative relationship that will have developed between gf and C, would be somewhat counterbalanced by the positive effect C would have on the development of gc. Therefore, C is expected to be more highly negatively linked to gf than to gc.

The first hypothesis (H1) therefore, is that C will be negatively correlated with both gf and gc, as measured by abstract and verbal reasoning respectively, in line with previous studies (Demetriou et al., 2003; Furnham et al., in press). The second hypothesis (H2) is that C will be more highly correlated with abstract reasoning (gf) than with verbal reasoning (gc), which would support Study 4, in the suggestion that gf may affect the development of Conscientiousness.

3.4.2. Method

Participants

A total of 201 participants were recruited for this study. Of these, 85 were female and 115 were male (one did not specify gender). Their age ranged from 16 to 61, with a mean of 38.05 and a standard deviation of 9.19. In the statistical analysis of the IQ measures, participants who scored below 3 (out of 35) on any IQ test were excluded from the analysis. This meant that in total 192 participants were included, of which 84 were female
and 108 were male. Their age ranged from 16 to 61 with a mean of 37.88 and a standard deviation of 9.03.

Materials

The General Reasoning Test Battery (GRT2) (Budd, 1993a). See Study 2 (section 2.2.2).

Fifteen Factor Questionnaire (15FQ) (Budd, 1992). See Study 2 (section 2.2.2).

Procedure

Participants were all job applicants tested by Psytech International as part of an assessment center exercise.

3.4.3. Results

Second-order factors of the 15FQ

It has been established by factor analysis that the 15FQ dimensions can be summarized in five broad dimensions of personality, which correspond to each of the five dimensions of the Five Factor Model (Budd, 1992). The Big 5 factors were computed for the present sample by using the formulae provided by the 15FQ manual (Budd, 1992), which have been presented in Study 2 (section 2.2.3).

Correlations: Correlations between the Big 5 factors, and the three intelligence measures used are presented in Table 3.4.1. Abstract reasoning significantly correlated with Conscientiousness ($r = -.26$, $p<.001$), and verbal reasoning significantly correlated with Neuroticism ($r = -.17$, $p<.05$), Agreeableness ($r = .24$, $p <.01$) and Conscientiousness ($r =$
Correlations between the three intelligence measures are also presented in Table 3.4.1.

<table>
<thead>
<tr>
<th></th>
<th>Abstract Reasoning</th>
<th>Numerical Reasoning</th>
<th>Verbal Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical Reasoning</td>
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<td>.57***</td>
<td></td>
</tr>
<tr>
<td>Verbal Reasoning</td>
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<td></td>
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<td>-.17*</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.09</td>
<td>-.09</td>
<td>.01</td>
</tr>
<tr>
<td>Openness</td>
<td>.03</td>
<td>-.05</td>
<td>-.06</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.12</td>
<td>-.01</td>
<td>.24**</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-.26*** (-.21**)</td>
<td>-.12 (-.13)</td>
<td>-.23*** (-.09)</td>
</tr>
</tbody>
</table>

*p<.05, **p<0.1, ***p<.001

Regressions: Three regression models were used, in order to investigate the extent to which the Big 5 factors (and specifically Conscientiousness) can predict intelligence. The dependent variables used were abstract, verbal and numerical reasoning. The independent variables used in all three regression models were the Big 5 factors. The β coefficients for these regressions are presented in Table 3.4.2.

The regression model which used abstract reasoning as the dependent variable was significant (F(5,186) = 2.75, p<.01) with Adj. R² = .04. Conscientiousness was a significant predictor of abstract reasoning (β = -.27, p<.01). The regression model that used numerical reasoning as the dependent variable was not significant. The regression model which used verbal reasoning as the dependent variable was significant (F(5,186) = 4.04, p<.01), with Adj. R² = .07. Agreeableness was a significant predictor of verbal reasoning (β = .24, p<.01).
Table 3.4.2: Beta coefficients for regressions of the Big 5 factors on the three intelligence measures

<table>
<thead>
<tr>
<th></th>
<th>Abstract Reasoning</th>
<th>Numerical Reasoning</th>
<th>Verbal Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
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<td>-.11</td>
<td>-.06</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.01</td>
<td>-.14</td>
<td>-.09</td>
</tr>
<tr>
<td>Openness</td>
<td>.06</td>
<td>.05</td>
<td>-.10</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-.05</td>
<td>-.08</td>
<td>.24**</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-.27**</td>
<td>-.16</td>
<td>-.11</td>
</tr>
<tr>
<td>Regression Model</td>
<td>F(5,186)=2.75**</td>
<td>F(5,186)=1.59</td>
<td>F(5,186)=4.04**</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>.04</td>
<td>.02</td>
<td>.07</td>
</tr>
</tbody>
</table>

**p<0.1

Partial correlations: Although Conscientiousness was significantly correlated with verbal reasoning, it was not a significant predictor of it once the shared variance among the predictor variables was taken into account. Therefore partial correlations were also performed among the three intelligence measures and Conscientiousness, controlling for the remaining Big 5 factors (Neuroticism, Extraversion, Openness and Agreeableness). Conscientiousness was significantly correlated with abstract reasoning (r = -.21, p<.01), but not with numerical or verbal reasoning. These partial correlations are also presented in Table 3.4.1.

In order to test whether Conscientiousness correlated significantly differently with abstract and verbal reasoning, a one-tailed t-test for non-independent partial correlations was conducted. The t value was significant t(183)= -1.74, p<.05, indicating that Conscientiousness correlated more strongly with abstract than with verbal reasoning.

Conscientiousness sub-factors: In order to further investigate the relationship between Conscientiousness and intelligence, correlations were computed for the sub-factors of Conscientiousness (Conscientious, Radical and Disciplined) and the three intelligence measures.

---

6 The formula used was $t = \frac{(r_{12} - r_{13}) \times \sqrt{(N-1)(1+r_{23})}}{\sqrt{2(1-r_{12}^2)(1-r_{13}^2)}} + \frac{r_{12} r_{13} r_{23} + r_{12} + r_{13} + r_{23}}{(1-r_{23})^2} \times \frac{1}{4}$, the ratio being distributed as t on $N-3$ df, where $r_{12}$: partial correlation of C with AR, $r_{13}$: partial correlation of C with VR and $r_{23}$: correlation of AR with VR.
measures. Conscientious was significantly correlated with abstract (r = -0.26, p < 0.001), numerical (r = -0.21, p < 0.01) and verbal reasoning (r = -0.29, p < 0.001), and Disciplined was significantly correlated with abstract (r = -0.16, p < 0.05) and verbal reasoning (r = -0.16, p < 0.05). Partial correlations were also computed, controlling for Neuroticism, Extraversion, Openness and Agreeableness. Conscientious was significantly correlated with abstract (r = -0.22, p < 0.01), numerical (r = -0.23, p < 0.01) and verbal reasoning (r = -0.18, p < 0.01). These correlations and partial correlations are presented in Table 3.4.3.

Table 3.4.3: Correlations (and partial correlations) between the Conscientiousness sub-factors and the three intelligence measures

<table>
<thead>
<tr>
<th></th>
<th>Abstract Reasoning</th>
<th>Numerical Reasoning</th>
<th>Verbal Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conscientious</td>
<td>-0.26*** (-0.22**)</td>
<td>-0.21** (-0.23**)</td>
<td>-0.29*** (-0.18**)</td>
</tr>
<tr>
<td>Restrained</td>
<td>-0.13 (-0.10)</td>
<td>0.06 (0.06)</td>
<td>0.01 (0.02)</td>
</tr>
<tr>
<td>Disciplined</td>
<td>-0.16* (-0.10)</td>
<td>-0.07 (-0.05)</td>
<td>-0.16* (0.01)</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.1, ***p < 0.001

3.4.4. Discussion

The aim of the present study was to investigate the relationship between Conscientiousness and intelligence. The first hypothesis (H1) was that C would negatively correlate with abstract (AR) and with verbal (VR) reasoning, in line with previous studies, which have reported significant correlations between C and measures of intelligence (Demetriou et al., 2003; Furnham et al., in press). This hypothesis was partly supported by the results. Although the correlation between C and AR and VR was negative, it was not significant for VR once the effect of Neuroticism, Extraversion, Openness and Agreeableness were partialled out. This finding therefore attests to the relationship between C and gf, but indicates that the relationship between C and gc may be mediated by other variables.
The second hypothesis (H2) was that C would be more highly correlated with AR than with verbal reasoning VR, suggesting that C is more highly correlated with fluid than with crystallized intelligence. Partial correlations between C and the intelligence measures showed that C was significantly correlated with AR, but not with VR. Furthermore these correlations were found to be significantly different, thus supporting the second hypothesis, which predicted C would more highly correlate with AR than with VR, indicating that it is more highly correlated with gf than with gc. Numerical reasoning was not included in the hypothesis, because although it is considered by most researchers to be a measure of gc (Kaufman, 2000) (due to the fact that it is dependent on the accumulation of knowledge), it is also considered by some researchers to be highly related with gf (Lohman, 2000) (due to the fact that mathematical problems require reasoning ability, seeing relationships and approaching new problems, which are characteristics of gf). Therefore it was considered that looking at how C related to numerical reasoning would not help clarify whether it is more correlated to gc or to gf.

The finding that C was significantly correlated with gf but not with gc, indicates that the direction of causality in the relationship between intelligence and C must be that intelligence affects the development of C. This is based on the fact that gf is biologically based, less susceptible to influences of the environment (Brody, 1992) and “not basically dependent on our experience” (Belsky, 1990). It is consequently not likely that an external factor, such as personality, would influence its development. Moreover, there appears to be no logical theoretical explanation for more Conscientious individuals to become less intelligent, or for less Conscientious individuals to become more intelligent.
This finding therefore supports Study 4 in the suggestion that C may be adaptive, in that it may develop to compensate for comparatively low gf.

The lower negative relationship observed between C and gc could be due to the counterbalancing effect which was proposed in the Introduction (section 3.4.1). This implies a possible causal relationship from C to gc, which could be due to the fact that certain characteristics of C (like being more organized, thorough, persistent and methodical) may lead individuals to be more devoted students during school education, thus increasing their gc. It would be interesting for future research to investigate this suggestion, by looking for example at how these characteristics of C are related to school performance. More importantly longitudinal studies which would look at the development of C and of gc from an early stage of life would be essential in order to provide conclusive evidence that it is gf that affects the development of C.

The sub-factors of C were also investigated, with respect to their relationship with the intelligence measures, so as to further explain the relationship of C and intelligence. The three sub-factors of Conscientiousness, as measured by the 15FQ, are Conscientious, Restrained and Disciplined. Individuals high on the Conscientious (vs. Expedient) sub-factor are described as conscientious, structured and persistent. Individuals high on the Restrained (vs. Direct) sub-factor tend to be cautious, diplomatic and tactful. Finally, individuals high on the Disciplined (vs. Informal) sub-factor tend to be controlled and conventional. Of these three sub-factors, only the Conscientious (vs. Expedient) sub-factor was significantly correlated with the intelligence measures. The Disciplined (vs. Informal) sub-factor was also significantly correlated with AR and VR, but the partial correlations (controlling for Neuroticism, Extraversion, Openness and Agreeableness)
were not significant. Looking at the characteristics of the Conscientious sub-factor provides further insight into which particular characteristics of Conscientiousness are related to intelligence.

Individuals who score highly on the Conscientious sub-factor tend to be persistent, persevering and meticulous in their work habits. They have high standards of work and behaviour and often have strong beliefs about the correct way of doing something. These characteristics would be beneficial in the school environment for obtaining high grades and also a high level of education, which would in turn lead to an increase in the individual’s gc. Therefore this supports the suggestion that the lower negative correlation between C and gc could be due to the fact that certain characteristics of Conscientious individuals may lead them to increase their gc, counterbalancing the negative effect which gf has on C. Furthermore, these characteristics also support the suggestion that individuals low on gf may compensate for it by working harder (and thus develop structured and persevering working habits), or that individuals high on gf may feel they don’t need to work so hard to accomplish things and therefore don’t develop these characteristics. Although these findings seem to reveal a clear picture on how Conscientiousness and intelligence are related, in order to truly test causality, longitudinal or experimental studies need to be done to accompany correlational research.

3.5. Summary

This Chapter investigated the major findings of the literature on the interface between intelligence and personality, which were also the main findings of Chapter 2. These
findings are that intelligence is (modestly) positively correlated with Openness (Brand, 1994; McCrae, 1994; Ackerman & Heggestad, 1997; Zeidner & Matthews, 2000; Austin et al., 2002) and negatively correlated with Neuroticism (Ackerman & Heggestad, 1997, Furnham et al., 1998a; Kyllonen, 1997; Zeidner & Matthews, 2000) and Conscientiousness (Demetriou et al., 2003; Furnham et al., in press).

The relationship between intelligence and Neuroticism was investigated in Study 3, which looked at the relationship between intelligence, trait Neuroticism, and state anxiety. The results indicated that Neuroticism is actually linked to intelligence test performance rather than to intelligence per se. This is because Neurotic individuals tend to experience higher levels of anxiety whilst taking an IQ test, which interferes with their performance.

The relationship between Openness and intelligence was investigated in Study 4, which looked at which sub-factors of Openness are correlated with fluid intelligence scores. This Study looked at gf rather than gc, since the relationship between Openness and gc has been investigated and explained in a number of studies. Results showed that Openness is indeed related to gf, although the size of the correlation is small. Analysis of the Openness sub-factors showed that this could be either because gf influences the development of Openness, or because Openness influences the development of gc, which is highly correlated with gf.

The relationship between intelligence and Conscientiousness was investigated in Studies 4 and 5. These studies showed that Conscientiousness is correlated with gf rather than gc, indicating that this relationship may have occurred due to gf affecting the development of
Conscientiousness. The analysis of the Conscientiousness sub-factors provided evidence in support of this suggestion.

The findings of Studies 3, 4 and 5 are represented pictorially in Figure 3.5.1. The single-pointing arrows represent direct relationships between two variables. The dashed arrows (between Neuroticism and IQ test performance, and Conscientiousness and gc) represent indirect relationships, mediated by other variables. Finally, the double-pointing arrow represents the correlation between gf and gc. The directionality of the arrows implies causality, which is however based merely on theoretical grounds. Longitudinal studies would be essential in order to actually prove this model.

Figure 3.5.1: Pictorial representation of the findings of Studies 3, 4 and 5
4.1. General Introduction

Chapters 2 and 3 investigated the relationship between intelligence and the personality factors of the Five-Factor Model, which is perhaps the most prominent model within the academic research area (Devito, 1985; Panayiotou et al., 2004). However, in the applied field of counseling and management training, psychologists often utilize other personality inventories. This is mainly for economic reasons, but also because the marketing fashion is not overly concerned with the psychometric properties of the inventories. As was mentioned in Chapter 1, the utility of investigating the interface of intelligence and personality lies not only in individual differences psychology, for the understanding of human behaviour, but also in the applied field of occupational psychology, where psychometric tests are used for recruitment and selection. It would therefore be beneficial to also investigate the relationship between intelligence and personality as measured by inventories frequently used in occupational settings, to replicate but also to extend previous findings.

Therefore the aim of Chapter 4 is to investigate the relationship between psychometric intelligence and personality measures commonly used in occupational settings. The main focus of this Chapter will be personality as measured by Jung’s theory of personality types, as the MBTI is one of the most commonly used inventories among occupational psychologists (Devito, 1985; Kennedy & Kennedy, 2004). Research however on the relationship between Jung’s personality types and intelligence is scarce. Therefore, in
order to provide grounds for basing hypotheses, and for comparing findings to previous research, Jung's personality types will be looked at in relation to the Big 5 factors. Study 6 will thus investigate the relationship between the Jung's personality types and the Big 5 factors of personality, in order to aid the research on the relationship between Jung's personality types and intelligence.

Study 7 will investigate the relationship between intelligence and Jung's personality types, measured by the Jung Type Indicator (Budd, 1993b). Intelligence will be measured as general, fluid, and crystallized intelligence, as it has been proposed that the crystallized and fluid aspects of intelligence differentially correlate with personality factors. Study 8 will extend Study 7, by investigating the relationship between fluid intelligence and Jung's personality types, measured by the Myers-Briggs Type Indicator (Myers & McCauley, 1985). This study will also look at how gf is related to personality, measured by two other inventories commonly used in occupational settings, the Fundamental Interpersonal Relations Orientation-Behaviour (Schutz, 1975), and the California Psychological Inventory-434 (Gough & Cook, 1997).
4.2. Study 6

4.2.1. Introduction

The aim of this study is to investigate the relationship between Jung’s personality types and the Big 5 personality factors. Amongst the inventories used to measure these constructs of personality, two of the most popular are the Myers-Briggs Type Indicator (MBTI) (Carskadon, 1979; Myers & McCaulley, 1985; Nutt, 1990; Furnham & Stringfield, 1993) and the Revised NEO-Personality Inventory (NEO PI-R) (Costa & McCrae, 1985; John, 1990; Gottfredson, Jones & Holland, 1993; Hofstee, Kiers, De Raad, Goldberg & Ostendorf, 1997). The former is mostly used in the academic research area, while the latter is mostly used in the applied field of counseling and management training (Devito, 1985; Kennedy & Kennedy, 2004). Although the two tests differ in a number of ways, researchers have recently been focusing on the investigation of similarities between them.

The NEO PI-R was developed by Costa and McCrae (1985) to measure five higher-order, orthogonal dimensions of personality, called the Big 5. According to this Five Factor Model (FFM), the five dimensions of personality are Neuroticism, Extraversion, Openness to experience, Agreeableness and Conscientiousness. Each of these super-factors is composed of six primary factors. Details on the primary and second-order factors of the FFM have been presented in Chapter 1. Although this model did not derive from any single theory of personality, there is abundant evidence that its scales operationalize on a number of theoretical perspectives (McCrae & Costa, 1989). The model has received much empirical support (Piedmont & Weinstein, 1993) and the NEO PI-R is one of the most widely used tests in personality research (Furnham, 1996;
Heaven, 1996; Furnham & Avison, 1997; Druschel & Sherman, 1999; Shafer, 2000; Saroglou, 2002; De Vries & Van Heck, in press).

The MBTI was developed by Myers (1962) as an objective measure of Jung's theory of psychological types. The test measures four internally consistent and relatively uncorrelated personality traits, namely Extraversion-Introversion (EI), Sensing-Intuition (SN), Thinking-Feeling (TF) and Judgment-Perception (JP). Details on the MBTI dimensions have also been presented in Chapter 1 (section 1.2.1). The MBTI has been criticized on the basis that there is no bi-modal distribution of preference scores in reality (Furnham, 1996a), that there is no support for the typological theory on which it is based (Sticker & Ross, 1964, Hicks, 1984) and that it has low construct validity (Saggino et al., 2001).

Based on the claim that the Jungian concepts which underlie the MBTI have been distorted, McCrae and Costa (1989) attempted to reinterpret the MBTI from the perspective of the FFM. In their study, they compared scores on the NEO PI-R and the MBTI in two analyses, one considering the four MBTI scales as discrete and one considering them as continuous variables. What they found was that the four MBTI indices measure aspects of four of the Big 5 dimensions of personality. More specifically, they found that EI was correlated with Extraversion, SN with Openness, TF with Agreeableness and JP with Conscientiousness. These results were replicated by McDonald, Anderson, Tsagarakis and Holland (1994). Furnham (1996a) also provided evidence supporting these results, and further found Neuroticism to be correlated to both EI and TF. Furthermore, Furnham (1996a) looked at the correlations between the MBTI scales and the 30 sub-factors of the FFM. The highest correlations were between EI and
Gregariousness, Warmth, and Positive emotions (Extraversion), between SN and Ideas, Fantasy and Aesthetics (Openness), between TF and Tender-mindedness, Trust and Altruism (Agreeableness), between JP and Order, Deliberation and Self discipline (Conscientiousness) and between EI and Self-consciousness, Depression and Vulnerability (Neuroticism).

The aim of this study is to replicate the findings of McCrae & Costa (1989) (N = 468) and of McDonald et al. (1994) (N = 209), on a large adult population (N = 900), showing similar correlations between the MBTI and the NEO PI-R, and also to replicate the findings of Furnham (1996a) (N = 160) and find similar patterns of correlations amongst the NEO PI-R sub-scales and the MBTI scales. Therefore, the hypotheses are that Extraversion will be correlated with EI (H1), Openness with SN (H2), Agreeableness with TF (H3), and Conscientiousness with JP (H4).

4.2.2. Method

Participants

A total of 900 participants were recruited in this study. Of these 717 were male and 183 were female. Their age ranged from 23 to 64, with a mean of 42. They were all British adults, tested by a business psychology consulting company as part of an assessment exercise.

Materials

*The Revised NEO Personality Inventory (NEO PI-R) (Costa & McCrae, 1985).* See Study 1 (section 2.1.2).

Procedure

Participants were tested by Kaisen Consulting, a British based management consulting firm run predominantly by chartered psychologists, as part of an individual assessment or career development center process.

4.2.3. Results

Correlations: Partial correlations between the Big 5 personality factors and the Myers-Briggs Type Indicator, controlling for gender and age, are presented in Table 4.2.1. The highest correlations between the two personality tests were as follows. Neuroticism was most highly correlated with MBTI Extraversion (r = -.30, p = .001) and Introversion (r = .31, p < .001). Costa & McCrae’s Extraversion was most highly correlated with Myers-Briggs Extraversion (r = .71, p < .001) and Introversion (r = -.72, p < .001). Openness was most highly correlated with Sensing (r = -.66, p < .001) and Intuition (r = .64, p < .001). Agreeableness was most highly correlated with Thinking (r = -.41, p < .001) and Feeling (r = .28, p < .001). Conscientiousness was most highly correlated with Judgment (r = .46, p < .001) and Perception (r = -.46, p < .001). These results are in agreement with McCrae & Costa’s (1989), McDonald et al. (1994) and Furnham’s (1996) findings, which are also presented in Table 4.2.1 for comparison purposes.
### Table 4.2.1: Partial correlations between MBTI factors and NEO PI-R sub-factors and super-factors

<table>
<thead>
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<th>I</th>
<th>S</th>
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<th>T</th>
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<td>.27***</td>
<td>.17***</td>
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<td>.17***</td>
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<td>-.10**</td>
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<td>.21***</td>
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* p<.05, ** p<.01, *** p<.001
Partial correlations between the sub-factors of the Big 5 and the MBTI dimensions, controlling for gender and age, are also presented in Table 4.2.1. EI was most highly correlated with Gregariousness (r = .67, p < .001), Warmth (R = .68, p < .001) and Positive emotions (r = .50, p < .001). SN was most highly correlated with Ideas (r = -.56, p < .001), Fantasy (r = -.53, p < .001) and Aesthetics (r = -.45, p < .001). TF was most highly correlated with Tender-mindedness (r = -.42, p < .001), Altruism (r = -.27, p < .001) and Trust (r = -.27, p < .001). JP was most highly correlated with Order (r = .50, p < .001), Deliberation (r = .44, p < .001) and Self-discipline (r = .32, p < .001). The highest correlations between the Neuroticism sub-factors and the MBTI dimensions were with Self-consciousness (r = -.44, p < .001), Depression (r = -.34, p < .001) and Vulnerability (r = -.29, p < .001), all of which are sub-factors of EI.

4.2.4. Discussion

The aim of this paper was to investigate the relationship between two well-established personality tests, the NEO PI-R and the MBTI. It was hypothesized that, in line with previous research (McCrae & Costa, 1989; McDonald et al., 1994), Extraversion would correlate with EI (H1), Openness with SN (H2), Agreeableness with TF (H3) and Conscientiousness with JP (H4). The results clearly supported all of these hypotheses, although the observed correlations were of a small magnitude. Neuroticism was also correlated with EI, a finding that has been reported previously by Furnham (1996a), although this correlation was smaller in magnitude compared to the other correlations.

These results demonstrate an overlap between the two personality measures, which can be better understood by looking at the correlations between the sub-factors of the Big 5
and the MBTI factors. The greatest overlap, as measured by the size of the correlations, is between Extraversion and MBTI Extraversion-Introversion, which is not surprising, as there is clearly considerable theoretical overlap between these factors (McCrae & Costa, 1989). More specifically, the sub-factors that most highly correlated with EI were Gregariousness, Warmth, and Positive emotions. The same sub-factors were reported by Furnham (1996a) as having the highest correlations with EI.

Openness to experience was negatively correlated with Sensing and positively correlated with Intuition. Sensing involves directly receiving information through the senses while Intuition involves going beyond the information provided by the senses in order to discover possibilities that may not be immediately obvious. When looking at the sub-factors of Openness, which most highly correlated with SN, the reason why these factors overlap is more apparent. The highest correlations were between SN and Ideas, Fantasy and Aesthetics, which measure whether a person is insightful, inventive, curious, original, imaginative, complicated and versatile, among other things, which logically would be characteristics of an Intuitive person. It should also be noted that the same sub-factors were found to have the highest correlations with SN in Furnham’s study (1996a).

Agreeableness was negatively correlated with Thinking and positively correlated with Feeling. Thinking people approach life in a rational, analytical way, searching for logical relationships and analyzing information by the strict principles of cause and effect, whereas Feeling people are more concerned with what they feel about a person or an event rather than what they can learn about it through logical analysis. The Agreeableness sub-factors, which most highly correlated with TF, were Tender-mindedness, Trust and Altruism, replicating Furnham’s (1996a) findings. These are characteristics of people
who are among other things sympathetic, warm, soft-hearted, kind, forgiving, trusting, peacable, and tolerant. It is therefore not surprising that Agreeable people tend to be Feeling.

Conscientiousness was positively correlated with Judging and negatively correlated with Perceiving. Judging is the process of coming to a conclusion about something whereas Perceiving is the process of becoming aware of something. Again, the overlap between these factors is better understood by looking at the correlations between the sub-factors and JP. The Conscientiousness sub-factors, which most highly correlated with JP, were Order, Deliberation and Self discipline, in accordance with Furnham (1996a). These are characteristics of people who are organized, thorough, methodical, industrious, who are not hasty or impulsive. It is therefore expected that Conscientious people would not simply take in information (Perceiving), but would process that information in order to reach to a conclusion (Judging).

Neuroticism was negatively correlated with MBTI Extraversion and positively correlated with Introversion, although this correlation was not very high in comparison to the other correlations. The Neuroticism sub-factors that were most highly correlated with EI were Self-consciousness, Depression and Anxiety. These results are very similar to Furnham's (1996a), who found Self-consciousness, Depression and Vulnerability to have the highest correlations with Neuroticism. These sub-factors represent people who are among other things shy, inhibited, anxious, moody, fearful, and who lack confidence. These characteristics in logic relate more to people whose mental processes are directed towards the inner world i.e. Introverts. The correlations between the Big 5 sub-factors and the MBTI factors clearly follow the pattern reported by Furnham (1996a).
This study is a replication of McCrae and Costa (1989), of McDonald et al. (1994) and of Furnham's (1996a) studies, attesting to the significant overlap between the NEO PI-R and the MBTI by using a large sample. It is therefore apparent that two of the most prominent personality inventories have a very similar underlying structure, despite the fact that they consist of different questions and have a different response format. This finding therefore provides grounds for optimism, in investigations for a unified theory of the structure of personality.

The extent of the overlap between the MBTI and the NEO PI-R does not necessarily mean, however, that the MBTI should be reinterpreted in terms of the FFM. The most important implication of this finding is that research that has been conducted on areas of overlap on the two tests separately, can be joined to provide a more comprehensive picture of how personality is related to these areas. The present study can thus be used in the investigation of the relationship between intelligence and Jung's personality types, by linking findings on the relationship between intelligence and the Big 5 to how the Big 5 are related to Jung's personality types.
4.3. Study 7

4.3.1. Introduction

The present study is an investigation of the extent to which Jung’s personality types (Jung, 1921) are related to psychometric intelligence. Most studies investigating the relationship between personality and intelligence have focused on measures of intelligence in relation to the personality factors of the Five Factor Model (FFM), proposed by McCrae and Costa (1987). However, although the FFM is perhaps the most prominent model within in the academic research area, the test that is mostly used in the applied field of counseling and management training, is the Myers-Briggs Type Indicator (Myers, 1962), which is measure of Jung’s personality types (Devito, 1985; Kennedy & Kennedy, 2004). This study will therefore investigate the relationship between intelligence and Jung’s Personality types, in order to extent the knowledge of how the constructs of personality and intelligence are interrelated.

There are various personality tests that are based on Jung’s theory of personality types, two of which are the Myers-Briggs Type Indicator (MBTI) (Myers, 1962), and the Jung Type Indicator (JTI) (Budd, 1993b). Both of these were developed to measure the four personality dimensions, which were proposed by Jung in his theory of personality types. These dimensions are Extraversion-Introversion (EI), Sensing-Intuition (SN), Thinking-Feeling (TF) and Judgment-Perception (JP). The sub-scales of the JTI correlate with the corresponding sub-scales of the MBTI by correlation coefficients ranging from .93 to 1 in absolute value (Budd, 1993b). Based on the extent of their overlap, it is assumed that findings of Study 6, on the relationship between the NEO PI-R and the MBTI, can also be applied to the relationship between the NEO PI-R and the JTI.
The overlap of the MBTI dimensions and the Big 5 factors, was first observed by McCrae and Costa (1989), who argued that the overlap is of such an extent, that the MBTI could be reinterpreted from the perspective of the FFM. More specifically, they found that EI was correlated with Extraversion, SN with Openness, TF with Agreeableness and JP with Conscientiousness. These findings were replicated by McDonald et al. (1994) and Furnham (1996a) further found Neuroticism to be negatively correlated to both EI and TF. Due to the high overlap between the two measures, hypotheses made here on the relationship between Jung's personality types and intelligence, will be based on findings of the relationship between the Big 5 and intelligence, as research on the relationship between intelligence and Jung's personality types is scarce.

The major findings on the relationship between intelligence and the Big 5 factors of personality are that intelligence is positively correlated with Openness to Experience (Brand, 1994; McCrae, 1994; Ackerman & Heggestad, 1997; Zeidner & Matthews, 2000; Austin et al., 2002; Chamorro-Premuzic et al., under review), negatively correlated with Neuroticism (Ackerman & Heggestad, 1997; Kylänen, 1997; Furnham et al., 1998a; Zeidner & Matthews, 2000) and Conscientiousness (Demetriou, et al., 2003; Furnham et al., in press) and correlated with Extraversion, the sign of the correlation depending on the testing conditions (Lynn et al., 1982; Ackerman & Heggestad 1997; Furnham et al., 1998a; Austin et al., 2002).

The studies that have investigated the relationship between Jung’s personality types and intelligence have mostly used the MBTI instrument (Schurr et al., 1988; Schurr et al., 1989; Schurr et al., 1994; Kaufman et al., 1996). The most consistent finding in this literature is that intelligence is positively correlated with the SN dimension. Myers and
McCaulley (1985) reported that students who scored higher on the Intuition pole, also tended to score higher on the California Test of Mental Maturity and on the Scholastic Aptitude Test-Verbal (SAT-V). This finding was supported by Kaufman et al. (1996) and, who found that individuals who scored higher on the Intuition pole, also tended to score higher on measures of general intelligence, and was also replicated in Study 1.

The other dimension that has been related to intelligence is JP, although researchers have not concluded on how precisely they are related. Myers and McCaulley (1985) proposed that Perceiving types average somewhat higher on intelligence tests than Judging types, whereas Judging types average somewhat higher in academic achievement (grades). Kaufman et al. (1996) argued that individuals at both poles are especially equipped to score highly on intelligence tests, as Judging individuals are concerned with decision making, planning and organizing, and Perceiving individuals are curious, adaptable and open to new events, characteristics which are related to intelligence. However, Study 1 showed that g was negatively correlated with Judgment whilst positively correlated with Perception.

Of the MBTI dimensions, those that have been found to be the least related to intelligence are TF and EI. Kaufman et al. (1996) reported no significant differences between the Thinking and the Feeling poles, and Study 1 found that although Thinking was negatively correlated with g, it was not a significant predictor of it. With respect to the EI dimension, Kaufman et al. (1996) found no significant correlations with intelligence. However, Study 1 found Extraversion to be negatively correlated, and a significant negative predictor of g. Similarly, Myers and McCaulley (1985) found that Introverts
show greater academic aptitude (which is highly correlated with intelligence; Elshout & Veenman, 1992), due to their capacity to deal intensively with concepts and ideas.

The aim of this study is to investigate the relationship between intelligence and personality, as measured by Jung’s personality types. In order to obtain a more comprehensive picture, four measures of intelligence will be used (general intelligence, numerical, verbal and abstract reasoning), which will be related to Jung’s personality types as measured by the Jung Type Indicator. Gender and age will be controlled for in the statistical analysis, in order to take into account their effect on intelligence. The general consensus on the effect of age on intelligence is that there is a decline of intelligence scores with age, with fluid intelligence peaking around the age of 17 and crystallized intelligence peaking around the age of 50 (Ryan et al., 2000). The general consensus on sex differences in intelligence is that although males do not differ from females on measures of general intelligence (APA Public Affairs Office, 1997), males tend to score higher on tests measuring visuo-spatial and mathematical ability, whereas females tend to score higher on tests measuring verbal ability (Maccoby & Jacklin, 1978; Hyde & Linn, 1988; Voyer et al., 1995).

Hypotheses are based on previous findings on the relationship between Jung’s personality dimensions with intelligence, in combination with findings on the relationship between the Big 5 factors and intelligence, by considering how the Big 5 are linked to the JTI dimensions. The first hypothesis (H1) is that SN will be significantly correlated with general intelligence (g) and with verbal reasoning. This would support the finding that SN is positively correlated with g (Kaufman et al., 1996) in line with Study 1, and also the finding that Openness (which is positively correlated with SN) is specifically
correlated with crystallized intelligence (Brand, 1994; Geoff & Ackerman, 1992; Kyllonen, 1997). The second hypothesis (H2) is that JP will be significantly correlated with g. This would support the finding that Judgment is negatively, and Perception is positively correlated with g (Study 1), and the finding that Conscientiousness (which is positively correlated with Judgment) is negatively correlated with g (Demetriou et al., 2003; Furnham et al., in press).

4.3.2. Method

Participants

A total of 4758 participants were recruited for this study. In the statistical analysis of the IQ measures, participants who scored 3 or below (out of 35) on any IQ test were excluded from the analysis. This meant that in total 4547 participants were included, of which 3720 were male and 819 were female (8 did not specify their gender). Their age ranged from 21 to 63 with a mean of 35.56 and a standard deviation of 8.36.

Materials

The General Reasoning Test Battery (GRT2) (Budd, 1993a). See Study 2 (section 2.2.2).

Jung Type Indicator (JTI) (Budd, 1993b). This is an un-timed questionnaire, taking approximately 10 minutes to complete, assessing a person's psychological type, using the categories first proposed by Jung (1921). These categories are Extraversion vs. Introversion (EI\(^7\)), Thinking vs. Feeling (TF), Sensing vs. Intuiting (SN), and Judging vs. Perceiving (JP). The JTI technical manual provides evidence for the test's reliability and validity (Budd, 1993b). JTI subscales were found to have a high level of reliability across

\(^{7}\) High score on EI indicates high Introversion whereas low score indicates high Extraversion, similarly for SN, TF, JP
a number of different samples, ranging from psychology and business undergraduates to technician applicants and personnel professionals, with Alpha coefficients ranging from .81 to .87. JTI subscales also demonstrate high levels of test-retest reliability, with coefficients ranging from .79 to .92 after a three-month period. Validity of the JTI has been assessed by correlating the JTI and the MBTI subscales, which yielded corrected correlation coefficients ranging from .93 to 1 in absolute value.

Procedure

Participants were all job applicants tested by Psytech International as part of an assessment center exercise.

4.3.3. Results

A measure of general intelligence was computed, by performing principal component analysis on the three intelligence measures. This yielded one factor (g), with loadings of .87 (numerical reasoning), .84 (abstract reasoning) and .83 (verbal reasoning).

Correlations: In order to investigate the relationship between personality and intelligence, Pearson product moment correlations were computed between measures of intelligence and personality dimensions. Due to the large sample size, the .001 significance level was adopted, to diminish the probability of making a Type I error. Correlations were also computed on intelligence measures and demographic factors (gender and age). The majority of these correlations were significant, therefore, partial correlations were also computed between intelligence measures and personality dimensions, controlling for demographic factors. These Pearson product moment and partial correlation coefficients are presented in Table 4.3.1.
Table 4.3.1: Pearson product moment and partial correlations between intelligence measures, personality and demographic factors

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*p<.001

Regressions: A series of multiple regressions were performed in order to investigate the relationship between intelligence and personality, gender and age. The dependent variables were $g$, NR, VR and AR. The same independent variables were used in all regression models: the four dimensions of the JTI, gender (coded 1 for male and 2 for female), and age. Again the .001 level was adopted, as a more appropriate significance level.

General intelligence ($g$): The first model, which used $g$ as the dependent variable, was significant ($F (6, 4532) = 122.53, p < .001$) with Adj. $R^2 = .14$. Significant predictors of general intelligence were El, TF (-), JP, sex (-) and age (-).

Numerical reasoning (NR): The model that used NR as the dependent variable was significant ($F (6, 4532) = 80.48, p < .001$) with Adj. $R^2 = .10$. Significant predictors of NR were El, TF (-), JP, sex (-) and age (-).

Verbal reasoning (VR): The model that used VR as the dependent variable was significant ($F (6, 4532) = 65.99, p < .001$) with Adj. $R^2 = .08$. Significant predictors of VR were El, SN, TF (-), JP and age (-).
Abstract reasoning (AR): The model that used AR as the dependent variable was significant ($F(6, 4532) = 172.25, p < .001$) with Adj. $R^2 = .19$. Significant predictors of AR were EI, TF (-), JP, sex (-) and age (-).

The $\beta$ coefficients and their corresponding $t$ values for these regression models are presented in Table 4.3.2.

Table 4.3.2: $\beta$ values for multiple regression coefficients on intelligence measures

<table>
<thead>
<tr>
<th></th>
<th>$g$ $\beta$</th>
<th>$t$</th>
<th>$NR$ $\beta$</th>
<th>$t$</th>
<th>$VR$ $\beta$</th>
<th>$t$</th>
<th>$AR$ $\beta$</th>
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<tbody>
<tr>
<td>EI</td>
<td>.12</td>
<td>8.49*</td>
<td>.10</td>
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<td>.11</td>
<td>7.13*</td>
<td>.10</td>
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<tr>
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<td>.04</td>
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<td>- .03</td>
<td>-1.72</td>
<td>.09</td>
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<tr>
<td>TF</td>
<td>-.17</td>
<td>-11.14*</td>
<td>-.16</td>
<td>-9.94*</td>
<td>-.12</td>
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<td>12.49*</td>
<td>.19</td>
<td>11.50*</td>
<td>.15</td>
<td>10.14*</td>
</tr>
<tr>
<td>Gender</td>
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<td>-3.64*</td>
<td>-.12</td>
<td>-8.04*</td>
<td>.04</td>
<td>2.61</td>
<td>-.05</td>
<td>-3.54*</td>
</tr>
<tr>
<td>Age</td>
<td>-.26</td>
<td>-18.11*</td>
<td>-.13</td>
<td>-8.73*</td>
<td>-.15</td>
<td>-10.23*</td>
<td>-.38</td>
<td>-27.21*</td>
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<tr>
<td>Regression model</td>
<td>$F(6,4532)=122.53*$</td>
<td>$F(6,4532)=80.48*$</td>
<td>$F(6,4532)=65.99*$</td>
<td>$F(6,4532)=175.25*$</td>
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<tr>
<td>Adj. $R^2$</td>
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<td>.08</td>
<td>.19</td>
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</tbody>
</table>

4.3.4. Discussion

The aim of this study was to investigate the relationship between Jung's personality dimensions and psychometric intelligence. Together, personality dimensions and demographic factors accounted for 14% of the variance in $g$, and between 8% and 19% of the variance in specific abilities. A series of hypotheses were tested, investigating the individual contribution of specific variables.

The first hypothesis (H1), which was that SN would be significantly correlated with verbal reasoning and with $g$, was supported by the results, although the size of the correlation was modest. The finding that SN was correlated with $g$, supports previous studies, which found that individuals who scored higher on the Intuition pole also tended...
to score higher on measures of general intelligence (Schurr et al., 1988; Kaufman et al., 1996). This finding, which was also reported in Study 1, indicates that individuals higher on g tend to go beyond the information provided by their senses, to discover possibilities that may not be directly obvious from sensory data (Intuition). One possible explanation for this is that g is required in order to understand relationships that are not directly evident. This implies that g leads to the development of Intuition. Evidence for this suggestion can also be found by looking at how SN is related to Openness, and how Openness is in turn related to g.

Several studies have shown that Openness is positively correlated Intuition, and negatively correlated with Sensing (McCrae & Costa, 1989; McDonald et al., 1994; Furnham, 1996). Study 6 revealed that of the sub-factors of Openness, the one that most highly correlates with the SN dimension is Ideas. This is also the sub-factor that most highly correlates with g (see Study 4). Ideas refers to intellectual curiosity, and is related to an active pursuit of intellectual interests, to open-mindedness and a willingness to consider new, perhaps unconventional ideas. What is therefore proposed is that it is individuals with high g who will be open-minded, and who will go beyond the information provided by their senses to discover underlying relationships, as they are the ones who have the ability to do this efficiently. The difficulty with exploring this idea further is that longitudinal studies would be essential in order to test a causal relationship between Openness and g, and most importantly g should be measured prior to the full development of personality characteristics, which would be very difficult at such an early age.
It can further be argued that individuals who actively pursue intellectual interests will thus develop their crystallized intelligence. This suggestion was also supported by the results, as SN was positively correlated with, and a significant predictor of verbal reasoning. The present findings therefore support the argument that Openness correlates with crystallized intelligence (Geoff & Ackerman, 1992; Brand, 1994, Kyllonen, 1997), but not that it specifically and exclusively correlates with it, as SN was also correlated with g. Therefore, the present results are also in line with Austin et al. (2002), with Chamorro-Premuzic et al. (under review), and with Study 1, which reported significant correlations between Openness and g.

The second hypothesis (H2), which was that JP would be significantly correlated with g, was supported by the results, in line with Study 1. JP was further positively correlated with, and a significant predictor of all intelligence measures, although the size of the correlation and the Beta coefficient was small. This finding indicates that individuals high on g tend to directly perceive information (Perceiving) instead of being concerned with organizing it (Judging). This relationship can be more easily comprehended by looking at the relationships of JP with Conscientiousness, and Conscientiousness with g. Study 6 showed that in line with previous studies (McCrae & Costa, 1989; McDonald et al., 1994; Furnham, 1996a), Conscientiousness was positively correlated with Judging and negatively correlated with Perceiving.

Study 6 further showed that of the sub-factors of Conscientiousness, the one that most highly correlates with JP is Order. This is also the sub-factor that most highly (negatively) correlates with g (see Study 4). Order refers to being organized, thorough, efficient, precise and methodical. It has been proposed that individuals low on g may
develop these characteristics of Conscientiousness, in order to cope efficiently with circumstances in which individuals high on g would be able to cope with, simply by relying on their intelligence. By the same line of reasoning, individuals high on g may not develop these characteristics of Conscientiousness as they are able to accomplish most tasks without them. This implies that g may affect the development of Conscientiousness in a competitive environment. Here the finding that individuals high on g tend to directly perceive information instead of organizing it, can also be explained in that they may not organize the information simply because they have the ability to comprehend and deal with it without having to organize it first.

The remaining two JTI personality dimensions (TF and EI) were also found to be related to intelligence, although the sizes of these correlations were modest. TF was negatively correlated with g, NR and AR, and it was further a significant predictor of all intelligence measures. This indicates that individuals high on g tend to logically analyze information in terms of the strict principles of cause and effect instead of identifying the emotional value that is attached to objects or events. This finding is odd considering that TF is most highly correlated with Agreeableness out of the Big 5 dimensions (McCrae & Costa, 1989; McDonald et al., 1994), and the fact that no relationship has been observed between Agreeableness and intelligence (Ackerman & Heggestad, 1997). However, it has been proposed that TF also correlates positively with Neuroticism (Furnham, 1996a), and Neuroticism has often been correlated (negatively) with measures of intelligence (Ackerman & Heggestad, 1997; Kyllonen, 1997; Furnham, et al. 1998; Zeidner & Matthews, 2000). It may therefore be the case that Thinking individuals tend to score
more highly on intelligence tests as they consider less the emotional value that is attached to events, which means that they are more emotionally stable and therefore less Neurotic.

Finally EI was significantly correlated with all intelligence measures, when sex and age were controlled for, and was also a significant predictor of these. This indicates that individuals, whose mental orientation is towards the internal world instead of the external, tend to score higher on intelligence tests. A relationship has often been reported between Big 5 Extraversion, which highly correlates with EI (McCrae & Costa, 1989; McDonald et al., 1994), and measures of intelligence. However, it has been proposed that Extraversion actually correlates with intelligence test performance instead of intelligence per se (Revelle et al., 1976; Robinson, 1985). This is because the resting level of cortical arousal is higher for Introverts than for Extraverts (Eysenck & Eysenck, 1985). Consequently, Extraverts tend to perform better on speeded tasks, which invoke arousal (Rawlings & Carnie, 1989) whereas Introverts tend to perform better on tasks requiring insight and reflection (Matthews, 1992). However, the GRT2 can be considered more as a speeded task than one requiring insight and reflection, as participants have to respond to 85 items in 28 minutes. It would therefore be expected that Extraverts should outperform Introverts on this test, however results were in the opposite direction. Future studies could examine whether there is indeed a difference in the resting levels of cortical arousal of Extraverts and Introverts as measured by the JTI. If this is not the case, the present results could be explained in that individuals whose mental processes are directed towards the internal world may have a better ability to concentrate while taking the test and therefore perform better.
In summary, when sex and age were controlled for, all of the JTI dimensions were significantly correlated with g. Together the JTI dimensions and demographic variables accounted for 14% of the variance in g. Investigation of the relationship between personality dimensions and specific intellectual abilities revealed that although some dimensions were significantly correlated with all the measures of intelligence when demographic factors were controlled for (EI and JP), other dimensions differentially correlated with them (e.g. TF significantly correlated with NR and AR, but not with VR). This indicates the importance of separately looking at how personality dimensions correlate with gf and gc, in line with the suggestion that different mechanisms may have lead to the development of these relationships (see Study 5).

The present findings contribute to research in two ways. Firstly they attest to the robustness of the findings on the relationship between intelligence and personality, as it is obvious that no matter how we measure both traits, and even though the correlations are modest, the same pattern is apparent. Secondly, the present study extends previous research on personality and intelligence, which has mostly focused on the Big 5 personality factors, and reveals how Jung’s personality dimensions, are related to general intelligence and to specific mental abilities. This is of special interest for occupational psychologists, as Jung’s personality types are very frequently used for selection, training and promotion purposes. Therefore an understanding of the underlying relationship between them can be used to improve their predictive validity.
4.4. Study 8

4.4.1. Introduction

The aim of this study was to investigate the relationship between fluid intelligence and personality, as measured by three less well researched, but nevertheless extensively used, personality inventories, the Myers-Briggs Type Indicator (MBTI), the Fundamental Interpersonal Relations Orientation-Behaviour Scale (FIRO-B) and the California Psychological Inventory-434 (CPI-434). The relationship between the MBTI and gf will be investigated in order to replicate the findings of Study 7, which used a less well-researched measure of Jung's personality types (the JTI).

The relationship between the FIRO-B and the CPI-434 dimensions and gf will be investigated for two reasons. Firstly these are inventories commonly used in occupational settings, and therefore related findings will have applicability in the occupational field apart from contributing to knowledge. Secondly this investigation will extend previous research, which looked at intelligence in relation to the Five-Factor Model, by looking at personality as understood by folk concepts (measured by the CPI-434) and also as behaviour in three interpersonal areas (measured by the FIRO-B). This would therefore indicate which findings are robust, by revealing whether areas of overlap between the tests yield the same findings, and it would also reveal if there are aspects of the relationship between personality and intelligence, which have been overlooked by research focusing on the Big 5. Due to the fact that research investigating the interface between intelligence and personality as measured by these inventories is scarce, previous findings on the Big 5, will form the basis of the hypotheses, in the cases where factors of these inventories overlap with the Big 5 factors. Previous findings on the relationship
between gf, gc and the Big 5, which have been summarized in section 4.3.1, are pictorially represented in Figure 4.4.1.

Figure 4.4.1: Model depicting relationships between fluid and crystallized intelligence and the Big 5 personality factors

Myers-Briggs Type Indicator (MBTI)

Researchers have looked to an extent at how the dimensions of Jung’s (1921) theory of psychological types, measured by the Myers-Briggs Type Indicator (Myers & McCaulley, 1985), correlate with intelligence. The MBTI measures four internally consistent personality dimensions, Judging-Perceiving (JP), Sensing-Intuition (SN), Thinking-Feeling (TF) and Extraversion-Introversion (EI) (Myers & McCaulley, 1985).
Studies have shown that there is a considerable amount of overlap between the MBTI dimensions and the Big 5 factors (McCrae & Costa, 1989; McDonald et al., 1994; Furnham, 1996a). More specifically, NEO Extraversion has been found to correlate with MBTI Extraversion positively and Introversion negatively (|.58|<r<|.74|), Openness with Sensing negatively and Intuition positively (|.52|<r<|.72|), Conscientiousness with Judging positively and Perceiving negatively (|.41|<r<|.62|) and Agreeableness with Thinking positively and Feeling negatively (|.28|<r<|.60|) (see Study 6, Table 4.2.1).

The most consistent finding, within the research of the relationship between intelligence and the MBTI dimensions, is that Sensing is negatively, and Intuition positively correlated with general intelligence (Myers & McCaulley, 1985; Kaufman et al., 1996). This is in line with the finding that Openness, which is negatively correlated with Sensing and positively with Intuition (Furnham, 1996a), is positively correlated with intelligence (Ackerman & Heggestad, 1997). With respect to the Judging-Perceiving dimension, Myers and McCaulley (1985) proposed that Perceiving types average somewhat higher on intelligence tests than Judging types, a finding which was supported in Study 1. This is in line with the finding that Conscientiousness, which is positively correlated with Judging and negatively with Perceiving (Furnham, 1996a), is negatively correlated with intelligence (Furnham et al., in press).

With respect to the Extraversion-Introversion dimension the findings have been contradictory, with reports of both positive and negative correlations between measures of intelligence and the EI dimension (Kaufman et al., 1996; see also Study 1 and 7). These contradictory results have also been observed between intelligence and Extraversion factor of the Five Factor Model, which positively correlates with MBTI
Extraversion and negatively with MBTI Introversion (Furnham, 1996a). Finally, although Kaufman (1996) did not find a significant correlation between the Thinking-Feeling dimension and intelligence, this dimension was found to be negatively correlated with intelligence in Study 7. This however does not correspond to the finding that the Thinking-Feeling dimension is correlated with Agreeableness (Furnham, 1996a), which is not related to intelligence (Ackerman & Heggestad, 1997).

The hypotheses tested in this study are based on the findings of Kaufman et al. (1996) and on the findings of Study 1 and 7. The first hypothesis (H1) is that gf will be positively correlated with Intuition and negatively correlated with Sensing. The second hypothesis (H2) is that gf will negatively correlate with Judging and positively correlate with Perceiving. Finally, the third hypothesis (H3) is that gf will correlate with Extraversion and Introversion. The direction of these relationships is not specified, due to the contradictory findings obtained on measures of Extraversion so far (Lynn et al., 1982; Ackerman & Heggestad 1997; Furnham et al., 1998a; Austin et al., 2002).

Fundamental Interpersonal Relations Orientation-Behaviour Scale (FIRO-B)

The FIRO-B was developed based on the assumption that all human interaction can be divided into three categories: issues related to Inclusion, issues related to Control and issues related to Affection. Inclusion is the individual’s need to maintain a relationship with other people, Control is the need to maintain a balance of power and influence in relationships, and Affection is the need to form close personal relationships with others (Furnham, 1996b). Within each of these categories there are two directions of behaviour, what the individual expresses to others, and what the individual wants from others.
Various studies have examined the concurrent validity of the FIRO-B, which relates logically and consistently with the Big Five (Furnham, 1996b).

Researchers appear not to have yet looked at how the FIRO-B dimensions relate to intelligence. However hypotheses may be encountered, based on how the manual describes the FIRO-B dimensions, and on how the FIRO-B dimensions correlate with the Big 5 factors. Inclusion and Control could both theoretically be expected to relate to intelligence. An individual high on Inclusion has a strong desire for contact with people, regardless of who initiates it, whereas an individual low on Inclusion prefers aloneness, and is described as “undersocial...introverted and withdrawn” (Schütz, 1978, page 13). This scale can therefore be theoretically linked to Extraversion, and indeed Furnham (1996b) found Inclusion to be significantly correlated with Extraversion of the Five-Factor Model. The Inclusion scale has further been linked to Extraversion as measured by the MBTI. Therefore, the fourth hypothesis (H4) is that Inclusion will be correlated with gf, the sign of the correlation again not being specified a priori.

The other FIRO-B measure which can be expected to be correlated with gf is Control, as a high score indicates a desire for structure, and a preference for giving and taking orders. Furthermore, an individual high on Expressed Control is believed to “try to attain intellectual or athletic superiority” (Schutz, 1978, page 14). Therefore the fifth hypothesis (H5) is that Control will be positively correlated with gf. This is because individuals with low gf are expected to be less likely to try to attain intellectual superiority than individuals high on gf, because they would be less successful. This implies that gc, which is attained intelligence, should also be correlated with Expressed Control. Furthermore, it is more likely that individuals high on gf, who have better reasoning and are better at
approaching problems (Brody, 1992), to have a preference for giving orders than
individuals low on gf.

California Psychological Inventory-434 (CPI-434)

The CPI-434 is a multi-scale personality inventory, assessing 20 “folk concepts” of
personality, which possess broad personal and social relevance. Each scale is designed to
forecast what a person will say or do under defined conditions (Gough & Cook, 1997).
These scales are Dominance, Capacity for Status, Sociability, Social Presence, Self-
Acceptance, Independence, Empathy, Responsibility, Socialization, Self-Control, Good
Impression, Communality, Well-Being, Tolerance, Achievement via Conformance,
Achievement via Independence, Intellectual Efficiency, Psychological Mindedness,
Flexibility and Femininity/Masculinity.

The folk concept scales of the CPI-434 have not been investigated in relation to
intelligence, apart from a report by Gough and Cook (1997), who suggested that the CPI-
434 scales do not correlate to any appreciable extent with the full scale of the Wechsler
Adult Intelligence Scale. However, their sample of females was too small (N = 27) and
although their sample of males was N = 158, they do not report probabilities for the
correlations, and some were as high as .25 and .26. Therefore, several hypotheses are
made with respect to the relationship between the CPI-434 scales and gf, based on their
meaning, as described in the CPI-434 manual (Gough & Cook, 1997).

The sixth hypothesis (H6) is that Intellectual Efficiency will be positively correlated with
gf. Individuals high on Intellectual Efficiency are described as “efficient in use of
intellectual abilities; can keep on at a task where others might get bored or discouraged”.
Intellectual efficiency can therefore be conceived as a self-estimation of intelligence, and
self-estimations of intelligence have been consistently found to correlate with psychometric intelligence by about $r = .30$ (Reilly & Mulhern, 1995; Paulhus et al., 1998; Furnham & Rawles, 1999; Furnham et al., 2001).

The seventh hypothesis (H7) is that Achievement via Independence will be positively correlated with gf. High scorers on this scale are described as having "strong drive to do well, [like] to work in settings that encourage freedom and individual initiative" (Gough & Cook, 1997, p. 75). It is therefore expected that it would be individuals high on gf who would enjoy working in such settings, due to their ability to cope with novel circumstances, whereas individuals low on gf would be expected to be discouraged and prefer to work in settings where individual initiative would not be required.

The CPI-434 also measures three structural scales, which have been partly derived by factor analysis of the 20 folk concepts. The first scale is Intenmality, is described as internal orientation, or introversion, and has been found to highly negatively correlate with Extraversion, as measured by the Eysenck Maudsley Personality Inventory and by the Myers-Briggs Type Indicator (Gough & Cook, 1997). The second structural scale is Norm-Acceptance, otherwise called 'adjustment by social conformity', is described by self-control, disciplined effectiveness and personal integrity, and has been found to highly positively correlate with Conscientiousness (McCrae, Costa & Piedmont, 1993; Gough & Cook, 1997). The third structural scale is Sense of Realization, which registers the sense of personal attainment, and has been (moderately) negatively linked to Neuroticism (McCrae et al., 1993). The CPI-434 manual reports satisfactory levels of reliability and validity of the test (Gough & Cook, 1997).
The final two hypotheses are related to the two structural scales of the CPI-434, which show a clearer overlap with the Big 5. Therefore the eighth hypothesis (H8) is that Internality, which corresponds to Extraversion, will be correlated with gf, the direction of the relationship again not being specified. Finally, the ninth hypothesis (H9) is that Norm-favouring, which is highly correlated with Conscientiousness, will be negatively correlated with gf.

The hypotheses are graphically represented in Figure 4.4.2, showing whether the expected relationship is between the personality factors and actual fluid intelligence or with performance on the IQ test. The Figure also shows which hypotheses were based on previous findings of the relationship between the Big 5 and gf.
Figure 4.4.2: Model representing hypotheses

Arrows represent causality merely on a theoretical basis
4.4.2. Method

Participants

A total of 383 participants were recruited for this study. Of these, 46 were female and 320 were male, the remainder did not specify their gender. Their age ranged from 19 to 66, with a mean of 38.14 and a standard deviation of 9.59.

Materials

*Raven's Advanced Progressive Matrices (APM)* (Raven, Raven & Court, 1998). This is a 36-item, timed (40 minutes) ability test, measuring eductive ability. Each of the items consists of a box that contains one or several figures, which are related by specific rules. An area of the box is missing and participants have to distinguish the missing part among five or seven similar figures, by deducing the rules of each box. The 36 items are arranged in increasing order of difficulty. The manual reports that studies on a wide range of age groups, cultural groups and clinical as well as normal populations, provide abundant evidence for the test's reliability (Alpha coefficient = .91) and validity (Raven et al., 1998).

*Myers-Briggs Type Indicator (MBTI)* (Myers & McCauley, 1985). See Study 1 (section 2.1.2).

*The Fundamental Interpersonal Relations Orientation Behaviour scale (FIRO-B)* (Schutz, 1978). This is a 54-item un-timed questionnaire measuring three interpersonal areas (inclusion, control and affection) in two directions of behaviour (expressed and wanted). It therefore yields scores on six scales, namely Expressed Inclusion, Wanted Inclusion, Expressed Control, Wanted Control, Expressed Affection and Wanted
Affection, and three scores on the interpersonal categories of Inclusion, Control and Affection. Each item on the questionnaire is measured on a six point Likert scale. The manual reports good measures of reliability (Alpha coefficients ranging from .90 to .94) and validity of the test (Schutz, 1978).

*California Psychological Inventory-434 (CPI-434)* (*Gough & Cook, 1997*). This is a 434-item un-timed questionnaire measuring 20 folk concept scales (Dominance, Capacity for Status, Sociability, Social Presence, Self-Acceptance, Independence, Empathy, Responsibility, Socialization, Self-Control, Good Impression, Communality, Well-Being, Tolerance, Achievement via Conformance, Achievement via Independence, Intellectual Efficiency, Psychological Mindedness, Flexibility and Femininity/Masculinity) and three structural scales (Internality, Norm-Favoring, Self-Realization). All items are statements answered by ‘true’ or ‘false’. The manual reports satisfactory levels of reliability and validity of the test (*Gough & Cook, 1997*).

**Procedure**

Participants were tested as part of a middle management development center exercise. All of the testers were trained in test administration and interpretation, to BPS Level A and B standard. The tests were administered in 3 sessions, with breaks in between to avoid any effects of fatigue.

**4.4.3. Results**

The frequency distribution of the intelligence scores was observed to investigate for any outliers. Individuals who scored 4 or below on the IQ test (2% of the participants) were
considered to be outliers, and were excluded from the statistical analysis. The frequency
distribution of the Cm scale of the CPI-434 was also observed, as the manual denotes that
scores below 27 may suggest random responding. The lowest score obtained was 26,
therefore no participants were excluded from the analysis on this basis.

Correlations: Correlations were computed between fluid intelligence, the scales of the
three personality measures (MBTI, FIRO-B and CPI-434), age, gender and level of
education. These Pearson product moment correlation coefficients are presented in Table
4.4.1. Of the MBTI dimensions, gf was significantly positively correlated with
Extraversion, Intuition and Perceiving; and negatively correlated with Introversion,
Sensing, Thinking and Judging. Of the FIRO-B dimensions, gf was significantly
positively correlated with Inclusion and Control. Of the CPI-434 dimensions, g was
significantly positively correlated with Capacity for Status, Sociability, Social Presence,
Self-Acceptance, Independence, Empathy, Responsibility, Well Being, Tolerance,
Achievement via Conformance, Achievement via Independence, Intellectual Efficiency,
Psychological Mindedness, Flexibility and Realization; and negatively correlated with
Masculinity/Femininity, Internality and Norm-favouring. Of the demographic factors, gf
was significantly negatively correlated with age.

Partial Correlations: Due to the fact that intelligence was significantly correlated with
age, correlations between intelligence and personality measures were recomputed,
partia ling out the effect of age. These partial correlations are also presented in Table
4.4.1. Of the MBTI dimensions, g was significantly positively correlated with Perceiving
and negatively with Sensing. Of the FIRO-B dimensions, g was significantly positively

9 Level of education had 5 levels (No formal equals, O' level/10th grade, BSc or equivalent, Masters or
equivalent, PhD or equivalent)
correlated with Control. Of the CPI-434 dimensions, g was significantly positively correlated with Capacity for Status, Social Presence, Self Acceptance, Independence, Empathy, Responsibility, Well Being, Tolerance, Achievement via Independence, Intellectual Efficiency, Psychological Mindedness, Flexibility and Realization; and negatively correlated with Masculinity/Femininity, Internality and Norm-favouring.

Table 4.4.1: Correlations between gf and the 8 MBTI scales, the 3 FIRO-B scales and the 23 CPI scales, age and gender, and partial correlations controlling for age

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<td>-.11</td>
</tr>
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<td>-.21**</td>
</tr>
<tr>
<td>Sociability</td>
<td>.25***</td>
<td>.11</td>
<td>-.33***</td>
</tr>
<tr>
<td>Social Presence</td>
<td>.36***</td>
<td>.27***</td>
<td>-.25***</td>
</tr>
<tr>
<td>Self-Acceptance</td>
<td>.33***</td>
<td>.25***</td>
<td>-.20**</td>
</tr>
<tr>
<td>Independence</td>
<td>.20**</td>
<td>.20**</td>
<td>-.06</td>
</tr>
<tr>
<td>Empathy</td>
<td>.32***</td>
<td>.23***</td>
<td>-.27***</td>
</tr>
<tr>
<td>Responsibility</td>
<td>.18**</td>
<td>.20**</td>
<td>-.02</td>
</tr>
<tr>
<td>Socialization</td>
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<td>.01</td>
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<tr>
<td>Self-Control</td>
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<td>-.09</td>
<td>-.00</td>
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<tr>
<td>Good Impression</td>
<td>-.03</td>
<td>-.06</td>
<td>-.07</td>
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<tr>
<td>Communality</td>
<td>.09</td>
<td>.12</td>
<td>.04</td>
</tr>
<tr>
<td>Well Being</td>
<td>.14*</td>
<td>.19**</td>
<td>.04</td>
</tr>
<tr>
<td>Tolerance</td>
<td>.24***</td>
<td>.23***</td>
<td>-.11*</td>
</tr>
<tr>
<td>Achievement via Conformance</td>
<td>.11*</td>
<td>.03</td>
<td>-.16**</td>
</tr>
<tr>
<td>Achievement via Independence</td>
<td>.36***</td>
<td>.29***</td>
<td>-.22***</td>
</tr>
<tr>
<td>Intellectual Efficiency</td>
<td>.37***</td>
<td>.35***</td>
<td>-.10</td>
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<tr>
<td>Psychological Mindedness</td>
<td>.28***</td>
<td>.25***</td>
<td>-.16**</td>
</tr>
<tr>
<td>Flexibility</td>
<td>.33***</td>
<td>.28***</td>
<td>-.20***</td>
</tr>
<tr>
<td>Femininity/Masculinity</td>
<td>-.19**</td>
<td>-.17**</td>
<td>.08</td>
</tr>
<tr>
<td>Internality (VI)</td>
<td>-.25***</td>
<td>-.17**</td>
<td>.26***</td>
</tr>
<tr>
<td>Norm-Favouring (V2)</td>
<td>-.21***</td>
<td>-.21**</td>
<td>.12*</td>
</tr>
<tr>
<td>Realization (V3)</td>
<td>.32***</td>
<td>.25***</td>
<td>-.24***</td>
</tr>
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<td>Demographic factors</td>
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<td>Age (N = 347)</td>
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<td>Gender (N = 348)</td>
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<tr>
<td>Education (N = 338)</td>
<td>.07</td>
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</table>

*p<.05, **p<.01, ***p<.001
Correlations: The differences observed between the correlations and the partial correlations seem to indicate that age is acting as a mediator variable in the relationship between gf and certain personality scales. In order to test this, correlations were also computed between the personality scales and age. These correlations are also presented in Table 4.4.1. Significant correlations were between age and Extraversion, Introversion, Judging, Perceiving, Inclusion, Capacity for Status, Sociability, Social Presence, Self-Acceptance, Empathy, Tolerance, Achievement, Conformance via Independence, Psychological Mindedness, Internality, Norm-Favouring and Realization.

Regressions: In order to further investigate the relationship between gf and personality dimensions, a series of multiple regressions were performed, using gf as the dependent variable, and the dimensions of each of the three personality tests as the independent variables. This shows the relationship between each personality dimension and gf, by taking into account the relationship between gf and the remaining dimensions of the inventory. The same regressions were also computed including age as an independent variable, to take into account its effect on gf. The Beta coefficients for these regressions are presented in Table 4.4.2.

Myers-Briggs Type Indicator

The first regression model investigated the relationship between gf and the MBTI dimensions. Due to the fact that the eight MBTI dimensions are not independent, they could not all be included as predictors in the regression model. Instead, from each of the bipolar scales, the dimension that most highly correlated with gf was included in the regression model, i.e. Extraversion, Sensing, Thinking and Perceiving. The model was significant ( \( F(4, 170) = 6.68, p<.001 \) ), with Adjusted \( R^2 = .12 \). Significant predictors of
gf were Extraversion ($\beta = .19$) and Perceiving ($\beta = .17$). When age was also included as an independent variable, the model was significant ( $F(5, 168) = 25.61, p < .001$ ), with Adjusted $R^2 = .42$. Age was the only significant predictor of gf ($\beta = -.59$).

**Fundamental Interpersonal Relations Orientation-Behaviour Scale**

The third regression model investigated the relationship between gf and the FIRO-B dimensions. The model was significant ( $F(3,343) = 6.47, p < .001$ ), with Adjusted $R^2 = .05$. Control ($\beta = .21$) was a significant predictor of gf. When age was also included as an independent variable, the model was significant ( $F(4,341) = 44.62, p < .001$ ), with Adjusted $R^2 = .34$. Significant predictors of gf were Control ($\beta = .18$) and age ($\beta = -.55$).

**California Psychological Inventory-434**

The fifth regression model investigated the relationship between gf and the CPI-434 structural scales, which have been derived mostly by factor analyzing the folk concept scales\(^\text{10}\). The folk concept scales could not be used in a regression analysis, as these scales have overlapping items and are therefore not independent. The regression model tested was significant ( $F(3,355) = 24.55, p < .001$ ), with Adjusted $R^2 = .17$. Significant predictors of gf were Internality ($\beta = -.21$), Norm-favoring ($\beta = -.18$) and Realization ($\beta = .26$). When age was also included as an independent variable, the model was significant ( $F(4,340) = 47.71, p < .001$ ), with Adjusted $R^2 = .35$. Significant predictors of gf were Internality ($\beta = -.09$), Norm-favoring ($\beta = -.11$), Realization ($\beta = .17$) and age ($\beta = -.48$).

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\(^{10}\) Factor analysis was also performed on the 20 folk concept scales, yielding 4 factors. These factors were also regressed on intelligence but did not account for a higher percentage of the variance than the structural scales did.
4.4.4. Discussion

The aim of the present study was to investigate the relationship between fluid intelligence and personality scales, measured by three personality inventories widely used within the occupational psychology field, the MBTI, the FIRO-B and the CPI-434. The main purpose was to provide consulting psychologists and human resource managers, who commonly use these personality measures along with intelligence measures, with a better understanding of how the constructs of personality and intelligence are interrelated.

Furthermore, by investigating how intelligence is linked to personality variables that are closely linked to the Big 5 factors, the robustness of previous findings on the Big 5 correlates of intelligence can be assessed.
Three hypotheses were made with regard to the relationship between the MBTI personality dimensions and gf, expecting gf to be positively correlated with Intuition (H1) and Perceiving (H2), negatively correlated with Sensing (H1) and Judging (H2), and correlated with Extraversion and Introversion (H3). The results only partly supported hypotheses H1 and H2. Although initial analysis of Pearson product moment correlations between the scales seemed to support all three hypotheses, further analysis of partiailling out age showed that results were not according to expectations.

Age was partialled out of the correlations because of its high negative correlation with fluid intelligence. This correlation indicated that fluid intelligence declines with age, which is a well-established finding within the research of intelligence (Stankov, 1994; Baltes & Lindenberger, 1997; Ryan et al., 2000; Kaufman, 2001). According to Cattell (1983), gf tends to increase up to the age of about 16 to 20 and steadily decrease thereafter. Researchers have advocated that this is because gf is associated with the central nervous system (CNS), and is therefore at its peak when the CNS is at its physiological peak (Belsky, 1990). Therefore, since the age of the sample ranged from 19 to 66, and was indeed negatively correlated with gf, partial correlations were computed between gf and the personality scales, controlling for age. Consequently, when age was partialled out of the correlations, the results showed that the only significant partial correlations were between gf and Sensing (negatively), and gf and Perceiving (positively). This implied that age acted as a mediator variable in the relationship between gf and certain personality scales, which was confirmed by the fact that these personality factors were significantly correlated with age.
The two MBTI dimensions which were significantly correlated with gf, even when age was partialled out, were those that have most consistently been found to correlate with intelligence measures in previous studies. Sensing has been repeatedly found to negatively correlate with intelligence measures (Myers & McCaulley, 1985; Kaufman, et al., 1996; see also Study 1 and 7), indicating that individuals who tend to emphasize immediate experiences and practicality tend to have lower levels of intelligence. This finding provides only partial support for H1, as Intuition was not accordingly positively correlated with gf. This indicates that individuals who tend to perceive possibilities and relationships via insight do not tend to have higher levels of intelligence. This finding is curious, because Intuitive individuals are described in the MBTI Expanded Analysis Report as “abstract, imaginative, intellectual, theoretical and original” (Saunders, 1989), and Intuition has repeatedly been found to correlate with intelligence (Myers & McCaulley, 1985; Kaufman et al., 1996). It should however be noted that this partial correlation had an associated probability of .06, therefore it just failed to reach significance, which means the lack of significance might be due to the particular sample.

Perceiving was also found to positively correlate with gf, providing however partial support for H2, because Judging was not found to be negatively correlated with gf. This finding is in line with Study 1, which reported Perceiving to be positively correlated with general intelligence, although Judging has also been negatively correlated with g, gf, and gc in Study 7. Perceiving individuals are curious, adaptable and open to new events and changes, characteristics, which as noted by Myers and McCaulley (1985), are related to intelligence. This relationship between the Perceiving dimension and intelligence would be useful in the human resource management field, because although judgers have very
beneficial characteristics for job performance like being well organized and getting the job done, perceivers tend to have high intelligence, which has been found to be the best predictor of job performance (Schmidt et al., 1988; Gottfredson, 1997; Tan & Libby, 1997; Graham, 1999).

The fourth hypothesis (H4) was regarding the Inclusion scale of the FIRO-B, expecting it to significantly correlate with gf. Although Inclusion was initially found to significantly correlate with gf, when age was partialled out the correlation was no longer significant, therefore the hypothesis was not supported. Age was again acting as a mediator variable for the relationship between Inclusion and gf. This relationship between Inclusion, gf and age is similar to that of MBTI-Extraversion with gf and age. Therefore the present finding indicates a link between Inclusion of the FIRO-B and Extraversion of the MBTI, which has also previously been reported by Gunn (1995). Wanted inclusion has further been found to correlate with Extraversion of the Five-Factor Model (Furnham, 1996b).

The fifth hypothesis (H5) was that Control would be positively correlated with gf. The results supported this hypothesis. Control was positively correlated with gf, even when age was partialled out, and it was furthermore found to be a significant predictor of gf. The interpersonal dimension of Control refers to the need to establish and maintain a satisfactory relationship with other people on aspects of control and power, and the need to attain intellectual superiority. The manual reports that high Control is associated with words such as “power, authority, dominance, influence, control, ruler, superior, officer, leader” whereas low Control is associated with words such as “rebellion, resistance, follower, anarchy, submissive” (Shutz, 1978, page 8). This finding therefore indicates that individuals who have a preference for structure, and for giving and taking orders,
tend to have higher levels of intelligence. It is suggested that this is because individuals high on gf, who are better at reasoning, at seeing relationships and approaching new problems, are more likely to try to attain intellectual superiority and to have a preference for giving orders than individuals low on gf, because they would be more successful at achieving it. This implies that gf affects the development of Control. Although causality cannot actually be claimed based on correlational analysis, there is theoretical basis to suggest it. Longitudinal studies would be needed in order to further prove or disprove this suggestion. Future studies should also investigate whether Control is related to gc, as the attempt to attain intellectual superiority is likely to lead an individual to invest in activities which will prompt the development of their gc.

The last four hypotheses were regarding the relationship of gf with the CPI-434 folk concept scales and structural scales. The sixth hypothesis (H6), which was that Intellectual Efficiency would be positively correlated with gf, was supported by the results, indicating that individuals high on gf, tend to score highly on this scale. Out of all the CPI scales, Intellectual Efficiency was actually the scale that most highly correlated with gf, not surprisingly, as individuals high on this scale are described as “efficient in use of intellectual abilities” (Gough & Cook, 1997). Intellectual efficiency can be viewed as a self-reported estimation of intellectual ability. Therefore the finding that this measure was positively correlated with intelligence is in line with previous studies, which report positive correlations between self-estimated and psychometric intelligence (Reilly & Mulhern, 1995; Paulhus et al., 1998; Furnham & Rawles, 1999; Furnham et al., 2001). This implies that people have some insight as to their intellectual abilities, although this is quite moderate. It has been suggested that this is because self-estimations of
intelligence are affected by various factors, such as gender, personality and conceptions about intelligence (Chamorro-Premuzic et al., under review).

The seventh hypothesis (H7) was supported by the results, indicating that individuals high on gf tend to get higher scores on the Achievement via Independence scale. Individuals high on this scale, have a strong drive to do well, and like to work in settings that encourage freedom and individual initiative (Gough & Cook, 1997). In order to work in such settings, one must have the ability to perform well under novel circumstances. But gf is indeed our "on-the-spot reasoning ability" (Belsky, 1990), it involves things like quick thinking, reasoning, seeing relationships and approaching new problems (Brody, 1992). It is therefore not surprising that Achievement via Independence was correlated with gf (it was actually the second highest correlate among the CPI personality factors), for it is quite unlikely that individuals who cannot cope with novel circumstances would seek them or enjoy them.

The eighth hypothesis (H8) was supported by the results, indicating that Internality would be correlated with gf. The direction of the correlation was not included in the hypothesis, due to the contradictory findings on the relationship between intelligence measures and measures of Extraversion, which are highly correlated with Internality (Gough & Cook, 1997). The direction of the correlation was found to be negative, implying that individuals low on Internality (i.e. Extraverts) tend to get higher scores on gf tests. Internality is the third measure of Extraversion used in the present study. Like the other two measures (MBTI Extraversion-Introversion and FIRO-B Inclusion), Internality was significantly correlated both with gf and with age, in directions indicating that Extraverts tend to receive higher gf scores, and Extraversion diminishes with age. However,
although age was a moderating factor in the relationship between Internality and gf, when it was partialled out of the correlation, the partial correlation still showed a significant, although decreased, relationship between Internality and gf.

Researchers have proposed that Extraversion is related to intelligence because it affects test performance, i.e. Introverts have been found to do better on problem-solving tasks that require insight and reflection, (Matthews, 1992), whereas Extraverts have been found to do better on speeded tasks (Rawlings & Carnie, 1989), supporting Eysenck and Eysenck’s (1985) arousal theory. The Raven’s Progressive Matrices test can in a sense be considered a speeded task, in that respondents have to solve 36 puzzles in 40 minutes, however, it is not a typical ‘speeded task’, like for example the Baddeley Reasoning Test (Baddeley, 1968) in which respondents have to answer 60 short questions 3 minutes. Future research could look at how different IQ tests (of different administration times, different number of items per administration time, or measuring different aspects of intelligence) correlate with measures of Extraversion, in order to clarify how Extraversion is related to test performance.

Finally, the ninth hypothesis (H9) was also supported, indicating that individuals high on gf tend to be low on Norm-Favoring. As mentioned earlier, Norm-Favoring has been found to highly correlate with Conscientiousness (Gough & Cook, 1997), which in turn has also been found to negatively correlate with intelligence (see Studies 1, 2, 4, 5). Therefore, the ‘compensation hypothesis’ (which was proposed in these Studies), which aimed at explaining the negative relationship between Conscientiousness and intelligence, could also be applied here. This implies that individuals in a competitive environment may become Norm-Favoring (otherwise called adjustment by social
conformity), and develop characteristics of self-control and disciplined effectiveness, in order to compensate for their lower gf.

There were several more significant correlations between CPI-434 scales and gf, which had not been predicted by the hypotheses. Summarizing these findings, gf was found to be related with being ambitious and independent (Capacity for Status), self-assured and spontaneous (Social Presence), with having a good opinion of ones’ self (Self-Acceptance), with being self sufficient and resourceful (Independence), understanding of other people’s feelings (Empathy), responsible and reasonable (Responsibility), optimistic about the future (Well-Being), tolerant of others’ beliefs and values (Tolerance), with being more interested in why people do what they do than in what they do (Psychological Mindedness), with being flexible and liking change and variety (Flexibility), with being decisive and rather unsentimental (low Femininity/Masculinity) and with having a sense of personal attainment (Realization).

These findings are not in line with the suggestion of Gough and Cook (1997) that the CPI-434 scales do not correlate to any appreciable extent with measures of intelligence. On the contrary 13 of the 20 folk concept scales, and all three structural scales were significantly correlated with gf, underlining the importance of investigating the relationship between personality and intelligence, as there seem to be many aspects of this relationship, which have not yet been discovered. Further research would be necessary, to investigate whether these findings are replicable, and also to provide further insight on how these relationships developed.

The present study provides further insight on how two major constructs of individual differences, personality and intelligence, are related, indicating that although the size of
the apparent relationships is small, they are however of statistical significance. The choice of the personality measures used served two purposes. The first purpose was to provide an extensive account of how personality is related to gf which was accomplished firstly by looking at the personality dimensions of the MBTI, which have been derived form an actual theory of personality, secondly by looking at personality as understood by folk concepts (measured by the CPI-434) and finally by looking at personality as behaviour in three interpersonal areas (measured by the FIRO-B).

The second purpose of the choice of these personality tests was that they are all tests commonly used in practical settings, including academic advising and career counseling (Stroop, 1970; Provost & Anchors, 1987; Srivastave & Shukla, 1995), organizational behaviour (Gaines, 1970; Bridges, 1992; Young, Arthur & Finch, 2000, Fisher, Macrossoon, & Semple, 2001) and leadership (McCaulley, 1990; Dhanens, 2000). It would therefore be very useful for psychologists working in such settings, who also require information about intelligence on the people they are dealing with (students, patients, clients or employees), to have information about the relationship between intelligence and personality as measured by the tests they actually use, for as Devito (1985) noted, the five-factor model is mostly used in the academic research area. Such information could diminish the need for IQ testing, which often finds opposition on the basis that IQ tests are biased or flawed (Furnham, 2001). It should be noted here that the statistical analysis showed that scores on the Raven’s Progressive Matrices were not correlated to either gender or level of education, providing support for un-biased and culture-free nature of the test.
Finally, the decision of looking at the fluid aspect of intelligence was made due to the fact that gf is primarily biologically based and less susceptible to influences of the environment (Brody, 1992). This means that any significant correlations observed between gf and personality scales, can be explained in one of three ways. The first is that gf has lead to the development of the specific personality factor. It could be suggested that such factors are Sensing and Perceiving, Control, Intellectual Efficiency, Achievement via Independence and Norm-Favoring (only factors for which hypotheses were made are considered here, as they were more extensively researched and described, providing the basis to make such suggestions).

A second explanation for an observed relationship is that it could be due to a mediating variable. Such factors were Extraversion, Introversion, Judging, and Inclusion, where age was mediating their relationship with gf. Finally an observed relationship could be due to the personality factor affecting IQ test performance. It is suggested that this may be the case for the Internality scale. The use of a fluid intelligence measure consequently excludes the possibility that an observed relationship is due to the personality factor having affected the development of the person's fluid intelligence. This could only be the case with gc, and therefore the relationship between gc and intelligence would best be investigated by longitudinal studies. It is therefore suggested that future research should investigate the relationship between intelligence and personality not only by looking at how the two constructs are linked, but by investigating why they are linked.
4.5. Summary

This Chapter investigated the relationship between psychometric intelligence and personality measures commonly used in occupational settings. In order to provide grounds for basing hypotheses, Study 6 investigated how the Big 5 personality factors are related to Jung’s personality dimensions. The results showed that in line with previous research (McCrae & Costa, 1989; McDonald et al., 1994), Extraversion was correlated with EI, Openness with SN, Agreeableness with TF and Conscientiousness with JP. Neuroticism was also correlated with EI, a finding that has been reported previously by Furnham (1996a) although this correlation was smaller in magnitude compared to the other correlations.

Study 7 investigated the relationship between Jung’s personality types and general, fluid and crystallized intelligence. General intelligence was significantly, albeit modestly, correlated with all four personality dimensions indicating an advantage for Introversion, Intuition, Thinking and Perceiving. These findings are in line with the majority of the findings of Study 1, which found an advantage for Introversion, Intuition and Perceiving, but a disadvantage for Thinking. Regressing personality and demographic factors on general intelligence indicated that they account for 14% of its variance. The investigation of personality and demographic predictors of specific mental abilities revealed that EI, TF and JP can be used to predict scores on all measures of intelligence, whereas SN can be used to predict only crystallized abilities (verbal reasoning).

Study 8 investigated the relationship between fluid intelligence and personality, as measured by three inventories commonly used in occupational settings, the MBTI, the FIRO-B and the CPI. Results showed that gf was positively correlated with Perceiving
(MBTI), Control (FIRO-B), Intellectual Efficiency (CPI-434), Achievement via Independence (CPI-434) and negatively correlated with Sensing (MBTI), Internality (CPI-434) and Norm-Favouring (CPI-434), supporting the majority of the hypotheses. A number of significant correlations were also observed between the CPI-434 scales and gf, which were not part of the hypotheses, further signifying the relationship between gf and personality.
Chapter 5: Intelligence, personality and occupational performance

5.1. General Introduction

The aim of this chapter is to investigate the relationship between intelligence, personality and job performance. One of the main concerns in the field of occupational psychology is to discover the criteria by which to select individuals in order to optimize occupational performance, job fit and job satisfaction. Psychometric tests are commonly utilized for this purpose, as they have been found to be valid predictors for performance in virtually all jobs (Schmidt, 1988; Barrick & Mount, 1991; Ree & Earles, 1994; Jackson & Corr, 1998). Among the psychometric tests used, tests measuring general mental ability have been found to be the best predictors of job performance across a variety of jobs (Gottfredson, 1997; Graham, 1999; Gottfredson, 2002). Tests measuring personality traits are also commonly used within the occupational community, although the validity of personality tests as predictors of job performance has been found to be quite lower in relation to other predictors (Schmitt et al., 1984; Flethcer, 1991; Salgado, 1997).

This chapter will consist of three studies, which will investigate how different measures of intelligence and personality are related to various measures of job performance. Studies 9 and 10 will investigate how measures of general and fluid intelligence, and personality as conceptualised by the five-factor and the four-factor model, are related to level of management. Although job performance is often measured by ratings of performance, this study will measure managerial level reached instead, in order to obtain a more objective measure of performance. It is recognized however, that this assertion rests on the basic assumption that promotion is primarily a function of performance in the
job as well as judged suitability for the new role. Study 10 will be an extension of Study 9, by investigating how the effect of age may moderate the relationship between intelligence, personality and level of management.

The purpose of these studies will be firstly to replicate the finding that intelligence is positively correlated with job performance, and more importantly, to clarify the relationship between the Big 5 factors and job performance, as there are inconsistent findings in previous studies. Moreover, these studies will investigate the relationship between the MBTI dimensions and job performance, which have been investigated to a lesser extent, despite the fact that the MBTI is among the most commonly used personality inventories in occupational settings.

Study 11 will investigate the relationship between intelligence and personality factors and self-rated, actual and simulated job performance. This study has two aims. The first is to investigate how job performance is related to intelligence and personality, measured by instruments commonly used in occupational settings. The second aim is to investigate how the choice of job performance measurements affects the relationship between intelligence, personality and job performance.
5.2. Study 9

5.2.1. Introduction

The aim of this study is to jointly investigate the effects of intelligence and personality on job performance. Previous findings on these relationships have been extensively presented in Chapter 1, and will be merely summarized here.

**Intelligence and job performance**

Intelligence as measured by IQ tests is the single most effective predictor of individual performance on the job (Borman et al., 1991; Varsa & Valutis, 1993; Gottfredson, 1997; Tan & Libby, 1997; Graham, 1999). Correlations between intelligence and actual job performance range between .32 and .38 (Jensen, 1980) whereas correlations between intelligence and rated performance have been found to range .25 and .60 (Hunter & Hunter, 1984). Researchers have investigated whether general mental ability (g), or whether specific mental abilities of high congruence to the job were better predictors of performance, and found that g was the best predictor, with specific abilities only adding little increment validity to a regression equation which already contained g as a predictor (Graham, 1999).

The relationship between ability and performance has been found to be linear (Coward & Sackett, 1990). It has however also been proposed that this relationship can be moderated by factors such as task consistency and task difficulty. For example, correlations between intelligence and job proficiency have been found to be higher for jobs of higher status than for ones of lower status (Hunter & Hunter, 1984). Also, Farrel and McDaniel (2001) found that for jobs of low task consistency g was the best predictor of performance;
however, for jobs of high task consistency, g was the best predictor of early performance, whereas other factors such as psychomotor ability best predicted later performance.

**Personality and Job Performance**

There is a widespread faith within the occupational community in the utility of personality tests during employee selection and recruitment (Schmitt et al., 1984; Fletcher, 1991). Three meta-analyses have indeed provided grounds for optimism in the utility of personality tests during selection (Barrick & Mount, 1991; Tett et al., 1991; Salgado, 1997), despite the suggestion that the validity of personality tests as predictors of job performance is quite low in relation to other predictors (Schmitt et al., 1984).

**The Big Five**

Most research on the effects of personality on job performance is based on the Big 5 personality factors (Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness) proposed by Costa and McCrae (1985). Of these, Conscientiousness and Neuroticism are the factors that are most consistently correlated with job performance (Barrick et al., 2001). Conscientiousness has been found to positively correlate with salary (Orpen, 1983; Barrick & Mount, 1991), with promotions (Howard & Bray, 1994; Jones & Whitemore, 1995), with supervisor ratings of job performance in the military (Hough et al., 1990) and with job status (Judge et al., 1999). It has however also been proposed that certain sub-factors of Conscientiousness, such as Achievement-striving and Dependability, may be detrimental for job performance in certain occupations such as health care workers (Hough, 1992; Hough et al., 1998).
Neuroticism and its sub-factors, have been repeatedly found to be negatively correlated with measures of job performance, such as salary (Rawls & Rawls, 1968; Harrell, 1969), occupational status (Melamed, 1996a, 1996b), and performance in assessment center exercises (Spector et al., 2000). It has however also been proposed that Neuroticism may be a positive predictor for some occupations, for example Goetz and Goetz (1973) found that creative painters and sculptors tend on average to be Neurotic Introverts.

Extraversion has also been linked in several studies to job performance, although the findings are not as consistent as for Conscientiousness and Neuroticism. Extraversion has been found to correlate with salary and job level (Melamed, 1996a, 1996b). Furthermore, dominance and sociability, which are facets of Extraversion, have been found to correlate with salary, job title and managerial promotions (Rawls & Rawls, 1968; Caspi et al., 1987; Howard & Bray, 1994). However, Barrick and Mount (1991) found Extraversion to be uncorrelated with job performance as a sales representative, and Stewart and Carson (1995) reported a negative correlation between Extraversion and performance in service jobs. It has further been suggested that Introverts may be better at handling routine work activities than Extraverts (Cooper & Payne, 1967)

Openness and Agreeableness are the factors which have the least consistently been found to correlate with job performance. Openness has been found to be a valid predictor of training proficiency (Barrick & Mount, 1991) and of effectiveness (Judge & Bono, 2000); and Agreeableness has been found to correlate with overall job performance (Judge & Bono, 2000). However, as Judge et al. (1999) noted, Openness and Agreeableness have characteristics that could be detrimental for job performance for specific occupations. For example, Open individuals could be dissatisfied in conventional jobs, while Agreeable
individuals with high altruism could sacrifice their success for pleasing others. Indeed, Openness has been found to negatively correlate with performance of rugby referees (Jackson & Corr, 1998) and Agreeableness has been found to negatively correlate with management potential (Howard & Bray, 1988).

Previous research on the relationship between job performance and the Big 5 factors, have therefore yielded some replicated but also some contradictory findings. This may be due to the fact that different measures of job performance were used in these studies. Therefore hypotheses in the present study will be based on past research that has investigated the relationship between the Big 5 and measures of job performance such as managerial level, job level, and managerial promotions.

The Big Four

Researchers have also looked, though to a much lesser extent, at the relationship between job performance and the four bipolar personality dimensions derived by the Myers-Briggs Type Indicator (Extraversion-Introversion, Sensing-Intuition, Thinking-Feeling, Judging-Perceiving) (Myers & McCauley, 1985). The EI dimension has been found to correlate modestly with self-reported income (Rice & Lindecamp, 1989). EI has also been indirectly linked to job performance through job satisfaction, with Extraverts being more satisfied than Introverts (Rahim, 1981). With respect to the SN dimension, Sensing individuals have been found to perform better at innovative projects than Intuitive individuals (Henderson & Nutt, 1980). It has however also been proposed that culture could be a moderating factor in the relationship of job performance with EI and SN (Furnham & Stringfield, 1993). For example EI has been found to positively correlate with team-work, commitment and potential for European managers, but negatively...
correlated with decision making and achieving key results for Chinese managers. Also SN has been found to correlate positively with job performance for Chinese managers, but negatively for European managers (Furnham & Stringfield, 1993).

The JP and the TF dimension have also been modestly linked to job performance. Myers (1962) argued that both JP and TF should be positively correlated with managerial performance. JP has been indirectly linked to job performance, through job satisfaction, with Judging types being more satisfied than perceiving types irrespective of their occupation (Rahim, 1981). Also the TF dimension has been found to be linked to success in small retailers (Rice & Lindecamp, 1989), and it has been suggested that Feeling individuals should perform better at jobs requiring innovation than Thinking individuals (Henderson & Nutt, 1980).

The aim of this study is to jointly investigate the effect of intelligence and personality on job performance, as measured by level of management. Many researchers have used ratings as criteria of job performance, however, this study measures managerial level reached instead, in order to obtain a more objective measure of performance. This rests on the basic assumption that promotion is primarily a function of performance in the job as well as judged suitability for the new role. It is assumed that in performance related as opposed to service-based organizations, level reflects ability, not service or particular relationships with senior managers. However, due to the particular nature of level of management as a measure of job performance, hypotheses will be based on findings regarding measures of job performance similar to managerial level, such as occupational status and promotions.
The first hypothesis (H1) is that intelligence will be positively correlated with managerial level, in line with previous research (Jensen, 1980; Graham, 1999). The second hypothesis is that Conscientiousness will be positively correlated with level of management (H2), in line with Judge et al. (1999), who found Conscientiousness to be positively correlated with job status. Conscientious people are ambitious, hard-working, dutiful and diligent and it is likely that their behaviours are observed and rewarded by promotion. The third hypothesis (H3) is that Neuroticism will be negatively correlated with managerial level, in line with Melamed (1996a, 1996b), who found Neuroticism to be negatively correlated with occupational status. Neurotics are moody and anxious, with low self-esteem and prone to risk aversion. These behaviours are self-evidently not desirable at middle or senior management level. Finally, in line with Howard and Bray (1994) who found sub-factors of Extraversion to be correlated with managerial promotions, it is hypothesized that Extraversion will be positively correlated (H4) with managerial level. Extraverts are sociable, self-confident and optimistic, which are characteristics valued at senior levels of management. With regard to the relationship between managerial level and the MBTI personality dimensions, it is hypothesized that MBTI Extraversion will be positively (and MBTI Introversion negatively) correlated with managerial level (H5), which is the most consistent finding within the limited research of MBTI correlates of job performance (Rahim, 1981; Rice & Lindecamp, 1989).

5.2.2. Method

Participants

A total of 859 participants were recruited in this study. Of these 653 were male and 205 were female. They were all British adults, tested by a psychological consulting company.
Materials

Level of management had three levels: manager-supervisor, graduate manager and manager of managers.


See Study 1 (section 2.1.2).

*Graduate and Managerial Assessment: Abstract (GMA:A; Blinkhorn 1985).* See Study 1 (section 2.1.2).

*The Revised NEO Personality Inventory (NEO PI-R)* (Costa & McCrae, 1985). See Study 1 (section 2.1.2).

*Myers-Briggs Type Indicator (MBTI).* (Myers & McCauley, 1985). See Study 1 (section 2.1.2).

Procedure

Participants were tested by Kaisen Consulting, during training and selection courses. Candidates were tested as part of an assessment center exercise. They had been pre-selected from a larger group who applied. All the testes were trained and chartered psychologists.

5.2.3. Results

Correlations: Correlations were computed between managerial level, scores on intelligence and personality variables, and gender. These correlation coefficients are presented in Table 5.2.1. Managerial level was significantly correlated with the GMA:A
(r = -.14) and with gender\textsuperscript{11} (r = -.18). Due to the fact that gender was significantly correlated with managerial level, partial correlations were also computed between managerial level, intelligence and personality, controlling for gender. These partial correlations are also presented in Table 5.2.1. Managerial level was negatively correlated with the GMA:A (r = -.13), and MBTI Introversion (r = -.13) and was positively correlated with MBTI Extraversion (r = .12).

Table 5.2.1: Pearson product moment correlations between Managerial level and intelligence and personality scores, and partial correlations, controlling for gender

<table>
<thead>
<tr>
<th>Managerial Level</th>
<th>r (N = 894)</th>
<th>$r_{\text{partial}}$ (N = 367)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGCTA</td>
<td>.02</td>
<td>.03</td>
</tr>
<tr>
<td>GMA:A</td>
<td>-.14\textsuperscript{**}</td>
<td>-.13\textsuperscript{*}</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-.07</td>
<td>-.08</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.01</td>
<td>.05</td>
</tr>
<tr>
<td>Openness</td>
<td>-.04</td>
<td>.02</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-.02</td>
<td>.07</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.01</td>
<td>.05</td>
</tr>
<tr>
<td>MBTI-Extraversion</td>
<td>.03</td>
<td>.12\textsuperscript{*}</td>
</tr>
<tr>
<td>MBTI-Introversion</td>
<td>-.04</td>
<td>-.13\textsuperscript{*}</td>
</tr>
<tr>
<td>MBTI-Sensing</td>
<td>-.04</td>
<td>-.05</td>
</tr>
<tr>
<td>MBTI-Intuition</td>
<td>.05</td>
<td>.06</td>
</tr>
<tr>
<td>MBTI-Thinking</td>
<td>.06</td>
<td>.06</td>
</tr>
<tr>
<td>MBTI-Feeling</td>
<td>-.04</td>
<td>-.02</td>
</tr>
<tr>
<td>MBTI-Judging</td>
<td>.02</td>
<td>.05</td>
</tr>
<tr>
<td>MBTI-Perceiving</td>
<td>-.03</td>
<td>-.07</td>
</tr>
<tr>
<td>Gender</td>
<td>-.18\textsuperscript{**}</td>
<td></td>
</tr>
</tbody>
</table>

*\textsuperscript{p}<.05, **\textsuperscript{p}<.001

Regressions: In order to investigate the extent to which intelligence, personality and gender can predict managerial level, multiple linear regression was performed, using managerial level as the dependent variable, and intelligence, personality scores\textsuperscript{12} and gender as the independent variables. The model was significant (F(12,358) = 2.79, p < .01), with Adjusted $R^2 = .05$. Significant predictors of managerial level were the GMA:A

\textsuperscript{11} Indicating that higher managerial level was correlated with being male

\textsuperscript{12} Due to the fact that the eight MBTI dimensions are not independent, only one of each bipolar dimensions were included in the regressions, the ones with the highest correlations with managerial level, i.e. Introversion, Intuition, Thinking and Judging
(β = -.13), MBTI Introversion (β = -.20) and gender (β = -.17). The β coefficients and their t values for this regression model are presented in Table 5.2.2.

Table 5.2.2: Beta coefficients for multiple regressions of intelligence, personality and demographic factors on managerial level

<table>
<thead>
<tr>
<th>Managerial Level (Study 1)</th>
<th>β</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGCTA</td>
<td>.05</td>
<td>.98</td>
</tr>
<tr>
<td>GMA:A</td>
<td>-.13</td>
<td>-2.45*</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-.02</td>
<td>-.37</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-.10</td>
<td>-1.20</td>
</tr>
<tr>
<td>Openness</td>
<td>-.04</td>
<td>-.47</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.09</td>
<td>1.54</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>MBTI-Introversion</td>
<td>-.20</td>
<td>-2.62**</td>
</tr>
<tr>
<td>MBTI-Intuition</td>
<td>.07</td>
<td>1.00</td>
</tr>
<tr>
<td>MBTI-Thinking</td>
<td>.08</td>
<td>1.43</td>
</tr>
<tr>
<td>MBTI-Judging</td>
<td>.05</td>
<td>.69</td>
</tr>
<tr>
<td>Gender</td>
<td>-.17</td>
<td>-3.07**</td>
</tr>
</tbody>
</table>

Regression Model
Adj. R² = F(12,358)=2.79**  .05

*p<.05, **p <.01, ***p<.001

5.2.4. Discussion

The aim of Study 9 was to jointly investigate the effect of intelligence and personality on job performance, as measured by level of management. The first hypothesis (H1), which was that intelligence would be positively correlated with managerial level, was not supported by the present results. On the contrary, one of the two intelligence measures used (GMA:A) was curiously found to negatively correlate with, and to be a negative predictor of level of management, indicating that higher level of management is related with lower intelligence levels.

Correlation coefficients however do not explain causality of an observed relationship. This means that the negative correlation between intelligence and level of management
could have developed in three ways. Firstly an individual's level of intelligence may have affected the level of management they reached. This explanation is counter-intuitive as there seems to be no logical reason for why individuals with lower intelligence should tend to receive the higher managerial positions, apart from the cases where appointment of a position is based on service or corruption rather than ability. The second explanation is that the level of management held by an individual may affect their intelligence. This is highly improbable, as fluid intelligence (which is measured by abstract reasoning of the GMA:A) is considered to be to a great extent biologically based (Brody, 1992), and therefore should be much less susceptible to influences of the environment. Finally, it could be the case that the relationship between intelligence and managerial level could be moderated by another variable, to which both intelligence and managerial level are related.

A variable that could indeed act as a moderator variable in this case, is age. Age would theoretically be positively correlated with level of management, as the more years an individual is in a firm, the more chances they have of obtaining a higher managerial level. On the other hand, age is negatively linked with fluid intelligence (Stankov, 1994; Matthews et al., 2000). Therefore, the negative relationship observed between intelligence and level of management may simply reflect a moderating effect of age. This suggestion could not be tested with the present sample, as information on participants' age was not available. This will however be investigated in Study 10, by looking at the relationship between intelligence and managerial level when participants' age is controlled for.
The second, third and fourth hypotheses, which expected to find significant positive correlations between managerial level and Conscientiousness (H2) and Extraversion (H4) and negative correlations with Neuroticism (H3), were not supported by the present results. This implies that job performance, measured by level of management, is not related to these personality factors. Previous studies have indeed reported findings contradictory to the present hypotheses i.e. job performance has been reported to negatively correlate with facets of Conscientiousness (Hough et al., 1998; Moon, 2001), to positively correlate with Neuroticism (Goetz & Goetz, 1973) and to negatively correlate with Extraversion (Stewart & Carson, 1995) for some occupations. However, the hypotheses were based on studies that used measures of job performance, of a similar nature to level of management. These results are therefore surprising and warrant further investigation. As with intelligence, it could be the case that a variable moderates the relationship between personality and level of management. The relationship between the Big 5 and job performance will be further investigated in Study 10.

The fifth hypothesis, which expected MBTI Extraversion to be positively, and MBTI Introversion to be negatively, correlated with managerial level, was supported by the results, and MBTI Introversion was further found to be a significant predictor of managerial level. These results support previous research, which found MBTI Extraversion-Introversion to be directly linked to job performance, as measured by self-reported income (Rice & Lindecamp, 1989), and indirectly linked to it, as measured by job satisfaction (Rahim, 1981). MBTI Extraversion refers to a person whose mental processes are directed at the external world whereas Introversion refers to an orientation towards the internal world (Myers, 1962). It is therefore logical that a higher level of
management, which requires good communication with other individuals and a good perception of processes occurring in the external world, to be positively correlated with Extraversion and negatively with Introversion.
5.3. Study 10

5.3.1. Introduction

It was proposed that the unexpected results observed in Study 9, regarding the negative correlation between an intelligence measure (GMA:A) and managerial level, could be due to a moderator factor, such as age, which negatively correlates with fluid intelligence (measured by the GMA:A) and positively correlates with level of management. It was therefore considered that in order to investigate the relationship of managerial level with intelligence and personality, age should be taken into consideration. The aim therefore of Study 10 is to further investigate the relationship between intelligence, personality, and job performance. The hypotheses made here are the same as in Study 9, with the difference that in the statistical analysis of this study, age will be controlled for.

The first hypothesis (H1) is that intelligence will be positively correlated with managerial level, in line with Jensen (1980) and Graham (1999). The second hypothesis (H2) is that Conscientiousness will be positively correlated with managerial level, and the third hypothesis (H3) is that Neuroticism will be negatively correlated with it, in line with Barrick et al., (1999). The fourth hypothesis (H4) is that Extraversion will be positively correlated with managerial level, in line with Howard and Bray (1994). Finally, the fifth hypothesis (H5) is that MBTI Extraversion will be positively (and MBTI Introversion negatively) correlated with managerial level, in line with Rice and Lindecamp (1989) and with the findings of Study 9.
5.3.2. Method

Participants

A total of 900 participants were recruited in this study. Of these 717 were male and 183 were female. Their age ranged from 23 to 64, with a mean of 42. They were all British adults, tested by a psychological consulting company.

Materials

Level of management had three levels: manager-supervisor, graduate manager and manager of managers.


*Graduate and Managerial Assessment: Abstract (GMA:A)* (Blinkhorn 1985). See Study 1 (section 2.1.2).

*Revised NEO Personality Inventory (NEO PI-R)* (Costa & McCrae, 1985). See Study 1 (section 2.1.2).

*Myers-Briggs Type Indicator (MBTI).* (Myers & McCauley, 1985). See Study 1 (section 2.1.2).

Procedure

Participants were tested by Kaisen Consulting, during training and selection courses. Candidates were tested as part of an assessment center exercise. They had been pre-selected from a larger group who applied. All the testes were trained and chartered psychologists.
5.3.3. Results

Correlations: Pearson product moment correlations were computed between managerial level, intelligence and personality scores, and demographic factors (gender and date of birth). These correlations are presented in Table 5.3.1. Managerial level was significantly correlated with GMA:A \( (r = -.11) \), Neuroticism \( (r = -.15) \), Extraversion \( (r = .14) \), Conscientiousness \( (r = .15) \), MBTI Introversion \( (r = -0.08) \), Sensing \( (r = -0.07) \), Intuition \( (r = .09) \), gender \( (r = -.15) \) and date of birth \( (r = -.32) \). Correlations between date of birth and the two intelligence measures were also computed. Date of birth was significantly correlated with the GMA:A \( (r = .18, p<.001) \) but not with the WGCTA.

Table 5.3.1: Correlations between Managerial level and personality scores, and partial correlations controlling for gender and date of birth

<table>
<thead>
<tr>
<th></th>
<th>( r ) (N = 900)</th>
<th>( r_{\text{partial}} ) (N = 894)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGCTA</td>
<td>.00</td>
<td>.01</td>
</tr>
<tr>
<td>GMA:A</td>
<td>-.11**</td>
<td>-.05</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-.15***</td>
<td>-.13***</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.14***</td>
<td>.21***</td>
</tr>
<tr>
<td>Openness</td>
<td>.02</td>
<td>.07</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.00</td>
<td>.02</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.15***</td>
<td>.13***</td>
</tr>
<tr>
<td>MBTI-Extraversion</td>
<td>.04</td>
<td>.10**</td>
</tr>
<tr>
<td>MBTI-Introversion</td>
<td>-.08*</td>
<td>-.14***</td>
</tr>
<tr>
<td>MBTI-Sensing</td>
<td>-.07*</td>
<td>-.09*</td>
</tr>
<tr>
<td>MBTI-Intuition</td>
<td>.09**</td>
<td>.11**</td>
</tr>
<tr>
<td>MBTI-Thinking</td>
<td>.06</td>
<td>.04</td>
</tr>
<tr>
<td>MBTI-Feeling</td>
<td>-.03</td>
<td>-.02</td>
</tr>
<tr>
<td>MBTI-Judging</td>
<td>.02</td>
<td>-.01</td>
</tr>
<tr>
<td>MBTI-Perceiving</td>
<td>.01</td>
<td>.04</td>
</tr>
<tr>
<td>Gender</td>
<td>-.15***</td>
<td></td>
</tr>
<tr>
<td>Date of Birth</td>
<td>-.32***</td>
<td></td>
</tr>
</tbody>
</table>

* \( p<.05 \), ** \( p<.01 \), *** \( p<.001 \)

Partial Correlations: Due to the fact that gender\(^{13}\) and date of birth\(^{14}\) were significantly correlated with managerial level, they were partialled out of the correlations that

\(^{13}\) Indicating an advantage for males
\(^{14}\) Indicating an advantage for older individuals
investigated the relationship between managerial level and personality. These partial correlations are also presented in Table 5.3.1. Managerial level was significantly correlated with Neuroticism ($r = -.13$), Extraversion ($r = .21$), Conscientiousness ($r = .13$), MBTI Extraversion ($r = .10$), MBTI Introversion ($r = -.14$), Sensing ($r = -.09$) and Intuition ($r = .11$).

**Big 5 sub-factors:** In order to provide more information on the relationship between managerial level and the Big 5 factors of personality, correlations and partial correlations (controlling for gender and date of birth) were also computed for the sub-factors of Neuroticism, Extraversion and Conscientiousness, which were the personality factors which significantly correlated with managerial level. These coefficients are presented in Table 5.3.2.

*Table 5.3.2: Partial Correlations for managerial level and sub-factors of Neuroticism, Extraversion and Conscientiousness, controlling for gender and date of birth*

<table>
<thead>
<tr>
<th>Sub-factor</th>
<th>$r$ (N = 900)</th>
<th>$r$ partial (N = 896)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1: Anxiety</td>
<td>-.17***</td>
<td>-.14***</td>
</tr>
<tr>
<td>N2: Angry-hostility</td>
<td>-.05</td>
<td>-.04</td>
</tr>
<tr>
<td>N3: Depression</td>
<td>-.13***</td>
<td>-.11**</td>
</tr>
<tr>
<td>N4: Self-conscious.</td>
<td>-.10**</td>
<td>-.10**</td>
</tr>
<tr>
<td>N5: Impulsiveness</td>
<td>-.04</td>
<td>.01</td>
</tr>
<tr>
<td>N6: Vulnerability</td>
<td>-.15***</td>
<td>-.14***</td>
</tr>
<tr>
<td>E1: Warmth</td>
<td>.04</td>
<td>.11**</td>
</tr>
<tr>
<td>E2: Gregariousness</td>
<td>.08*</td>
<td>.13***</td>
</tr>
<tr>
<td>E3: Assertiveness</td>
<td>.21***</td>
<td>.22**</td>
</tr>
<tr>
<td>E4: Activity</td>
<td>.20***</td>
<td>.23***</td>
</tr>
<tr>
<td>E5: Excitement seek.</td>
<td>-.01</td>
<td>.07*</td>
</tr>
<tr>
<td>E6: Positive emotions</td>
<td>.04</td>
<td>.10**</td>
</tr>
<tr>
<td>C1: Competence</td>
<td>.13***</td>
<td>.12**</td>
</tr>
<tr>
<td>C2: Order</td>
<td>.09**</td>
<td>.08*</td>
</tr>
<tr>
<td>C3: Dutifulness</td>
<td>.14***</td>
<td>.12***</td>
</tr>
<tr>
<td>C4: Achievement-striv.</td>
<td>.18***</td>
<td>.19***</td>
</tr>
<tr>
<td>C5: Self discipline</td>
<td>.08*</td>
<td>.07*</td>
</tr>
<tr>
<td>C6: Deliberation</td>
<td>.04</td>
<td>-.01</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01, ***p<.001*
Of the sub-factors of Neuroticism, significant (negative) correlates, as well as partial correlates of managerial level were anxiety, depression, self-consciousness and vulnerability. Of the sub-factors of Extraversion, significant (positive) correlates of managerial level were gregariousness, assertiveness and activity, while all of the Extraversion sub-factors (warmth, gregariousness, assertiveness, activity, excitement-seeking and positive emotions) were significantly partially correlated with managerial level. Finally, of the sub-factors of Conscientiousness, significant (positive) correlates as well as partial correlates of managerial level were competence, order, dutifulness, achievement-striving and self discipline.

Regressions: In order to investigate the extent to which intelligence, personality and demographic factors can predict managerial level, two multiple linear regressions were performed, using managerial level as the dependent variable. Due to the fact that the eight MBTI personality dimensions are in fact four bi-polar dimensions (Extraversion-Introversion, Sensing-Intuition, Thinking-Feeling and Judging-Perceiving), which means that they are in pairs highly correlated between them, they could not all be included in the regression models. Therefore, of each bi-polar dimension, the scale that was most highly correlated with managerial level was included as an independent variable, i.e. Introversion, Intuition, Thinking and Judging. The first regression model used the two intelligence measures, the Big 5 personality factors and the four MBTI scales as independent variables. The model was significant ($F(11,887) = 5.76, p<.001$), with $\text{Adjusted } R^2 = .06$. Significant predictors of managerial level were the GMA:A ($\beta = -.12$), Extraversion ($\beta = .14$), Openness ($\beta = -.13$), Conscientiousness ($\beta = .11$) and Intuition ($\beta = .16$). The second regression model used the same intelligence and personality factors,
as well as the two demographic factors as independent variables. The model was significant ($F(13, 885) = 13.55, p < .001$), with Adjusted $R^2 = .15$. Significant predictors of managerial level were Extraversion ($\beta = .20$), Openness ($\beta = -.12$), Conscientiousness ($\beta = .09$), Intuition ($\beta = .14$) and date of birth ($\beta = -.32$). The $\beta$ coefficients and their $t$-values for these regressions are presented in Table 5.3.3.

Table 5.3.3: Beta coefficients for multiple regressions of personality and demographic factors on managerial level

<table>
<thead>
<tr>
<th>Managerial Level</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$\beta$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGCTA</td>
<td>.05</td>
<td>1.41</td>
<td>.04</td>
<td>1.09</td>
</tr>
<tr>
<td>GMA:A</td>
<td>-.12</td>
<td>-3.46**</td>
<td>-.05</td>
<td>-1.54</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>-.06</td>
<td>-1.52</td>
<td>.00</td>
<td>.02</td>
</tr>
<tr>
<td>Extraversion</td>
<td>.14</td>
<td>2.55*</td>
<td>.20</td>
<td>3.97***</td>
</tr>
<tr>
<td>Openness</td>
<td>-.13</td>
<td>-2.76**</td>
<td>-.12</td>
<td>-2.71**</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.01</td>
<td>.24</td>
<td>.04</td>
<td>.99</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.11</td>
<td>2.39*</td>
<td>.09</td>
<td>2.18*</td>
</tr>
<tr>
<td>MBTI-Introversion</td>
<td>.04</td>
<td>.81</td>
<td>.02</td>
<td>.42</td>
</tr>
<tr>
<td>MBTI-Intuition</td>
<td>.16</td>
<td>3.49***</td>
<td>.14</td>
<td>3.29**</td>
</tr>
<tr>
<td>MBTI-Thinking</td>
<td>.04</td>
<td>.92</td>
<td>.04</td>
<td>1.11</td>
</tr>
<tr>
<td>MBTI-Judging</td>
<td>-.00</td>
<td>-.03</td>
<td>-.02</td>
<td>-.50</td>
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<tr>
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<td>-.06</td>
<td>1.69</td>
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<tr>
<td>Date of birth</td>
<td></td>
<td></td>
<td>-.32***</td>
<td>-9.49***</td>
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<td>Regression Model</td>
<td>$F(11, 887) = 5.76***$</td>
<td></td>
<td>$F(13, 885) = 13.55***$</td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>.06</td>
<td>1.15</td>
<td></td>
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</tr>
</tbody>
</table>

* $p < .05$, ** $p < .01$, *** $p < .001$

5.2.4. Discussion

The aim of Study 10 was to extend the Study 9, which investigated the relationship between job performance, personality and intelligence, by taking into account the effect of age. The first hypothesis, which was that intelligence would positively correlate with managerial level, was not supported by the results, indicating that job performance as measured by managerial level is not related to level of intelligence. These findings are not in line with previous studies (Jensen, 1980; Graham, 1999), which proposed that intelligence is the best predictor of job performance. It should however be taken into
account that all participants had a managerial position. Intelligence may therefore have been a factor by which individuals had been selected for, to receive a managerial position in the first place. This would have caused a restriction of range in the data, which could be responsible for the insignificance of the results. It would be interesting for future studies to test this, by looking at a sample that would include individuals of non-managerial positions as well as individuals of many different levels of management within the same organization, and by taking into account experience. Future studies could also investigate whether there are inter-organizational differences in requirements for appointment of higher managerial positions.

In relation to Study 9, the present results showed that when age was controlled for, fluid intelligence (measured by GMA:A) was no longer a negative predictor of level of management. This supports the suggestion made, that the negative relationship observed between these two variables in Study 9 was due to age acting as a moderator variable in their relationship. This is because age is negatively correlated with one variable (fluid intelligence) whereas it is positively correlated with the other variable (managerial level).

The second hypothesis, which was that Conscientiousness would positively correlate with level of management, was supported by the results. Conscientiousness was furthermore found to be a significant predictor of managerial level. This finding supports previous studies, which reported Conscientiousness to be positively correlated with job performance as measured by job status (Judge et al., 1999), and promotions (Howard & Bray, 1994; Jones & Whitemore, 1995). This is also in line with studies, which have found Conscientiousness to correlate with several other measures of job performance, for example with salary (Orpen, 1983, Barrick & Mount, 1991) and supervisor ratings of job
performance in the military (Hough et al., 1990). As Mount et al. (1999) noted, “Conscientiousness is an important correlate of job performance across numerous jobs and diverse criterion types”.

Conscientiousness is associated with characteristics such as dutifulness and self-discipline, characteristics that are essential within an occupational framework. In line with this, the investigation of the sub-factors of Conscientiousness did indeed show that managerial level was significantly correlated with competence, order, dutifulness and self-discipline. This implies that individuals are more likely to be promoted to higher managerial positions if they are capable, sensitive and effective (competence), well-organized (order), dependable and reliable (dutifulness), ambitious and hard-working (achievement-striving). It is however also possible that the relationship between Conscientiousness and managerial level is reversed, i.e. that demands of high level jobs result in the development of these characteristics of Conscientiousness.

The third hypothesis, which was that Neuroticism would negatively correlate with managerial level was supported by the results, in line with previous studies (Salgado, 1997; Barrick et al., 1999). Neuroticism is related to characteristics such as anxiety and angry-hostility which could be detrimental for occupational performance in general. In the present study, the sub-factors of Neuroticism, which negatively correlated with managerial level were anxiety, depression, self-consciousness and vulnerability. This implies that individuals are less likely to be promoted to higher managerial positions if they are nervous and tense (anxiety), if they are prone to feelings of sadness and hopelessness (depression), to feelings of inferiority and to shyness (self-consciousness) and if they are unable to cope with feelings of stress and with difficult situations.
(vulnerability). It may be the case that individuals with such characteristics are not promoted into higher managerial positions due to consideration that these could be detrimental for their job performance. Alternatively it may be the case that individuals with these characteristics avoid higher levels of management, as this comes along with greater responsibilities, which might make them more anxious or vulnerable.

The fourth hypothesis, which was that Extraversion would be positively correlated with managerial level, was supported by the results, in line with Howard and Bray (1994), who found sociability, a characteristic of Extraversion to be correlated with managerial promotions. Extraversion was also a significant predictor of managerial level. Investigation of the sub-factors of Extraversion showed that they were all positively correlated with managerial level. This implies that individuals who are friendly (warmth), dominant and socially ascendant (assertiveness), energetic (activity), who enjoy social stimulation (gregariousness), excitement (excitement seeking) and who are cheerful and optimistic (positive emotions) are more likely to receive higher managerial positions.

The fifth hypothesis, which expected MBTI Extraversion to be positively, and MBTI Introversion to be negatively, correlated with managerial level, was partly supported by the results. MBTI Extraversion was not significantly correlated with level of management initially, however, when gender and age were controlled for, the partial correlation was significant. This indicates that gender and age may have been moderating the relationship between Extraversion and level of management. Introversion on the other hand was negatively correlated with managerial level even when gender and age were not controlled for, and was further found to be a significant predictor of managerial level. These results are in line with previous research, which found MBTI Extraversion-
Introversion to be directly linked to job performance, as measured by self-reported income (Rice & Lindecamp, 1989), and indirectly liked to it, as measured by job satisfaction (Rahim, 1981). MBTI Extraversion refers to a person whose mental processes are directed at the external world whereas Introversion refers to an orientation towards the internal world (Myers, 1962). Therefore good communication skills and a good perception of processes occurring in the external world, which are characteristics of Extraversion, are beneficial for performance on a managerial position.

The results showed that MBTI Intuition was also positively correlated with managerial level, and Sensing was negatively correlated with it. Sensing and Intuition are two alternative ways of perceiving information. Sensing individuals are more observant, they receive information directly through the senses, whereas Intuitive individuals are more introspective, they discover possibilities that may not be immediately obvious from sensory data (Myers, 1962). This finding not surprisingly indicates that performing well at a managerial position involves going beyond the sensory data to discover further possibilities.

In summary, the results showed that when gender and age were controlled for, managerial level was positively correlated with Conscientiousness, Extraversion, MBTI Extraversion and Intuition, and negatively correlated with Neuroticism, MBTI Introversion and Sensing. Despite the fact that men and women are nowadays considered to have equal opportunities in the occupational settings, the present results showed that men are more likely to obtain higher managerial positions than women. This however does not necessarily imply that women are actually given fewer opportunities to obtain higher managerial positions. They may themselves not be seeking higher levels of
management, which denotes higher responsibilities, as they may be more family- than career-oriented.

The finding that age was a significant correlate of managerial level is not surprising, as the more years an individual is in a corporation, the more chances they have of being promoted. The fact that most personality factors were significantly correlated with managerial level even when age and gender were not controlled for, indicates the importance of personality characteristics in being promoted to higher levels of management. It should also be noted that level of management may also be influenced by other factors, apart from gender and age, for example by relationships with senior managers. It would be interesting for future studies to investigate the relationship between personality and level of management by taking into consideration more variables that may be related to managerial promotions, for example likeability, service and relationships with senior managers. These however can only be measured subjectively, which would affect the reliability of the findings. Despite the fact that such factors were not controlled for in the present study, personality characteristics were found to be significantly correlated with level of management, which further denotes the important role of personality on job performance.

This study attests to the utility of personality tests used during recruitment and promotions, supporting the three meta-analyses (Barrick & Mount, 1991; Tett et al., 1991, Salgado, 1997), which suggested that there are grounds for optimism in using personality tests as predictors of job performance. There may be personality factors that are specifically beneficial in certain job environments, as Extraversion seems to be for managers. Other personality factors, like Conscientiousness and low Neuroticism seem to
be beneficial for job performance across the occupational range. Future studies should look at a range of occupations in order to identify which personality factors are more beneficial for which occupations, a finding that would be very useful for occupational psychologists and human resource managers.
5.4. Study 11

5.4.1. Introduction

The aim of this study is to investigate how intelligence and personality factors are related to job performance, in order to assess the utility of power and preference psychometric tests in recruitment and promotions. Furthermore, it will extend previous research by investigating whether the lack of consensus on predictors of job performance is due to the fact that researchers have been using different measures of performance. The present study will look at how intelligence and personality factors correlate with three measures of job performance, self-rated, simulated and “actual” job performance, indicated by salary. Salary is an indicator of actual job performance because good performance results in performance related pay and in promotions, both of which are related to higher salary.

Intelligence as measured by IQ tests has been found to be the single most effective predictor of individual performance on the job (Borman et al., 1991; Varsa & Valutis, 1993; Gottfredson, 1997; Tan & Libby, 1997; Graham, 1999). Although studies 9 and 10 did not find intelligence to be significantly correlated with level of management, it was suggested that this might have been due a restriction of range in the sample. The hypotheses of this study will therefore be based on the general consensus that intelligence is positively correlated with job performance (Gottfredson, 1997).

This study will investigate how job performance is related to personality dimensions, measured by the Occupational Personality Questionnaire (OPQ), a measurement developed by Saville, Holdsworth, Nyfield, Cramp and Mabey (1984). The choice of this instrument was made on the basis that it is widely used in personnel selection and staff
development (Matthews & Stanton, 1994), and therefore an understanding of how its personality dimensions actually predict job performance would benefit the applied field of occupational and consulting psychology. Furthermore, research on the factor structure of the OPQ has shown that there are five factors underlying the OPQ dimensions, which are equivalent to the Big 5 personality factors (Matthews, Stanton, Graham & Brimelow, 1990; Matthews & Stanton, 1994; Beaujouan, 2000). This means that hypotheses can be formulated, based on previous findings on the relationship between the Big 5 and job performance, as research on the relationship between the OPQ dimensions and job performance is scarce. These findings have been reviewed in Chapter 1 and have been summarized in study 9.

Several studies have looked at the factor structure of the OPQ, by factor analysing the primary dimensions of the inventory. Most of these studies yielded a five-factor structure that corresponds fairly well to the Big 5 model of personality (Matthews et al., 1990; Matthews & Stanton, 1994; Beaujouan, 2000). Table 5.4.1 summarizes which OPQ scales were found to load on each of the Big 5 factors in Matthews and Stanton’s study (1994), as this used the same version of the OPQ that was used by the present study. The sign indicates whether the scale is positively or negatively correlated with the corresponding factor. Persuasive, Controlling, Independent, Outgoing, Affiliative, Socially Confident, Modest, Democratic and Caring loaded on Extraversion; Artistic, Behavioural, Traditional, Change Oriented, Conceptual and Innovative on Openness; Practical, Data Rational, Forward Planning, Detail Conscious and Conscientious on Conscientiousness; Relaxed, Worrying, Tough Minded Emotional Control, Optimistic
and Critical on Neuroticism; Active, Competitive, Achieving, Decisive and Socially Desirable on Agreeableness.

Table 5.4.1: The relationship between the OPQ dimensions and the Big 5 factors; adopted by Matthews and Stanton (1994)

<table>
<thead>
<tr>
<th>Extraversion</th>
<th>Openness</th>
<th>Conscientiousness</th>
<th>Neuroticism</th>
<th>Agreeableness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persuasive</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlling</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent</td>
<td>+</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Outgoing</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affiliative</td>
<td>+</td>
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<td></td>
</tr>
<tr>
<td>Soc.Confident</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modest</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Democratic</td>
<td>-</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Caring</td>
<td>-</td>
<td></td>
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</tr>
<tr>
<td>Artistic</td>
<td>+</td>
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<tr>
<td>Behavioural</td>
<td>+</td>
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<tr>
<td>Traditional</td>
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<td></td>
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<tr>
<td>Change Or.</td>
<td>+</td>
<td></td>
<td></td>
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<tr>
<td>Conceptual</td>
<td>+</td>
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<tr>
<td>Innovative</td>
<td>+</td>
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<tr>
<td>Practical</td>
<td>+</td>
<td></td>
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<tr>
<td>Data Rational</td>
<td>+</td>
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<tr>
<td>Forw.Planning</td>
<td>+</td>
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<tr>
<td>Det.Conscious</td>
<td>+</td>
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<td></td>
</tr>
<tr>
<td>Conscientious</td>
<td>+</td>
<td></td>
<td></td>
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<tr>
<td>Relaxed</td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td>Worrying</td>
<td>+</td>
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<tr>
<td>Tough Mind.</td>
<td>-</td>
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<td>Em.Control</td>
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<td>Optimistic</td>
<td>-</td>
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<tr>
<td>Critical</td>
<td>+</td>
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<td>Active</td>
<td>+</td>
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<tr>
<td>Competitive</td>
<td>+</td>
<td></td>
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<tr>
<td>Achieving</td>
<td>+</td>
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<tr>
<td>Decisive</td>
<td>+</td>
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<tr>
<td>Soc.Desirable</td>
<td>+</td>
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</table>

The first hypothesis (H1) is based on previous research which suggested that general intelligence is the most effective predictor of job performance (Graham, 1999), expecting
intelligence to be positively correlated with all three measures of job performance. The second hypothesis (H2) is based on previous studies which found that Conscientiousness consistently predicts job performance, as measured "objectively" by salary (Barrick & Mount, 1991), promotions (Howard & Bray, 1994), and managerial level (Study 10), as well as subjectively by supervisor and peer ratings (Hough et al., 1990; Borman et al., 1991). This hypothesis expected the OPQ dimensions that load on Conscientiousness to be significantly correlated with actual (salary) and rated performance. The third hypothesis (H3) is based on previous studies, which found Neuroticism to be negatively correlated with job performance as measured by salary (Harrell, 1969), occupational success in training (Jessup & Jessup, 1971), managerial level (Study 10) and by assessment centre exercises (Spector et al., 2000). This hypothesis expected the OPQ dimensions that load on Neuroticism to be negatively correlated with actual, simulated and rated performance.

5.4.2. Method

Participants

A total of 150 participants were included in this study. Of these 111 were male and 39 were female. Their age ranged from 26 to 53, with a mean of 36.75 and a standard deviation of 5.83. All participants were employees of the British Royal Mail, in 18 different sectors including business services, information services, logistics and contract distribution, packages and express, post office network, service delivery and transaction services.
Materials

*Cognitive Process Profile (CPP)* (*Prinsloo, 2001*). This is an intelligence test of cognitive processes, measuring the extent to which an individual tends to use his judgment confidently and effectively when dealing with unfamiliar and ambiguous information. The manual provides support for the test’s construct validity and reports Alpha reliability coefficients between .65 and .89.

*Occupational Personality Questionnaire (OPQ)* (*Saville & Holdsworth, 1984*). This is an un-timed personality questionnaire, designed to give information on individual styles or preferences at work. It measures relationships with people (assertiveness, gregariousness and empathy), thinking style (fields of use, abstract, and structure) and feelings and emotions (anxieties, controls and energies). The manual reports studies consistently supporting the tests’ construct validity, and reliabilities ranging from .67 to .88 with a median of .81.

*Job Performance Measures:*

*Salary:* Salary had seven levels, ‘7’ denoting the highest salary and ‘1’ denoting the lowest salary.

*Simulated performance:* This was an exercise of simulated work performance. Participants were given a hypothetical situation with certain goals, and were asked to produce solutions by which they would achieve these goals. The exercise was scored on a scale form “1” to “4” (“4”: Excellent, “3”: Above average, “2”: Average, “1”: Poor), by two trained psychologists, ensuring reliability of the scores.
Self-rated potential managerial performance: This is a composite score of questionnaires measuring Thinking, Judgment, Leadership and Achievement orientation. Scores were on a scale from “1” to “5” (“5”: Very high level of ability, “4”: More than acceptable level of ability, “3”: An acceptable level of ability, “2”: Less than acceptable level of ability, “1”: Unacceptable level of ability).

Procedure

Participants had been pre-selected by an Assessment Centre during recruitment, on the basis of interviews and psychometric tests. Participants were tested by trained psychologists of the British Royal Mail.

5.4.3. Results

Distributions of intelligence and personality measures:

The distributions of intelligence and personality dimensions were examined, in order to investigate whether scores were normally distributed. This was because participants had been initially selected for the job, based on intelligence and personality measures amongst other criteria. All personality measures except Consistent were approximately normally distributed. Scores ranged from 0 to 10, with means ranging between 4.14 and 6.70 and standard deviations ranging between 1.39 and 2.23. Scores on Consistent ranged between 2 and 7, with a mean of 6.25, a median of 7, and a standard deviation of 1.09, and were highly positively skewed. Scores on the intelligence test were also positively skewed, ranging from 37 to 81, with a mean of 66.95, a median of 68.5 and a standard deviation of 8.32.
Correlations:

Pearson product moment correlations were computed to investigate the relationship between the three measures of job performance, intelligence and personality factors.

Table 5.4.2: Correlations between measures of job performance, intelligence, personality and demographic factors

<table>
<thead>
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<th></th>
<th>Salary</th>
<th>Simulated Performance</th>
<th>Rated Performance</th>
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<td>.56***</td>
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<td>Rated Performance</td>
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<td><strong>Intelligence</strong></td>
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<tr>
<td>CPP</td>
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<td>.23**</td>
<td>.17*</td>
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<td>.19*</td>
<td>.18*</td>
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<td>-.09</td>
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<td>.17*</td>
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<td>.03</td>
<td>.08</td>
</tr>
<tr>
<td>Critical</td>
<td>-.11</td>
<td>-.03</td>
<td>-.18*</td>
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<tr>
<td><strong>Agreeableness</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Active</td>
<td>.03</td>
<td>.07</td>
<td>.18*</td>
</tr>
<tr>
<td>Competitive</td>
<td>-.07</td>
<td>.14</td>
<td>.06</td>
</tr>
<tr>
<td>Achieving</td>
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<td>.16</td>
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<tr>
<td>Decisive</td>
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<td>Age</td>
<td>.26**</td>
<td>-.16</td>
<td>.10</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01, ***p<.001
Salary was positively correlated with Extraversion (Controlling) and Agreeableness (Achieving) and negatively correlated with Openness (Change Oriented). Simulated performance was positively correlated with intelligence, Extraversion (Controlling, Democratic) and Agreeableness (Decisive), and negatively correlated with Openness (Artistic, Traditional). Rated performance was positively correlated with intelligence, Extraversion (Controlling, Socially Confident) and Agreeableness (Active), and negatively correlated with Openness (Traditional) and Neuroticism (Relaxed, Worrying, Critical). These correlation coefficients are presented in Table 5.4.2.

**Linear Multiple Regressions:**

Three multiple regressions were performed in order to investigate whether intelligence and personality dimensions can predict job performance. The dependent variables used were the three measures of job performance. The independent variables were intelligence and the OPQ personality dimensions. The model which used salary as the dependent variable was not significant ($F(32, 101) = 1.01, p = .46$, Adjusted $R^2 = .00$). However, Change Oriented was a significant predictor of salary ($\beta = -.31, t = -2.72, p<.01$). The model which used simulated performance as the dependent variable was significant ($F(32, 101) = 1.82, p<.05$, Adjusted $R^2 = .16$). Significant predictors of simulated performance were Practical, Conceptual and Decisive. The $\beta$ coefficients of the predictors for this model are presented in Table 5.4.3. Finally, the model which used rated performance as the dependent variable was not significant ($F(32, 101) = 1.28, p = .18$, Adjusted $R^2 = .06$). However, Traditional ($\beta = -.25, t = 2.26, p<.05$) and Conscientious ($\beta = .26, t = 2.11, p<.05$) were significant predictors of rated performance.
Table 5.4.3: β values for multiple regression coefficients of simulated performance

<table>
<thead>
<tr>
<th>Simulated Performance</th>
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<tr>
<td>Intelligence</td>
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<tr>
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</tr>
<tr>
<td>Modest</td>
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<td>-.54</td>
</tr>
<tr>
<td>Democratic</td>
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<tr>
<td>Caring</td>
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<tr>
<td>Behavioural</td>
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<td>0.92</td>
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<tr>
<td>Change Oriented</td>
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<td>Innovative</td>
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<tr>
<td>Practical</td>
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<td>Conscientious</td>
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<tr>
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<tr>
<td>Tough Minded</td>
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<td>1.92</td>
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<tr>
<td>Emotionally Controlled</td>
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<tr>
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<td>Consistent</td>
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</table>

Regression Model: F(32,101) = 1.82*
Adjusted R\(^2\) = .16

*P<.05

Stepwise Regressions:

It was assumed that the two of the models tested above, failed to reach significance due to the fact that they included too many non-significant predictors as independent variables. Therefore three stepwise regressions were performed, using again the three job
performance measures as dependent variables, and intelligence and the OPQ personality dimensions as independent variables. This was in order to derive a model that would only include as predictors the variables that account for a significant percentage of the variance of the dependent variable.

The stepwise regression model which used salary as the dependent variable was significant (F (2,131) = 6.59, p<.01), with Adjusted $R^2 = .08$. Significant predictors of salary were Change Oriented ($\beta = -.24, t = -2.86, p<.01$) and Achieving ($\beta = .18, t = 2.18, p<.05$). The model which used simulated performance as the dependent variable was significant (F (2, 131) = 11.23, p<.001), with Adjusted $R^2 = .13$. Significant predictors of simulated performance were Traditional ($\beta = -.31, t = -3.78, p<.001$) and Decisive ($\beta = .19, t = 2.38, p<.05$). The model which used rated performance as the dependent variable was significant (F (2, 131) = 9.30, p<.001), with Adjusted $R^2 = .11$. Significant predictors of rated performance were Traditional ($\beta = -.31, t = -3.72, p<.001$) and Critical ($\beta = -.20, t = -2.42, p<.05$).

The same stepwise regressions were also performed by including gender and age as independent variables in order to investigate whether they are related to job performance. The regression models for simulated and rated performance yielded the same results as above, showing that gender and age are not related to these measures of job performance. However, the model which used salary as the dependent variable (F(3, 100) = 9.09, p<.002, Adjusted $R^2 = .15$) yielded age to be the most significant predictor of salary ($\beta = .29, t = 3.59, p<.001$). Change Oriented ($\beta = -.22, t = -2.78, p<.01$) and Achieving ($\beta = .21, t = 2.62, p<.05$) were also significant predictors of salary.
5.4.4. Discussion

The aim of this study was to investigate the relationship between intelligence and personality factors with job performance, in order to assess the utility of psychometric tests for recruitment and promotions. Furthermore, this study aimed to investigate whether different factors correlate with job performance when job performance is judged by different criteria.

The first hypothesis was that intelligence would be significantly correlated with all three measures of job performance, based on the suggestion that intelligence is the most effective predictor of individual performance on the job (Borman et al., 1991; Varsa & Valutis, 1993; Gottfredson, 1997; Tan & Libby, 1997; Graham, 1999). This hypothesis was partly supported by the results, as intelligence was significantly correlated with simulated and rated performance, but not with actual performance as measured by salary.

The finding that intelligence was correlated with rated performance is in line with Hunter and Hunter (1984), although the magnitude of the correlation is lower than the one reported in their study. This finding indicates that more intelligent individuals tend to rate themselves as performing better on their job. The present study used self-ratings in order to assess performance, based on questions that measured the general areas of thinking, judgment, leadership potential and achievement orientation. The use of self-ratings however has the problem of participants over-rating (or under-rating) their performance, it would therefore be preferable for future studies to use 360° ratings, in order to obtain a more unbiased measure of performance.

Intelligence was further significantly correlated with simulated performance. Simulated performance was a task in which participants were given a hypothetical situation with
given goals, and were asked to produce solutions by which they would achieve these goals. According to Perkins (1995), intelligence is among other things the ability to solve problems, to accomplish tasks and to perform complex projects. It is therefore not surprising that intelligence was correlated with scores on this task. Achievement on simulated performance tasks would also be expected to be influenced by knowledge of the job and also by the time participants have been on the same job, i.e. with familiarity. Tasks however that have been designed in order to measure simulated job performance, are usually especially formed so that they will not be influenced by previous knowledge and familiarity with the job. However, future studies on the effect of intelligence on simulated performance should include measurements of job knowledge and years in one’s job, so that these factors can be partialled out of the correlations of intelligence with job performance.

The finding that intelligence was not correlated with salary is not in line with previous studies, which found general intelligence to be correlated with actual job performance as measured by occupational income and status (Herrnstein & Murray, 1994; Gottfredson, 1997; Jensen, 1998; Mackintosch, 1998). One possible explanation for this is that participants had been pre-selected on the basis of their intelligence during recruitment, which may have caused a restriction in the range of intelligence scores. The distribution of IQ scores supports this, as this was positively skewed. This finding may imply that intelligence does not predict occupational success, but occupational failure. In other words, individuals may need to be above a certain level of intelligence in order to perform well on their job, but if all individuals are above that level, other factors may be more important predictors of job performance. This would be apparent if relationships
between intelligence and job performance were found to be non-linear. Although studies have found this relationship to be linear (Hawk, 1970, Schmidt, Hunter, McKenzie & Muldrow, 1979), criticisms of these studies have been raised (Coward, Sackett & Wilkinson, under review), which indicates that further research should be conducted to investigate this further.

The second hypothesis, which was that the sub-factors of Conscientiousness would be positively correlated with salary and rated job performance was not supported by the results. This hypothesis was based on a number of studies, which have reported positive correlations between Conscientiousness and job performance (Barrick & Mount, 1991; Salgado, 1997; Mount & Barrick, 1998; Barrick et al., 1999). Conscientiousness has been specifically found to predict job performance, as measured by salary (Orpen, 1983; Barrick & Mount, 1991) and supervisor ratings (Hough et al., 1990; Borman et al., 1991), which were two of the performance measures used in the present study.

One possible explanation for the present findings may be, as was proposed earlier, that participants had been pre-selected based on psychometric tests, which may have caused a restriction in the range of Conscientiousness scores. However, the Conscientiousness sub-factors were normally distributed, thus not suggesting a restriction in the range of the scores. It could be the case that this finding is not due to some extraneous factor distorting the results, and that it implies that Conscientiousness is not related to performance across all job criteria and across all occupational groups, as has been proposed by Barrick and Mount (1991).

Recent studies have indeed proposed that certain sub-factors of Conscientiousness may be detrimental for specific occupations (Hough, 1992; Hough et al., 1998; Tett, 1998;...
Boudreau, Boswell & Judge, 2001). Moon (2001) suggested that a negative correlation between Conscientiousness and job performance may be due to the fact that Conscientious individuals often exchange being fast for being thorough, which would not be beneficial for all jobs, such as managers or police officers, and that Conscientiousness may interfere with innovation, which is essential for artistic professions.

The third hypothesis, which was that the sub-factors of Neuroticism would be negatively correlated with the three measures of performance, was partly supported by the results. This was based on previous studies, which found Neuroticism to be negatively correlated with job performance as measured by salary (Harrell, 1969) occupational success during training (Jessup & Jessup, 1971) and by assessment centre exercises (Spector et al., 2000). The present results found two of the Neuroticism sub-factors (Relaxed and Worrying) to be significantly correlated with rated performance. Worrying was also a significant predictor of rated performance in the stepwise regressions.

The finding, that Neuroticism was correlated with self-rated, but not with simulated or actual performance (salary), may imply that Neuroticism is more correlated with intrinsic than with extrinsic measures of performance. Indeed, Boudreau et al. (2001) found Neuroticism to be correlated with intrinsic, but not with extrinsic job success for European executives. Neurotic individuals tend to experience feelings of negative affect (Watson & Clark, 1997), which may be conceived by the raters as job dissatisfaction, which may have led them to administer lower ratings. Neuroticism has previously been linked to lower job satisfaction (Boudreau et al. 2001), therefore future research could investigate this further by looking at whether perceived job dissatisfaction leads to lower ratings of job success.
One scale which was consistently correlated with all measures of job performance was Controlling, which is a facet of Extraversion. Several studies have reported positive correlations between Extraversion and job performance (Howard & Bray, 1994; Borman et al., 1995; Melamed, 1996a, 1996b; Judge et al., 1999), although negative correlations have also been reported (Stewart & Carson, 1995). It seems that Extraversion is a factor that is either beneficial or detrimental for occupational performance, depending on the nature of the job. It has been proposed that Introversion may be beneficial for jobs that require handling routine activities (Cooper & Payne, 1967).

Several scales of Openness and Agreeableness were also correlated with measures of job performance, although different scales were correlated with the different measures. The results indicated that individuals low on Openness and high on Agreeableness tended to perform better on their job. These results are in line with previous studies, which found that job performance is positively correlated with Agreeableness (Tett et al., 1991) and negatively correlated with Openness (Jackson & Corr, 1998). However, studies have also reported the reverse relationship, i.e. that job performance is negatively correlated with Agreeableness (Howard & Bray, 1988) and positively correlated with Openness (Judge & Bono, 2000). This could imply that the relationship between these personality factors and performance also depends on the nature of the job.

The main purpose of this study was to investigate how intelligence and personality affect occupational performance. The evidence suggests that both intelligence and personality factors correlate with job performance, which signifies the importance of taking these factors into consideration, when making decisions regarding recruitment and promotions. It has previously been suggested that failure to employ psychometric tests during
selection may lead to substantial economic losses (Schmidt, 1988). It is therefore essential to investigate further which factors are particularly beneficial for specific jobs, so that occupational psychologists and human resource managers can utilize psychometric tests more efficiently.

The present study also investigated whether it is the same factors that are significantly correlated with job performance irrespective of the way job performance is measured. Three measures were investigated, rated performance, simulated performance, and actual performance. The results indicate that the majority of the scales were only correlated with one or two of the job performance measures. This implies that discrepancies found in previous studies as to the significant correlates and predictors of job performance may be due to the different ways by which performance was measured. This must caution researchers who investigate which factors are significant predictors of job performance, to consider whether their findings are representative according to what measure they use.

Reaching a conclusion on which job performance measure to accept as most representative is not an easy task, as all measures have their drawbacks. Performance rating scales are by far the most often utilized criteria for measuring occupational performance (Borman et al., 1991). Rated performance has however the drawback that factors such as the relationship between the ratee and the rater, and personal characteristics of the ratee, may influence the ratings (Guion, 1983). One way to overcome this problem is by using 360° feedback, which would pool the scores of many raters, thus producing a more unbiased measure. Researchers should also investigate which factors influence performance ratings, and how to measure them, in order to take these factors into account when applying job performance rating scales.
Simulated performance on the other hand, has the drawback that performance might be influenced by the time an individual has been on the job (and subsequently by job knowledge), and also that it measures performance only on one occasion, which might be influenced by irrelevant factors, such as illness. Finally salary, which is a measure of actual performance, will be also affected by factors such as the years an individual has been in the organization. In conclusion, as there is no optimal method of measuring job performance, and since intelligence and personality factors differentially correlate with performance depending on the way of its measurement, researchers should ideally use more than one measures of job performance.

5.5. Summary

The aim of Chapter 5 was to investigate the relationship between intelligence, personality and job performance. Studies 9 and 10 investigated how intelligence, the Big 5 and the ‘Big 4’ personality factors are related to job performance, measured by level of management. Study 10 was a replication of study 9, with the difference that the effect of age was also taken into account. Results showed that in contrast to expectations, intelligence was not a significant predictor of job performance, although it was suggested that this may have been due to a restriction of range in the sample. Regarding the relationship of managerial level to personality factors, when age and gender were controlled for, Conscientiousness, Extraversion, MBTI Extraversion and Intuition were positively correlated with job performance, and Neuroticism, MBTI Introversion and Sensing were negatively correlated with job performance.
Study 11 investigated the relationship between intelligence and personality factors and self-rated, actual and simulated job performance. Intelligence was correlated with simulated and self-rated job performance, but not with salary. Significant correlations were found between facets of Extraversion (positive), Agreeableness (positive) and Openness (negative) with all measures of job performance. Rated performance was also negatively correlated with facets Neuroticism.
Chapter 6: Conclusions

6.1. Summary of findings and implications

The aim of this thesis was to investigate the interface of intelligence and personality, and within this framework to also look at how these constructs are related to occupational performance. The investigation of the relationship between intelligence and personality contributes to research in two fields. The first is the field of individual differences research, by providing a better understanding of the structure, development and dynamic mechanisms and processes underlying stable traits. The second is the applied field of organizational psychology, by providing psychologists with an understanding of how two of the most frequently used constructs in recruitment and selection, are interrelated.

The present thesis on the interface of intelligence and personality, focused mostly on how gf and gc are related to the Big 5 factors of personality. The findings of the five studies (Studies 1, 2, 3, 4, 5) which investigated these relationships are summarized in Table 6.1.1. The asterisk indicates the cases where the β regression coefficient was significant.

A space is left where a relationship was not investigated by the relevant studies.

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*Indicates a significant β regression coefficient

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The major findings concerning the relationship between intelligence and the Big 5, involve the factors of Neuroticism, Openness to Experience and Conscientiousness. Neuroticism was negatively correlated with measures of intelligence (Studies 2, 3, 5), supporting previous studies (Ackerman & Heggestad, 1997, Kyllonen, 1997; Furnham et al., 1998; Zeidner & Matthews, 2000). The nature of this negative correlation was investigated in Study 3. Results showed that Neuroticism is actually more systematically related to intelligence test performance than to intelligence per se. This was concluded because the relationship between intelligence and Neuroticism was mediated by state anxiety. This was explained in that Neurotic individuals experience higher levels of state anxiety under testing conditions, which interferes with their performance on the IQ tests.

This finding implies that IQ tests may underestimate the true intelligence of Neurotic individuals. It should however be noted that intelligence and Neuroticism are usually measured in order to predict some form of performance (e.g. academic or occupational). On this basis, since anxiety affects the performance of high Neurotics on IQ tests, it may also affect their performance on academic or occupational settings, if conditions are stressful or demanding. This suggestion is in line with Meijer (2001) and Oostedam and Meijer (2003), who proposed that test anxiety might be an important bias-factor in the measurement of intelligence, as well as in educational testing. This signifies the importance of forming testing conditions with the minimal possible level of anxiety in educational settings, so as to avoid underestimating the performance of Neurotic individuals.

Another Big 5 factor that was correlated with measures of crystallized, fluid as well as general intelligence (positively), is Openness to Experience (Studies 1, 2, 4). This
supports studies, which suggested that Openness specifically correlates with gc (Goff & Ackerman, 1992; Kyllonen, 1997; Ashton et al., 2000; Zeidner & Matthews, 2000), but also studies which proposed that Openness also correlates with g and gf (Brand, 1994; McCrae, 1994; Zeidner & Matthews, 2000; Austin et al., 2002; Chamorro-Premuzic et al., under review). The rational for the relationship between gc and Openness differs to that for the relationship between Openness and gf. It is suggested that gf may affect the development of Openness, in that it predisposes an individual to develop intellectual interests and intellectual curiosity. This is because individuals high on gf would probably find it more rewarding than individuals with low gf to deal with novel experiences, due to their ability to cope with these efficiently. This would thus lead them to become more Open to experiences. Openness in turn may affect the development of gc. This is because Open individuals, are more intellectually curious and behaviourally flexible, and are more motivated to engage in intellectual activities, which causes them to expand their gc.

A number of studies showed that Conscientiousness is negatively correlated with measures of intelligence (Studies 1, 2, 4, 5). This could indicate that Conscientious individuals spend more time in taking an IQ test, in order to answer each question conscientiously, thus answering less questions, and obtaining a lower score. However, it was observed that Conscientiousness more highly correlates with gf rather than gc (Study 5). Therefore this indicates that Conscientiousness is not related to test taking style, or IQ test performance, but to intelligence per se, and more specifically to fluid intelligence. This was explained in that gf may affect the development of Conscientiousness. This is because in a competitive environment, relatively less able individuals may become more Conscientious, in order to compensate for their comparative disadvantage in intelligence.
By the same rational, more intelligent individuals may not become so Conscientious over time, as they are able to rely on their intelligence to accomplish most cognitive tasks. Study 4 further found that the sub-factors of Conscientiousness that correlate with gf are Order, Self-Discipline, and Deliberation, thus providing further support for the suggestion that Conscientiousness may develop in order to compensate for low gf.

The finding that Conscientiousness is negatively correlated with intelligence has important implications in the occupational environment. For example a company that only uses intelligence or personality inventories during selection procedures, may recruit individuals high on Conscientiousness, which may have a disadvantage in intelligence; or conversely recruit individuals who are highly intelligent, but not well-organized or hard working. It is therefore proposed that intelligence and personality measures should be used in conjunction in occupational settings in order to make accurate judgments. The finding that intelligence is negatively correlated with Conscientiousness could also be used in child development. Attempts could be made for example in the school or the home environment, to make it rewarding for highly intelligent individuals to develop characteristics of Conscientiousness.

Finally, although Big 5 Extraversion was not significantly correlated with measures of intelligence, it was however a significant predictor of several intelligence measures (Studies 1, 2, 4). Extraversion was however both a positive and a negative predictor across studies. This indicates that Extraversion, like Neuroticism, may be mostly related to intelligence test performance, than to intelligence per se. It has been proposed that Extraverts tend to perform better on speeded tasks, whereas Introverts tend to perform better on tasks requiring reflection and insight (Rawlings & Carnie, 1989; Matthews,
This implies that the intelligence levels of Extraverted or Introverted individuals may be undermined according to the nature of the IQ test.

The most important implication of the present investigation of the relationship between intelligence and the Big 5 factors is that the findings attest to an overlap between the constructs of intelligence and personality, despite the fact that the correlations observed are of a small magnitude. This indicates that their interface should be studied in order to provide a comprehensive picture of individual functioning. This is because by studying the two constructs individually, conclusions can be drawn regarding only the structure of the two constructs. By studying their interface, conclusions can also be drawn regarding their development.

The studies that looked at the relationship between intelligence and personality measures commonly used in occupational settings, also provided evidence attesting to the relationship between intelligence and personality, although these correlations were also of a small magnitude. This aspect of the interface of the two constructs focused mainly on how intelligence correlates with measures of Jung's personality types. The findings of the three studies (Studies 1, 7, 8), which looked at Jung's personality types in relation to g, gc and gf, are summarized in Table 6.1.2.

The most consistent findings within this line of research are related to the Sensing-Intuition and Judging-Perceiving dimensions. Intuition was generally found to be positively and Sensing negatively correlated with measures of intelligence, although correlations that did not reach statistical significance were also observed. This is generally in line with the finding that Openness is positively correlated with intelligence, as Openness positively correlates with Intuition and negatively correlates with Sensing.
This indicates the importance of investigating the relationship between different measures of personality. The benefits are not only in providing the basis for validating the various personality measures, and in revealing their overlap in order to provide a unified theory of personality. Investigations on how factors of one personality inventory are related to some variable can also be used, to provide the basis for investigating how other measures of personality are also related to the same variable. Furthermore, when these studies yield consistent findings, they attest to the robustness of the observed relationships.

Table 6.1.2. Summary of findings on the relationship between intelligence and Jung’s personality types

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<tr>
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<tr>
<td>Judging</td>
<td>- ns - -  - - - - - - - -</td>
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<tr>
<td>Perceiving</td>
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</table>

Judging was generally found to be negatively, and Perceiving positively, correlated with measures of intelligence, although correlations that did not reach statistical significance were also observed. This finding is generally in line with the suggestion that Conscientiousness is negatively correlated with intelligence, as it positively correlates with Judging and negatively correlates with Perceiving. This implies that the finding that Conscientiousness negatively correlates with intelligence can be generalized for various measures of Conscientiousness, and is not specific for Conscientiousness as measured by the Five Factor Model.
Another finding which emerged from these studies, is that intelligence is related to the Extraversion-Introversion dimension of Jung's personality types. This dimension was both positively and negatively correlated with measures of intelligence, and some non-significant results were also observed. This is therefore partly supporting the finding that intelligence is correlated with Big 5 Extraversion, which was also both positively and negatively related to intelligence, depending on the nature of the test. Finally, Thinking-Feeling was also both positively and negatively correlated with measures of intelligence. This finding is curious in that the Thinking-Feeling dimension has been correlated with Agreeableness, which has generally been found to be unrelated to intelligence. However, Study 1 revealed significant correlations between intelligence and Agreeableness at the sub-factor level, which may indicate that there is a relationship between intelligence and Agreeableness, which may have been overlooked by studies that focus only at the super-trait level.

A number of significant correlations were also observed between dimensions of the FIRO-B and the CPI personality inventories and fluid intelligence. These were only investigated in one study (Study 8), and will therefore not be repeated here. Hypotheses were however based on previous research regarding the relationship between intelligence and the Big 5 personality factors, and results supported these hypotheses. It can therefore be concluded from this study that no matter which measures are used, a similar pattern of results is observed. This attests to the robustness of the relationship between intelligence and personality, despite the fact that correlations are of a modest magnitude.

Another important finding on the relationship between intelligence and personality, as measured by inventories besides the NEO PI-R, is that a number of correlations were
observed, which were not included in the hypotheses. This implies that although investigations on the relationship between intelligence and personality should focus on the Five Factor Model, other personality inventories could be used as well. This is because although the FFM is one of the most prominent models of personality, and the most widely researched as to its relationship with intelligence, there seem to be aspects of this relationship, which have not yet been discovered. Furthermore, findings of these Studies are important in the occupational field of psychology, where these tests are used along with intelligence measures for recruitment and selection. Therefore knowledge of how these tests are correlated can provide a better understanding of the underlying processes and provide grounds to make more accurate judgements during selection procedures.

Within this framework, the relationship of intelligence, personality and job performance was also investigated in Chapter 5. Findings on these relationships are summarized in Table 6.1.3.

Table 6.1.3. Summary of findings on the relationship between job performance, intelligence and the Big 5 personality factors

<table>
<thead>
<tr>
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<th>Study 10</th>
<th>Study 11</th>
<th>Study 12</th>
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<tbody>
<tr>
<td>Intelligence</td>
<td>- / ns</td>
<td>ns</td>
<td>+ / ns</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>ns</td>
<td>-</td>
<td>- / ns</td>
</tr>
<tr>
<td>Extraversion</td>
<td>ns</td>
<td>+</td>
<td>+ / - / ns</td>
</tr>
<tr>
<td>Openness</td>
<td>ns</td>
<td>ns</td>
<td>- / ns</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>ns</td>
<td>ns</td>
<td>+ / ns</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>ns</td>
<td>+</td>
<td>ns</td>
</tr>
</tbody>
</table>

The initial results (Studies 9, 10) on the relationship between intelligence and job performance were surprising, as these two variables were not significantly correlated
when job performance was measured by level of management. Using level of management as a measure of job performance has however certain limitations, which may have affected the results. These limitations are discussed in section 6.2. It was furthermore acknowledged that the samples used might not have been ideal for this investigation. This is because all participants already possessed a managerial position, which means they most likely had already been selected, based on their intelligence. It is therefore implied that a certain level of intelligence might be a prerequisite for occupational success, but once this level is present, other factors may be more important in predicting job performance. The same line of reasoning can be applied for the non-significant relationship between intelligence and salary, which was observed in Study 11.

Intelligence was however a significant predictor of job performance, as measured by self-rated and simulated performance (Study 11). This indicates that more intelligent individuals tend to rate themselves as performing better on their job, but also that they actually perform better in simulated tasks of job performance. It is therefore apparent that individuals are accurate on their judgment of their occupational performance. This finding, if replicated, would indicate that job performance could be measured by ratings instead of the more time-consuming job performance simulations tasks.

The finding that intelligence predicts job performance has important political implications. Based on Herrnstein and Murray's (1994) findings on racial differences in intelligence, this may lead to a discrimination against black individuals for job positions as well as for higher salaries. In line with this, Johnson and Neal (1998) found racial differences in wage outcomes, which were explained by "skill deficits" of black individuals. It has been proposed, however, that it is of course not solely the case that
employees select employers based on their intelligence. Wilk, Desmarais and Sackett (1995) proposed that according to the 'gravitational' hypothesis, individuals with higher cognitive ability select jobs that require higher cognitive ability, whereas individuals with lower cognitive ability select jobs that are not as demanding.

The investigation of personality correlates of job performance yielded several significant results, although these were not always consistent across studies. When job performance was measured as level of management, and age was controlled for, job performance was positively correlated with Conscientiousness, Extraversion, MBTI Extraversion and Intuition; and negatively correlated with Neuroticism, MBTI Introversion and Sensing (Study 10).

Salary, simulated and self-rated performance were all positively correlated with sub-factors of Extraversion and Agreeableness, and negatively correlated with sub-factors of Openness. Self-rated performance was also negatively correlated with sub-factors of Neuroticism (Study 11). Although these correlations showed a fairly consistent picture of how the Big 5 factors correlate with job performance, at the lower level of personality traits, it was apparent that different sub-factors correlate with different measures of job performance. This signifies the importance of using valid measures of job performance in this type of research, so that results can be representative of job performance in general, and not just for the measure used in the specific investigations.

Understanding the determinants of occupational success can contribute in practice by creating decision aids to improve performance. This has important economic as well as safety consequences for organizations. Organizations that identify individuals best suited to the demands of their positions will be the most competitive. Also in occupations such
as air traffic control, nuclear plant organizations and anesthesiology, it is important to identify the individual differences in vigilance performance for safety reasons. Investigating the relationship between intelligence and job performance reveals whether an individual can do the job, whereas investigating the relationship between performance and personality reveals whether the individual will do the job (Sackett, Gruys & Ellingson, 1998). Therefore in order to have an integrated picture of job performance, researchers should ideally look at the effect of both constructs.
6.2. Limitations and future research

This final section will discuss the limitations of the studies presented, indicating the areas that warrant further research. One limitation, regarding the studies that investigated the relationship between measures of intelligence and personality, is that some of the measures used have not yet received compelling support on their validity, or have been widely used in academic research (e.g. GRT2, 15FQ). This could have caused a restriction in the applicability of the findings. However, studies using such measures yielded the same results as studies that used widely researched measures, such as the Raven’s Progressive Matrices, the NEO PI-R and the MBTI. Therefore this attests to the validity of these measures, since they yielded the same outcomes as well-validated tests, and furthermore attests to the robustness of the findings. The use of different measures also posed the problem that results could not be directly replicated across studies. However, the samples used were large enough to overcome the possibility that the results may be sample-specific.

An important limitation in these studies is that although suggestions were made in order to explain, and not just to observe, the relationship between measures of intelligence and personality variables, causality could only be inferred on theoretical grounds. The major cause for this limitation is time constraint. This is because in the relationship between personality variables (e.g. Openness, Conscientiousness) and psychometric intelligence per se, as opposed to intelligence test performance, longitudinal studies would be essential in order to actually test whether one variable affects the development of the other. This therefore went beyond the scope of the present thesis. However, although longitudinal studies are essential to prove causality, discovering the theoretical basis of
the development of these relationships, which was attempted in the present Studies, is
also essential.

The relationship between Extraversion and intelligence was not investigated in depth in
this thesis. This was partly because the first two studies found Extraversion to be only a
predictor of intelligence, and not a significant correlate of it, but also because findings on
the relationship between the other Big 5 factors and intelligence seemed less clear, and
therefore more interesting to investigate. The finding that Extraverts have a higher resting
level of cortical arousal than Introverts (Eysenck, 1994), which may affect their
performance on an intelligence test according to its nature, is well documented (Rawlings
& Carnie, 1989; Mattews, 1992; Roberts, 2002; Bates & Rock, 2004). It would however
be interesting for future studies to actually test how Extraversion affects performance on
a wide range of intelligence tests, in order to specify exactly which types of tests benefit
Introverts and which Extraverts.

Future research could also investigate the relationship between intelligence,
Conscientiousness and job performance. The interesting aspect of this relationship is that
both intelligence and Conscientiousness are positively correlated with job performance,
whereas the correlation between them is negative. One possible explanation for this, is
that since Conscientiousness consists of six sub-factors, different sub-factors may
correlate with intelligence and different with job performance. Studies 4 and 10 indicate
that this is a plausible explanation. Observing Tables 3.3.3 and 5.3.2, it is apparent that
intelligence is correlated with order, self-discipline and deliberation, whereas job
performance is most highly correlated with competence, dutifulness and achievement
striving. It would therefore be interesting for future studies to investigate this suggestion.
Future research on the relationship between intelligence and the super-trait level of the Big 5 factors of personality should attempt to explain the empirical findings on theoretical grounds. A basis for such grounds can be derived in Ackerman's (1996) PPIK theory (Intelligence-as-Process, Personality, Interests, intelligence-as-Knowledge). According to this theory, individuals start off with differing levels of intelligence-as-process, a concept similar to gf. This form of intelligence interacts with the development of personality and interest variables, causing individuals to devote greater or lesser amounts of cognitive effort in the acquisition of domain-specific knowledge. The PPIK theory, which has been supported by later studies (Ackerman & Heggestad, 1997; Rholfus & Ackerman, 1999; Ackerman, 2000; Ackerman & Beier, 2003), therefore provides a framework by which correlations between personality factors and gf and gc can be explained.

Future research on the relationship between intelligence and the Big 5 factors of personality could also look at the sub-factor level of the Big 5, not just at the super-traits. The main purpose for this is that by looking at which sub-factors of the Big 5 are correlated with intelligence, one can draw conclusions as to how the observed relationships may have developed. Furthermore, by focusing only on higher-level personality traits, one may miss relationships that exist at lower level personality traits. For example Agreeableness was found to be unrelated to intelligence in the majority of the studies presented here, however significant positive as well as negative correlations were observed between intelligence measures and Agreeableness sub-factors (Study 1). This indicates a relationship may be present between intelligence and Agreeableness at the sub-factor level, which may have been overlooked by studies that only investigated
the higher order factors of personality. Future research should also investigate whether it is mid-level or higher-level traits of personality that account for highest percentage of the variance in intelligence scores.

Most of the studies investigating the relationship between personality and intelligence, also investigated whether demographic variables moderated this relationship. Although in most relationships, when demographic variables were partialled out of intelligence-personality correlations, or were included as predictors in regression models, they were not moderating the observed relationships, this was not always the case. In the studies that specifically looked at personality correlates of fluid intelligence, age was frequently moderating the apparent relationships, especially when the age range of the sample was large. This indicates the importance of taking into consideration variables that may be moderating the relationship between intelligence and personality. The present investigation only considered gender and age as possible moderating variables. Future studies should investigate whether other factors, such as participants' beliefs on the validity of the tests, may also moderate this relationship, so that they can be controlled for in the statistical analyses.

The major limitation in the studies that investigated the relationship between intelligence, personality and job performance, is regarding the variables used to measure performance. A basic limitation of managerial level (Studies 9, 10) is that it comprises of only three levels, which means that possible relationships may have been undermined due to the low variability of the dependent variable. Furthermore, it is assumed that managerial level is a good measure of job performance in that good performance is rewarded by promotions. However, a limitation lies in that there are other factors that also influence whether an
individual is promoted to a higher managerial position. Such factors for example may be
the relationship to senior managers, human capital attributes (e.g. training, education),
and the time one has been in an organization. The same limitation holds for job
performance as measured by salary (Study 11). Future studies should therefore identify
the variables, which may be moderating the relationship between job performance,
intelligence and personality, and control for these in the statistical analyses.

Self-rated job performance measures have the major drawback that the participant may
portray an improved self-image, although this did not seem to be the case in Study 11, as
self-rated performance was correlated with simulated performance. Other-rated job
performance measures however also have limitations, such as restriction of range and
halo effects (Furnham & Stringfield, 1993) and may be influenced by factors such as
personal characteristics of the ratee and the relationship between the ratee and the rater.
Finally simulated performance may be influenced by factors such as job knowledge and
physical conditions on the day of the testing.

It is therefore apparent that most single measures of job performance have limitations,
and that further research is essential in order to identify the variables that may be
moderating the relationship between intelligence, personality and job performance. Given
the importance of understanding the determinants of occupational success, it is surprising
that researchers have not investigated this extensively. The problem however with
investigating this issue, is the difficulty in obtaining data from organizations that may or
may not actually gather it. Given the benefits of identifying the determinants of
occupational success, organizations should invest in research in this field.
From the point of view of the organizational benefits of revealing the predictors of job performance, it is also surprising that the tests used for recruitment and selection are often not well-validated tests, or tests that have been researched as to their direct relationship to job performance. This is however due to economic constraints, as the well-validated tests are commonly more expensive for business people to purchase. This signifies the importance in further investigating the relationship between job performance and intelligence and personality, as measured by inventories commonly used in occupational settings.

A fundamental problem in the investigation of personality influences on job performance stems from the current lack of a unified theory, which would explain how, as well as why, personality variables are related to performance on the job. One recent attempt was made by Hogan and Holland (2003), who applied a socio-analytic theory to performance at work. They suggested that organizational behaviour is based on two generalizations, that people always work in groups, and groups are structured in terms of status hierarchies. They thus suggested that organizational behaviour is based on two motivational patterns, to get along with other members of the group, and to get ahead or achieve status. Hogan and Holland (2003) proposed that personality factors should be investigated in terms of these two motivational patterns, in order to explain occupational performance on a theoretical basis. This is at present a suggestion, which may or may not be supported by future studies. It is however important that future research takes the investigation of personality and intelligence correlates of job performance one step further than looking at correlations between these variables, to provide a unified theory, which explains the underlying mechanisms that lead to these relationships.
In view of the finding that intelligence and personality are moderately related, one can ask whether measures of both are really necessary for predicting occupational performance. If one of the two is sufficient to make a good prediction, this would have important economic consequences in the applied field of occupational psychology. However, the finding that two positive predictors of job performance, such as intelligence and Conscientiousness, are negatively correlated between them, indicates the importance in incorporating measures of both in order to make optimal predictions of job success.

One possibility that could be researched, is whether a joint measurement of personality and processing speed would give a good prediction of job performance. This is based on the grounds that processing speed is highly correlated with g (Rindermann & Neubauer, 2001). If evidence is found to support this suggestion, processing speed measures could replace the more time-consuming, and threat-perceived intelligence tests in the organizational settings.
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