VALIDATION OF WECHSLER ADULT INTELLIGENCE SCALE-FOURTH EDITION (WAIS-IV) IN THE GHANAIAN POPULATION

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DECLARATION

This is to certify that this thesis is the result of research undertaken by Daniel Miezah under supervision towards the award of Master of Philosophy in Clinical Psychology Degree in the University of Ghana, Legon.

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ABSTRACT

This study examined the validity and reliability of WAIS-IV amongst a Ghanaian sample. It also developed local norms on the WAIS-IV to be used in Ghana and examined the factor structure of the WAIS-IV. A sample of two hundred and fifty one (251) healthy students and workers was selected from two Senior high schools and the University of Ghana, Legon in the Greater Accra Region of Ghana. Through the use of a cross sectional design, participants of this study were sampled using a purposive sampling technique. The participants of the study were administered both the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) and the Raven's Standard Progressive Matrices (SPM). A Two-Way Analysis of Covariance (ANCOVA) using educational years as a covariate showed that there were significant age and sex-related differences in performance on the WAIS-IV and it indices. Also, results from the analysis using Pearson Product-Moment Correlation Coefficient showed that the Standard Progressive Matrices which is a non-verbal test of intelligence correlated significantly and strongly with WAIS-IV indices (PRI and PSI) that measure non-verbal intelligence than with WAIS-IV VCI which measures verbal intelligence. Moreover, through the use of Paired Samples t-test it was found that there were significant differences between the American published norms and the Ghanaian norms developed from this study on the WAIS-IV. In addition, the four-factor structure of the WAIS-IV was not confirmed. The implications of these findings were discussed in relation to clinical practice in Ghana. It was concluded that there are potential cultural biases in Western imported psychological tests and hence the need for these tests to be validated before being used in Ghana.

DEDICATION

This thesis is dedicated to my God.

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To God be the glory.

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LIST OF ABBREVIATIONS

V-IQ	Verbal IQ
P-IQ	Performance IQ
IQ	Intelligence Quotient
WISC	Wechsler Intelligence Scale for Children
WPPSI	Wechsler Preschool and Primary Scale of Intelligence
POI	Perceptual Organization Index
VCI	Verbal comprehension Index
PSI	Processing speed index
WMI	Working memory index
BD	Block Design
Gf	Fluid Intelligence
GC	Crystallised Intelligence
WAIS-IV	Wechsler Adult Intelligence Scale-Fourth Edition
SPM	Raven's Standard Progressive Matrices
WMS-IV	Wechsler Memory Scale - Fourth Edition
WISC-III^{uk}	Wechsler Intelligence Scale for Children-Fourth UK Edition
FSIQ	Full Scale Intelligence Quotient
Gsm	Short-term memory
Gv	Visual Intelligence
Gs	Processing Speed
PRI	Perceptual reasoning index
IQ	Intelligence Quotient
CPM	Raven's Coloured Progressive Matrices
WAIS-III	Wechsler Adult Intelligence Scale-Third Edition
WAIS-R	Wechsler Adult Intelligence Scale-Revised

CHAPTER ONE

INTRODUCTION

Concept of Intelligence

There have been varied definitions and conceptions of intelligence. The early definitions of intelligence focused on specific or general abilities. In defining intelligence, Charles Spearman (1863–1945) emphasised general ability (*g*) which involved the recognition of relationships (Spearman, 1904) and intelligent activities involved in combining this *g* with specific abilities. Alfred Binet (1857–1911) and Théodore Simon (1872–1961) defined intelligence as "judgment, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances. To judge well, to comprehend well, to reason well, these are the essential activities of intelligence" (Binet & Simon, 1905, p. 43). Lewis Terman (1877–1956), stressed on both knowledge and abstract thinking in defining intelligence (Terman, 1918). The definition provided by David Wechsler (1896– 1981) was "The aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment" (Wechsler, 1958, p. 7). This definition has been one of the most popular definitions of intelligence and has been cited copiously for over half of a century.

Moreover, contemporary definitions of intelligence have focused on how a person functions in the real world and in traditional academic settings (Wagner, 2000). For instance, Armour-Thomas and Gopaul-McNichol (1998) have reported on the importance of a relativistic definition of intelligence which recognises the relevance of the interaction between the cultural set-up of an individual and his or her biological makeup. Gardner also defined intelligence as the "ability to solve problems or fashion products that are of consequence in a particular cultural setting or community" (1993b, p. 15). It is obvious that Gardner saw that intelligent behaviour

had a relationship with specific types of functioning in the real world settings. Robert Sternberg opined that "the essence of intelligence is that it provides a means to govern ourselves so that our thoughts and actions are organised, coherent, and responsive to both our internally driven needs and to the needs of the environment" (Sternberg, 1986, p. 141). His theory was separated into three main parts which included creative, practical and analytical aspects of intelligent behaviour (Sternberg, 1994). Although many more definitions of intelligence can be cited, it is obvious that all these definitions generally suggest that intelligence involve ability to learn, solve problems and adapt to one's environment. The significance of defining intelligence has implications of how intelligence is tested and it is clearly manifested in the different forms of testing for intelligence.

History of Intelligence Testing

During the latter part of the nineteenth century, psychologist started giving attention to the measurement of intelligence. Sir Francis Galton who is considered to be the father of psychological testing developed the first intelligence test (Kaufman & Kaufman, 1983). He stated that individuals who are very intelligent have highly developed senses since we all get information from the environment through our senses. Galton developed and measured sensory and motor tasks as a means of measuring the construct of intelligence.

At the end of the nineteenth century, Alfred Binet and his collaborators came up with tasks to be used in the measurement of children's intelligence (Binet & Simon, 1905). In his opinion, tasks developed by Galton for measuring intelligence could not differentiate between adults and children and were also not complex enough for measuring intelligence. In opposition to the sensorimotor tasks developed by Galton, Binet developed tasks mainly based on language and focused on judgment, memory, comprehension, and reasoning. In 1905, Binet and Simon

developed their first in a series of tests designed to assess intelligence. Their test was called the "Binet-Simon Scale". In 1908, the Binet-Simon scale was revised and age groups from three to thirteen years were added to it (Binet & Simon, 1908). Again, by 1911 the Binet-Simon scale was revised to include age fifteen and consisted of five adult tests that were not graded (Kaufman, 1990a). Just after Alfred Binet introduced intelligence testing in France, the U.S. Public Health Service began using such tests to measure the intelligence of people seeking to immigrate to the United States. Henry H. Goddard, who had been highly instrumental in getting Binet's test adopted for use in various settings in the United States, was the chief researcher assigned to the project. Early on, Goddard raised questions about how meaningful such tests are when used with people from various cultural and language backgrounds. Goddard (1913) used interpreters in test administration, employed a bilingual psychologist, and administered mental tests to selected immigrants who appeared mentally retarded to trained observers. Goddard found most immigrants from various nationalities to be mentally deficient when tested. Goddard (1917) thought the findings could be due to "hereditary defect" or "apparent defect due to deprivation" (p. 243). Thus, these findings were largely the result of using a translated Binet test that overestimated mental deficiency among both native English-speaking and immigrant populations (Terman, 1916).

The adaptation and translation of the Binet-Simon scale for use in America was carried out by Lewis Terman (1916). He standardised this measure on both children and adolescents (Kaufman, 2000b). The Stanford-Binet test developed by Terman and subsequent revisions (Terman & Merrill, 1937, 1960) was a very popular intelligence test in America for almost forty years.

During World War I in 1917, psychological assessment was extended to the assessment of adults in the U.S. (Anastasi & Urbina, 1997). Following a need by the American military for the selection and placement of soldiers, Arthur Otis (Terman's student) developed an IQ test that became known as Army Alpha. Another test called Army Beta was developed for the assessment of immigrants who could not speak much English (Anastasi, 1988). The Army Beta composed items that were nonverbal and was meant to be administered to a group of people. Eventually, the American Army psychologists developed a test called the Army Performance Scale Examination which was an individually administered test to help in the assessment of individuals who could not be properly tested on Army Alpha or Beta tests which were group-administered tests.

In the mid-1930s, David Wechsler became a key contributor in the field of psychological assessment. He approached psychological assessment by combining his experience in psychological testing which he acquired as a World War I examiner and his training in statistics which he learnt from Charles Spearman and Karl Pearson in England. In developing his test, Wechsler focused on using a set of tasks to acquire clinical information from individuals. The Wechsler-Bellevue Intelligence Scale (Wechsler, 1939) was the first test that Wechsler developed. A second form of the Wechsler-Bellevue Intelligence Scale was developed in 1946 and the Wechsler Intelligence Scale for Children (WISC); (Wechsler, 1949) was developed based on the second form of the Wechsler-Bellevue Intelligence Scale. The WISC eventually became one of the most commonly used tests in the assessment of intellectual abilities (Stott & Ball, 1965).

Sir Cyril Burt is one of the controversial figures in the history of intelligence testing due to his work on the heritability of intelligence and later evidence that he used fraudulent data to

support his ideas (Scarr, 1994). Burt (1909) conducted a study to compare the intelligence of boys enrolled in an elite preparatory academy with the intelligence of boys attending a regular school. In order to control for environmental influences, he chose measures (such as mirror drawing) that were unlikely to have been learned during the students' lifetimes. Because the preparatory school students scored higher than the regular students, he concluded that they had more innate intelligence. Although Burt believed that intelligence is largely inherited, he admitted that environmental factors are also essential (Burt, 1922).

Some of the contemporary tests of intelligence include the Wechsler Intelligence scales, Stanford-Binet Intelligence Scales, Woodcock-Johnson Test of Cognitive Ability and the Kaufman Assessment Batteries. The Wechsler Intelligence tests are the most popular and commonly used of the contemporary tests of intelligence. This is may be partly because a lot of research has been done to improve it. It could also be due to the fact that Wechsler tests measure both crystallised and fluid intellectual abilities.

Criticisms against Intelligence Testing

Although intelligence tests are widely used in different fields including Psychology and Education, their uses have been usually criticised. For example, the validity of intelligence tests have been criticised. A valid test measures what it claims to measure (Kline, 2000). Intelligence tests have been criticised to measure variables other than intelligence. For instance, it is argued that intelligence tests measure test-taking skills of people instead of their intelligence. The use of intelligence tests for predicting social outcomes have also been criticised. Researchers have shown that general intelligence (*g*) correlate with some variables (Deary, Strand, Smith, & Fernandes, 2007). It is essential to note that correlational studies just show relationships between the variables but does not indicate causality. Therefore, those who criticise intelligence testing

believe that intelligence should not be used to predict other life outcomes such as Job success. Intelligence tests have been criticised for being biased such they show group differences (Neisser et al., 1996). For instance, studies have shown both age and gender differences in intelligence (Salthouse & Saklofske, 2010). In addition, intelligence tests have been shown to be culturally biased (Cockcroft, Alloway, Copello & Milligan, 2015). These differences may be due to differences in testing procedures or cultural relativity of test items.

A Brief History of Psychological Testing in Ghana

It is not known exactly when psychological testing began in Ghana but it can be inferred that it has been part of psychological practice ever since psychology as discipline emerged during the colonial days (de Graft Aikins, Ofori-Atta, Anum, & Dzokoto, 2014, Oppong Asante & Oppong, 2012). Although western psychological tests have been used in Ghana for a very long time only a few validation studies have been done to examine the validity of these tests in the Ghanaian context. Some of the few Western psychological tests which have been standardised in Ghana include Multidimensional Aptitude Battery (Debrah, 2002), Raven's Standard Progressive Matrices (Yawson, 2008), Basic Personality Inventory (Oteng-Yeboah, 2005), Wechsler Intelligence Scale for Children, Third Edition (Edwin, 2001), Coping Inventory for Stressful Situations (kyei, 2008) and Raven's Coloured Progressive Matrices (Anum, 2014). Intelligence tests have been used in organisational, clinical and educational settings in Ghana. In organisational settings, intelligence tests have been used when selecting and classifying employees. Moreover, in organisational settings intelligence tests have been utilised in areas such as hiring, job assignment, transfer, promotion and termination of appointments. Intelligence tests have been very useful in educational settings for selecting students through examinations and also in identifying learning difficulties amongst them. Again, in educational settings

intelligence tests have been used to identify extremely slow or fast students and to undertake vocational and school counselling (Anastasi & Urbina, 1997).

In clinical settings, intelligence tests are used as part of neuropsychological assessments to examine neuropsychological deficits of patients (Axelrod & Wall, 2007).Intelligence tests have been considered as part of neuropsychological assessments since neuroimaging techniques are sometimes not able to detect subtle brain dysfunctions (Comer, 2010). Intelligence tests have been useful in the identification of children with intellectual deficit disorders (Anastasi & Urbina, 1997). Moreover, intelligence tests have been used in the assessment of patients to detect intellectual deficiencies in clinical settings. Furthermore, Psychological tests have been used in the assessment of individuals who experience emotional and behavioural problems (Anastasi & Urbina, 1997). Psychological tests are also utilised as important tools for conducting research.

The need to validate and standardise psychological tests

It has been argued that no test can be completely culture free or unbiased (Plank, 2001). Such an argument raises concern on the appropriateness of applying conventional assessment tools to individuals with different cultural backgrounds (Tseng, 2001). The differences in test scores have been particularly attributed to social factors (Neisser et al., 1996), English proficiency (Beiser & Gotowiec, 2000), environmental factors (Neisser et al., 1996), socio-economic status (Beiser & Gotowiec, 2000; Suzuki & Valencia, 1997), acculturation (Flanagan & Ortiz, 2001; Sattler, 2001), cultural factors (Beiser & Gotowiec, 2000; Neisser et al., 1996), and test content bias (Suzuki & Valencia, 1997). It can be deduced that Western standardised psychological tests which are used in countries with different cultural backgrounds like Ghana are likely to lead to misdiagnosis, mischaracterizations, and erroneous conclusions about individuals and groups when test outcomes are influenced by socio-cultural factors (Beiser &

Gotowiec, 2000). Validation studies are needed since it cannot be assumed that a test developed to measure for example Intelligence in a western country would measure the same construct in a country with a different socio-cultural background like Ghana. Moreover, it cannot be assumed that the norms of the western psychological tests are applicable to people from countries with different cultural backgrounds. It is therefore important to conduct validation studies on western psychological tests before using them in a different cultural setup.

The Current Study

In Ghana different editions of the Wechsler intelligence scales have been used in clinical, educational or industrial settings. Most of these Wechsler intelligence scales have not been validated and lack local normative data for the Ghanaian population. Such a situation is likely to cause clinicians to make misdiagnosis and invalid decisions on the intellectual potential of their clients due to cross cultural differences. To date, the only study in Ghana that has worked on validating and developing norms on one of the Wechsler intelligence tests for the Ghanaian population is that of Edwin (2001). Edwin (2001) found that the scaled scores for Ghanaian children were lower than scores on the British published norms, differences that may be attributed to contextual factors (Neisser et al., 1996). Reference to foreign published norms for the WAIS-IV in Ghana therefore may lead to mischaracterization and misdiagnoses of individuals. The focus of this study was to validate the WAIS-IV for the Ghanaian population since it is a global intelligence test that measures cognitive ability in multi-dimensions. Thus, the WAIS-IV is one of the most widely used neuropsychological test for measuring both verbal and non-verbal cognitive abilities in Ghana and the world.

Aims and Objectives

The main aims of this study were to develop local norms on the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) for the Ghanaian population and to test for group differences on the various WAIS-IV indices. Specifically this study sought:

1. To standardise the WAIS-IV on a sample of Ghanaians.
2. To examine age differences in performance on the WAIS-IV.
3. To examine gender differences in performance on the WAIS-IV.
4. To examine the relationship between the WAIS-IV and the Raven's Standard Progressive Matrices (SPM).
5. To examine for differences between the WAIS-IV American published norms and the Ghanaian norms developed from the current study.

Relevance of the Study

This study will help to develop local norms on the WAIS-IV which can be used within clinical, industrial and educational settings in Ghana for neuropsychological assessments. The Psychologists working in various sectors of Ghana will use the norms developed from this study on the WAIS-IV to interpret the results of their neuropsychological testing and to make medical decisions concerning their clients. The study will also provide Psychologist in Ghana with information on whether the WAIS-IV is applicable to the Ghana setting or not .Furthermore, the study will provide both clinicians and patients with knowledge on decline in cognitive ability with aging. In addition, the findings of the study will be useful to researchers who conduct studies involving the measurement of the intelligence of adolescents and adults.

CHAPTER TWO

LITERATURE REVIEW

Introduction

The main aims of this study were to develop local norms on the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) for the Ghanaian population and to test for group differences on the various WAIS-IV indices. Reviews of related studies and theories are presented in this chapter. This chapter also covers the rationale for the study and the statement of hypotheses.

Theoretical Framework

Cattell-Horn-Carroll (CHC) theory

The Cattell-Horn-Carroll (CHC) theory of intelligence is one of the most comprehensive and widely accepted theory of the structure of intelligence or cognitive ability. This theory was developed based on the studies of Raymond Cattell, John Horn, and John Carroll (Schneider & McGrew, 2012). Cattell developed his Fluid–Crystallized (*Gf-Gc*) theory during the 1940s. He conceptualised cognitive ability into Fluid Intelligence (*Gf*) and Crystallized Intelligence (*Gc*) (Cattell, 1957). Cattell opined that Fluid Intelligence (*Gf*) consisted of both inductive and deductive reasoning abilities. He believed that biological factors influenced these abilities. In addition, he proposed that Crystallized Intelligence (*Gc*) was made up of knowledge that a person acquires in life (Cattell, 1971). In 1965, John Horn expanded Cattell's theory by adding four abilities. These abilities were visual perception or processing (Gv), short-term memory (Short-term Acquisition and Retrieval—SAR or Gsm), long-term storage and retrieval (Tertiary Storage and Retrieval—TSR or Glr), and speed of processing (Gs) (Horn, 1968). Carroll (1997) divided cognitive abilities into four groups or levels. He classified the *G* abilities as broad

(stratum II) abilities which consisted of *Gf* and *Gc*. He believed that the broad abilities (*Gf* and *Gc*) were made up of narrow (stratum I) abilities (Carroll, 1993). According to Carroll the narrow abilities ‘‘represent greater specializations of abilities, often in quite specific ways that reflect the effects of experience and learning, or the adoption of particular strategies of performance’’ (Carroll, 1993, p. 634). He opined that stratum III consisted of the general level of cognitive ability (general factor, *g*). Thus, stratum III consisted of both broad (stratum II) and narrow (stratum I) abilities.

McGrew (1997) was the first person who proposed an integrated Cattell-Horn and Carroll model. This model was later revised by McGrew and Flanagan (1998) and revised again by Flanagan et al. (2000). This integrated model proposed by McGrew and others was referred to as the Cattell-Horn-Carroll (CHC) theory. The CHC theory includes 16 broad cognitive abilities which are made up of over 80 narrow cognitive abilities. The main idea of the CHC theory is that there are three strata or levels of cognitive abilities that are hierarchical in nature. Stratum I consist of narrow abilities whiles Stratum II is made up of broad abilities. Stratum III of the CHC theory is made up of the general cognitive ability (*g*).

Gardner’s theory of multiple intelligences

The theory of multiple intelligences was developed by Gardner (1983). Gardner in 1983 published a book titled "Frames of Mind." In this book he proposed seven different types of intelligence. Subsequently, Gardner (1994) proposed an eighth type of intelligence. He opined that intelligence is not a unitary concept. Thus, he argued that there is nothing like “general intelligence”. He rather believed that people have multiple intelligences. The eight multiple intelligences according to Gardner (1983, 1994) are logical-mathematical, bodily-kinesthetic, linguistic, musical, spatial, interpersonal, intrapersonal and naturalist intelligence. According to

Gardner (1983) linguistic intelligence helps us in reading a book, writing a paper or comprehending spoken words. In addition, logical-mathematical intelligence is utilised when we are solving mathematical problems. Moreover, in Gardner's view, interpersonal intelligence helps us to relate with people we encounter in the society.

Review of related studies

Culture and Intelligence

The evidence in support of cultural differences in cognitive ability and performance on intelligence tests support the view that individuals in minority cultures always perform poorly (Heaton, Taylor, & Manly, 2003). This controversy stemmed from the fact that some researchers have equated this difference in performance to inferior ability on the part of minority culture (Rushton & Jensen, 2005). There are however, other views preceding this, particularly from research among African Americans which showed that non-white test takers scored lower than Whites (Kaufman, McLean & Reynolds, 1991). Scientific data in support of these issues will be reviewed in this section.

The connection between race and intelligence has been a subject of debate for several decades in the psychological literature. The debate is stemmed from the finding that Caucasians tend to on average score higher than test takers of African ancestry on IQ tests (Rushton & Jensen, 2005). Psychologists seem to be divided on the basis of these differences in test scores. Jensen (1969) caused much public debate with his article "How Much Can We Boost IQ and School Achievement?" In this article he argued that racial differences in intelligence are largely due to heredity. Thus, he reported in his article that intelligence is largely determined by genetic factors. In addition, Rushton and Jensen (2005) argued that genetic factors account for about half of the gap between races in average IQ. Critics have argued that heritability explanations for

ethnic differences in IQ have a variety of flaws and weaknesses (Sternberg, 2005). For example, research suggests that the heritability of intelligence may be notably lower in samples drawn from the lower socioeconomic classes as opposed to higher socioeconomic classes (Turkheimer et al., 2003). Eysenck and Kamin (1981) have stated that "differences in the average IQ of various human populations could be entirely due to environmental differences, even if within each population all variation were due to genetic differences"(p. 97). This statement implies that even if within-group differences in IQ are highly genetic, between-groups differences in IQ could still be caused solely by environmental factors (Block, 2002). Weizmann et al. (1990) also criticised the view of Rushton (1988a) that intelligence is largely inherited. Weizmann et al. (1990) opined that the influence of environmental factors on intelligence cannot be ignored. There is increasing evidence that culture shapes cognitive development in a major way such that intelligence development will show racial differences that is explained by culture more than ability. On many occasions researchers have reported on differences in the IQ scores of different cultures. For instance, African American, Hispanics and Native Americans tend to have lower scores than that of Caucasians and Asians (Cohen & Swerdlik, 2004). In his 1969 study Jensen found a 12 point IQ differential between Blacks and Whites (as cited in Amante, VanHouten, Grieve, Bader, & Margules, 1977). Jensen and Reynolds (1982) reported a disparity of 1 SD (15 or 16 points) between Blacks and Whites on intelligence tests. In Ghana, Glewwe and Jacoby (1992) reported in a World Bank study that tested a representative sample of 1,736 individuals ranging in age from 11 to 20 years old from the entire country. All had completed primary school; half were attending middle school. Their mean score on the Coloured Progressive Matrices was 19 out of 36, which is below the 1st percentile for 151/2-year-olds on U.S. norms, an IQ equivalent of less than 70. Kramer, Allen, and Gergen (1995) reported on culture

differences on cognitive tests with highest scores among white children, intermediate scores among Hispanic children and lowest scores achieved by black children. With regard to Southern African research, Rushton and Jensen (2003) reported that, race differences exist between groups tested on the Raven's which has resulted in a ranking in terms of scores with Whites scoring the highest, followed by Indians, Coloureds and Blacks (who score the lowest). Prifitera, Weiss, Saklofske and Rolfhus (2005) also found persistent group differences between African Americans, Hispanics and Whites in the WISC-IV standardisation sample, despite matching of the sample for a number of subject characteristics, including age, gender, geographic region, socio-economic status and level of education.

These evidences suggest that one's culture have an impact on the determination of intelligence. Sometimes, even within a single country such as Switzerland, three distinct cultural groups (German, French, and Italian) exist to complicate the measurement of intelligence (Georgas, Weiss, van de Vijer, & Saklofske, 2003).The differences in access to education has been proposed to account for such a situation.

In their study, Cockcroft, Alloway, Copello and Milligan (2015) tested a sample of Black South African University students who spoke English as a second language by using Wechsler Adult Intelligence Scale-Third Edition (WAIS-III). These Black South African University students were multilingual and from a low socio-economic background. The mean scaled scores of the South African students on the WAIS-III were compared to that of white British monolingual students who had a higher socio-economic background. By using multi-group confirmatory factor analysis it was found that the WAIS-III was not measurement invariant between the South African and British students. This meant that the WAIS-III seemed to be measuring different constructs between the groups. The researchers found that the British

students had higher mean scaled scores than the South African students on the WAIS-III subtests of the Verbal Comprehension Index and the Perceptual Organisation Index. It also was found that the South African students had higher mean scaled scores than the British students on the WAIS-III subtests of the Processing Speed Index. However, the researchers found no significant differences between the two groups on the WAIS-III subtests of the Working Memory Index.

In a related study in Canada, Harrison, Holmes, Silvestri, and Armstrong (2015) examined if any significant differences existed between the WAIS-IV Canadian and American normative data. The study involved 861 postsecondary students. These researchers found that their sample had significant lower scaled scores when the WAIS-IV Canadian norms were used than when WAIS-IV American published norms were used. Their findings implied that there were significant differences between the WAIS-IV Canadian and American norms. The researchers attributed this finding to differences in sample size and also sampling bias. Thus, the researchers explained that their sample size was not obtained in a random manner.

Similarly, Harrison, Armstrong, Harrison, Lange, and Iverson (2014) examined whether there were any significant differences between the Canadian and American WAIS-IV norms. The WAIS-IV was administered to 432 Canadian postsecondary-level students who were being assessed for mental health problems. These researchers found that WAIS-IV Full Scale IQ, Index and subtest scores were significantly lower when Canadian norms were used for transforming the raw scores to scaled scores than when the American published norms were used. The results of this study showed that there were significant differences between the American and Canadian WAIS-IV normative data. These researchers attributed their finding to differences in sample size and also sampling bias. Both the study of Harrison et al. (2015) and Harrison et al. (2014) arrived at the same finding that their sample had significant lower scaled scores when the WAIS-IV

Canadian norms were used than when WAIS-IV American published norms were used. These findings may be attributed to cultural differences between the two countries. This is significant given that the two countries are close neighbours and seem to share a lot more in common than they do with other societies.

Miller, Davidson, Schindler and Messier (2013) in their study conducted in Canada involving 145 older adults administered both the WAIS-IV and the Older Adult version of the WMS-IV. They investigated whether their dataset matched that of the publisher's normative sample through comparison of their scaled scores with the published norms. The results from the study indicated that their sample had significantly higher scaled scores than the normative sample on the Information, Coding and Vocabulary subtests of the WAIS-IV. Thus, they found significant differences between the norms derived from their sample and the American published norms. The findings of Miller et al. (2013) are contradictory to that Harrison et al. (2015) and Harrison et al. (2014).

In yet another study, Suwartono, Halim, Hidajat, Hendriks, and Kessels (2014) conducted a standardization study on the WAIS-IV in Indonesia. Through the use of quota sampling technique 148 healthy individuals representing gender, age groups, educational levels, and different ethnic backgrounds were selected. The US version of the WAIS-IV was translated into Indonesian-language. The findings indicated that the sequence of administering the American WAIS-IV is not applicable to the Indonesian sample due to differences in the WAIS-IV index difficulties between the US and Indonesian version of the WAIS-IV.

In his paper, Shuttleworth-Edwards (2012) supported the view that there are cross-cultural differences in the use of western psychological tests in the African context. He therefore proposed methods to help South African practitioners to make use of the clinically improved

WAIS-IV which has not yet been validated in South Africa and lacked local norms for its use in South Africa. Thus, Shuttleworth-Edwards (2012) proposed a statistical procedures for changing WAIS-IV raw scores into WAIS-Ill scores through the use of the existing WAIS-Ill South African norms. While this approach may help practitioners overcome some of the cross-cultural differences associated with the use of the WAIS-IV in the South African context, the best approach to solving the problem of cross-cultural differences on the use of the western psychological tests in the African context is to conduct validation studies on these tests.

Roivainen (2013) compared the American and Finnish WAIS, WAIS-R, and WAIS-III norms for the nonverbal and working memory subtests. It was found that the American standardisation samples had higher mean raw scores on the Coding and Digit span subtests than the Finnish samples. It was also found that the Finnish samples had higher mean raw scores on the Block design subtest than the American samples. However, no significant differences were found between the American and Finnish standardisation samples on the rest of the nonverbal subtests of the WAIS, WAIS-R, and WAIS-III. Linguistic, educational, and socio-cultural factors may be the reasons for the differences between these two countries.

Grieve and Van Eeden (2010) aimed to standardise verbal subtests of the WAIS-III to be used for Afrikaans-speaking South Africans. These verbal subtests of the WAIS-III had already been translated to Afrikaans language. A sample size of 82 participants was used in this study. The findings of the study showed that there was a significant difference between the mean scaled scores of the Afrikaans speakers who were sampled from urban areas and the non-urbanised sample of Afrikaans speakers with low educational quality on the WAIS-III. The urbanised Afrikaans speakers had higher mean scaled scores on the WAIS-III than the non-urbanised sample of Afrikaans speakers with low educational quality.

A different but a related study to the one above was conducted in South Africa. Shuttleworth-Edwards et al. (2004) conducted a study among two South African groups across three variables (language, level of education, and quality of education) and administered the Wechsler Adult Intelligence Scale (WAIS-III) to a South African sample of 68 participants (age range 19–30). The participants were either Whites whose first language was English or Blacks with a Black South African first language. Education quality was said to be high if one went to a white private school and low if one went to a formerly Department Education Training school. Their analysis revealed highly significant effects for language, level and quality of education between the two groups. It was also found that there were no significant differences between WAIS-III scores obtained by the White English and the Black African first language samples with advantaged education and the American standardisation sample. However, WAIS-III scores obtained by the black African first language sample with disadvantaged education were significantly lower than that of the American standardisation sample. The findings of this study showed that individuals with higher quality of education had higher scores on the WAIS-III irrespective of their first language or race. These two South African studies suggest that both education and language affect performance on the Wechsler tests. It therefore implies a need to stratify norms on the Wechsler tests by taking such variables into consideration in order to reduce their effects and reduce cultural bias in the Wechsler tests.

Human Sciences Research Council (HSRC) in South Africa conducted a study to adapt and standardise the Wechsler Adult Intelligence Scale – III (WAIS-III) for English-speaking South Africans (Claassen, Krynauw, Hotzhauzen, & Mathe, 2001). A sample size of 250 participants from each of four ethnic groups (Black, Coloured, Indian, and White) in South Africa were included in the study. The sample size for the study included both first and second

language English speakers who were educated either in English or Afrikaans. The researchers stratified for the effect of level of education (number of years of education completed).However, they did not stratify for the effect of quality of education on the WAIS-III. After administering the WAIS-III to the participants of the study, items identified to be biased against non-white South Africans were changed. Also, WAIS-III Information and Comprehension subtests items that seemed to be unrelated to the South African culture were replaced with appropriate items. The findings of this study showed that the English-speaking white South Africans significantly had higher mean scores on the WAIS-III than the other groups.

In the only study on the Wechsler scales in Ghana, Edwin (2001) standardised the WISC-III^{uk} for use in Ghana by using 200 Ghanaian school children. It was found that Ghanaian children had lower mean scaled scores on almost all the subtests of the WISC-III^{uk} except the Digit Span subtest when British published norms were used instead of the Ghanaian norms. The researcher attributed these differences in performance on the WISC-III^{uk} between the British and the Ghanaian norms to differences in cultural backgrounds. It was also found that there were no significant differences in the mean scaled scores of males and females on almost all the subtests of the WISC-III^{uk} except the mazes subtest. The researcher found significant correlations between the Raven's coloured progressive matrices test and the subtests of the WISC-III^{uk} except the coding and the symbol search subtests. According to Edwin (2001) these differences in the performance on the WISC-III^{uk} between the two countries may be attributed to their different cultural backgrounds. Specifically, these differences may be explained by differences in education, language and income. Thus, educational resources and opportunities are limited in public schools which serve a majority of Ghanaian children when compared to Western richer countries such as Britain where the WISC-III^{uk} was normed.

Another important validation study conducted on a neuropsychological test in Ghana is that of Anum (2014).In this study he developed local norms on the Raven's Colored Progressive Matrices based on data collected from seven hundred and sixty-three urban and rural children in Ghana. Interestingly, when the researcher compared his developed local norms on the Raven's Colored Progressive Matrices with the British published norms, he found that the scores for the Ghanaian norms were lower. He concluded that British children perform better on the Raven's Colored Progressive Matrices than Ghanaian children. The researcher attributed these differences in performance between the two countries to differences in cultural factors such as education.

Based on the evidence from the literature reviewed, it appears that most validation studies on the Wechsler Intelligence scales have been conducted in the Western countries with only a few of such studies conducted in Africa. This literature also suggests that the few standardisation studies conducted on the Wechsler Intelligence scales in Africa have been done mostly in South Africa on the previous editions of the Wechsler Intelligence scales such as WAIS-III. To date, the only study in Ghana that has worked on validating and developing norms on Wechsler intelligence tests for the Ghanaian population is that of Edwin (2001) which was conducted on the WISC-III^{uk} among Ghanaian children. Furthermore, it appears to date, no study or few studies has been conducted in Africa to validate and standardise the WAIS-IV even though it is widely used in most African countries including Ghana.

Age and Intelligence

Studies on the relationships between age and intelligence began almost 100 years ago in comparisons between adults and children (Kirkpatrick, 1903). Age has been reported as a variable which significantly influences intelligence test scores (Wechsler, 1997). It has also been reported that neuropsychological test scores tends to be negatively correlated with age among

adults (Cerella, 1990).However, it has been argued that some adults maintain their cognitive functioning even during later years in life (von Faber *et al*., 2001).A number of studies have been conducted to find out whether cognitive abilities decline with increasing age in adults using the Wechsler Adult Intelligence Scales (Salthouse & Saklofske, 2010).

In a study conducted in Indonesia mentioned earlier, Suwartono *et al*. (2014) aimed to adapt and validate the Wechsler Adult Intelligence Scale—fourth edition (WAIS-IV) for use in Indonesia. It was found that all WAIS-IV Processing Speed index subtests showed significant age-dependent declines. Also, these researchers found that most of the Perceptual Reasoning index subtests and the Working Memory index subtests showed significant age-dependent decline. However, they found no significant correlations between the Verbal Comprehension index subtests and age. Such findings are consistent with previous literature which suggests that measures of fluid intelligence are more prone to the effects of aging than measures of crystallised intelligence (Kaufman & Horn, 1996).These researchers also found no significant differences mean score of males and females in any of the WAIS-IV indices.

In a related study, Daseking and Petermann (2013) conducted an analysis of the data (*N*=1664) that was used during the standardisation of the German Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV). They found that the eldest age group had the lowest mean raw scores in all the WAIS-IV subtests. It was also found that the 20-29 age group had the highest mean raw scores in all the WAIS-IV subtests except the information subtest. The researchers found that WAIS-IV subtests of the Perceptual Reasoning and Processing Speed indexes showed significant age-dependent lost. However, WAIS-IV subtests of the Verbal Comprehension and Working Memory Indexes showed a lesser age-dependent lost. These findings suggest that there are cognitive declines in all cognitive abilities as people grow during

adulthood. Thus, even verbal comprehension ability which is known to be maintained during aging in adulthood may show significant declines with increasing age. Therefore, such a finding is contradictory to what is already known in the literature.

Baxendale (2011) also used WAIS-IV standardization data to conduct a cross-sectional analysis in which she set ages 16–17 years as the reference group for all adults. First, she identified the raw score for each subtest that yielded a scaled score of 10 at ages 16–17. Then she entered that identical profile of raw scores into the scaled-score tables for each of 13 age groups between 16–17 and 85–90 and computed mean Indexes and Full Scale IQs for each age group. She repeated this procedure for scaled scores of 6 (IQ =73) and 14 (IQ=129) and graphed the results for the three different ability groups. It was found that VCI was maintained for much of the life span before declining mildly. WMI showed notable decline relative to the VCI, but far less decline than the extremely vulnerable PRI and PSI. These findings imply that measures of fluid intelligence are more prone to the effects of aging than measures of crystallised intelligence (Kaufman & Horn, 1996).

In a similar study, Salthouse and Saklofske (2010) used WAIS-IV standardization data to compare the performance of individuals in two broad age groups: 16–64 (*n*= 1,600) and 65–90 (*n*= 600). They reported that the mean score for the younger age group was higher than that of the older age group in all the WAIS-IV index scores. When Salthouse and Saklofske (2010) compared the two groups on the separate subtests, the education-controlled effect sizes for Vocabulary (-0.29) and Information (-0.20) indicated that the older sample outperformed the younger sample on these subtests. In contrast, the younger group scored higher on the Similarities subtest and the Digit Span Sequencing task. Also, the researchers found lower IQ test performance by older than younger adults.

Kaufman (2001) analysed data from the WAIS-III standardization sample of 2,450 individuals at ages 16–89 years (basing all IQs on a reference group ages 20–34). The increase in age range to almost 90 years made it clear that Verbal-IQ (V-IQ) is a maintained ability and remains robust well into the 70s, but it is decidedly not maintained through very old age (Kaufman, 2001). After age 79, Crystallised Intelligence declined precipitously. In fact, V-IQ decreased just as much as Performance IQ (P-IQ) for people in their 80s, even with education controlled. P-IQ peaked in young adulthood, and then declined steadily and dramatically across the age range (especially at ages 45 and above); education-adjusted mean P-IQs were below 80 for adults in their 80s. The four WAIS-III Indexes displayed patterns of age-by-age education-adjusted means that are decidedly different from each other. It was found that VCI was maintained throughout most of the adult life span, whereas the other three Indexes were vulnerable to the effects of aging. WMI was the least vulnerable of the three and PSI was the most vulnerable, considerably more so than POI (now called PRI on the WAIS-IV).

Ryan, Sattler and Lopez (2000) examined the effect of age on the Wechsler Adult Intelligence Scale-III (WAIS-III) by using the WAIS-III standardization sample. This standardisation sample was divided into 13 age groups during the standardisation of the WAIS-III. It was found that there were significant differences between the younger and older age groups in the verbal subtests of the WAIS-III. Also, WAIS-III Performance subtests showed significant changes across the various age groups in the study. The researchers concluded that as age increases performance on processing speed and perceptual organisation subtests show high significant changes whilst subtests that measure verbal abilities show small or no changes. They explained that their findings are similar to previous findings in the literature that fluid intelligence abilities decline more with increasing age than crystallised intelligence abilities.

Similarly, Kaufman, Reynolds and McLean (1989) analysed the WAIS-R standardization data for ages 20–74 years (*N* =1,480), a sample that was carefully stratified on gender, race (Caucasian–non-Caucasian), geographic region, educational attainment, and occupation. The researchers used both ANOVA and multiple regression methodology, controlled for educational attainment, and based norms for all adults on a reference group of 20- to 34-year-olds. After controlling for education, the decline in Verbal IQ (V-IQ) with age disappeared, but the decline in Performance-IQ (P-IQ) remained substantial. On the Verbal Scale, the peak IQ (99.8) occurred for ages 55–64 after equating for education level; even at ages 70–74, the weighted mean V-IQ was nearly 98. In contrast, education-controlled means in P-IQ dipped below 90 at ages 55–64 and below 80 for 70–74-year-olds.

There is some consistency in the intelligence literature that there are age-related differences. These differences are not necessarily linear in nature. What is even more interesting is the finding that intelligence and age relations vary for different constructs such as for processing speed (Kaufman, 2001) and for verbal comprehension (Birren & Morrison, 1961)

Gender and Intelligence

The literature on sex differences in intelligence is extensive. Throughout the literature, evidence has suggested some consistent sex differences in cognitive abilities, namely spatial and verbal abilities. Spatial abilities are generally thought to be those skills required to represent, transform, generate or recall symbolic, non-linguistic information (Linn & Petersen, 1985). In a seminal work, Maccoby and Jacklin (1974) established that sex differences in spatial abilities exist in favour of males. The work of Maccoby and Jacklin (1974) provided a landmark contribution to the field, with their review of verbal ability studies published between 1964 and 1974. They concluded there was evidence of female advantage of verbal skills, particularly from

the age of 16 onwards. In a meta-analytic study by conducted by Voyer, Voyer, and Bryden (1995), they analysed 286 studies and reported a mean weighted *d* of 0.37, which demonstrated a highly significant male advantage in overall spatial abilities. In a study involving young children, Tzuriel and Egozi (2010) administered mental rotations tasks to boys and girls before and after they participated in a programme designed to promote the representation and transformation of spatial information. They found that boys performed significantly better than girls on spatial relations tasks only in the pre-intervention phase. They concluded that their intervention eliminated the sex difference, and actually reversed it. In the post-intervention assessment, girls performed significantly better than boys.

In a different but a related study involving a sample of 152 high school students, Moè (2009) tested the motivational aspect of performance in mental rotation. Study participants completed a listening task pertaining to the capability of the groups to rotate objects in their minds. Participants were assigned to one of three conditions and were informed about the experimental task according to one of the following: men were better at the experimental task than women; women were better than men at the task; and a control task where neither gender was referenced. Participants were then asked to complete either an easy or difficult mental rotation task. In general, the results reveal that the male participants were primarily influenced by the information relating to task difficulty. The performance of females was affected by positive instructions about gender, and their performance matched that of males when they were led to believe that females were better than men on the task.

One task that often shows the largest consistent sex difference is verbal fluency. Tasks of verbal fluency require participants to generate as many words as possible in a specified time period. In a lexical condition of the task, the words must begin with a particular letter (e.g., the

letter G), whereas in the categorical condition, the words must come from a specific category (e.g., types of animals). In a study of 97 students studying undergraduate psychology and medicine, Weiss, Kemmler, Deisenhammer, Fleischhacker, and Delazer (2003) found that females perform significantly better on lexical fluency (d = 0.45) but not on categorical fluency (d = 0.24). Such research claims cannot be considered particularly generalizable in light of the sample they used: university students studying psychology and medicine are likely to be in the upper range of the distribution of intellectual function, and are unlikely to represent average males and females.

The question of sex differences in general intelligence however has not been that consistent. There is considerable debate with respect to mean and variability of scores on general intelligence between males and females. Some researchers conclude that there are no differences in the mean performance of males and females in general intelligence (Colom, Juan-Espinosa, Abad, & García, 2000; Van der Sluis et al., 2006). For example, Rojahn and Naglieri (2006) failed to find meaningful sex differences using the Naglieri Nonverbal Ability Test with a sample of children between the ages of six to 17 years. In another study of sex differences in *g* as measured by the Woodcock-Johnson III, Keith, Reynolds, Patel and Ridley (2008) found that inconsistent differences emerge across the age span of their sample (six to 59 years). They found an inconsistent difference for children (six to 11 years); for adolescents (12 to 17 years), they found a small non-significant difference in favour of females; and for adults (18 to 59 years) they found a significant female advantage. In a study conducted by Van der Sluis et al. (2008), they found that at the subtest level of the WISC, girls outperformed boys on Coding, while the boys outperformed girls on Information and Arithmetic. Despite these differences on the subtests, they concluded that there were no significant differences in *g*.

In a study by Irwing (2012) using the U.S standardisation sample of the WAIS-III consisting of 2450 individuals aged from 16 to 89 years significant sex differences were found. Males had higher mean scaled scores than females with respect to *g* (general intelligence), information subtest, arithmetic subtest and symbol search subtest of the WAIS-III. Females had higher mean scaled scores than males in the processing speed index of the WAIS-III.

In a related study, Van der Sluis et al. (2006) examined if sex differences existed on the Dutch WAIS-III by using a sample of 294 females and 228 males between 18 and 46 years old. They found that in terms of the subtests, females had higher means scores than males on the Digit–Symbol Substitution whilst males had higher mean scores than females on Information, Arithmetic and Matrix reasoning. However, the researchers found no significant sex differences in the mean scores of six subtests of the WAIS-III (similarities, vocabulary, Letter–Number Sequencing, Block design, coding and picture completion). In terms of the WAIS-III Indexes, no sex differences were found with respect to the Verbal Comprehension index. However, males had higher mean scores than females on the Working Memory and Perceptual Organization indexes. It was also found that females had higher mean scores than males on Processing Speed index.

Similarly, Heaton et al. (2003) examined WAIS-III gender differences at ages 20–89 years on the VCI, POI (Perceptual Organization Index), and PSI for a normal sample of 1,075 males and 1,237 females (analyses for WMI were based on 503 males and 570 females). They computed age-corrected and education-corrected z scores and observed the following gender differences: Females scored higher on PSI (.36 SD); males scored higher on VCI (.25 SD), POI (.17 SD), and WMI (.15 SD).

Various explanations have been offered to explain the gender differences from the perspectives of biology, environment and life experiences. Biological explanations attribute the differences to genetic determinants (Docherty, Kovas, Petrill, & Plomin, 2010; Johnson, Carothers, & Deary, 2009) and hormonal influence prenatally and throughout the individual's life (Hines, 2010). Anatomical and structural differences in the brain have also been controversially implicated including differing brain sizes between the sexes (Cahill, 2006; Lynn, Allik, & Must, 2000). Different life experiences and societal gender stereotypes are often implicated in the debate surrounding cognitive sex differences (Ceci, Williams, & Barnett, 2009; Désert, Préaux, & Jund, 2009).

Validation Studies of the Wechsler Intelligence scales

Cockcroft et al. (2015) tested a sample of black South African university students (*N*=107) who spoke English as a second language by using Wechsler Adult Intelligence Scale Third Edition (WAIS-III). These black South African university students were multilingual and had a low socio-economic background. The mean scaled scores of the South African students on the WAIS-III were compared to that of white British monolingual students (*N*=349) who had a higher socio-economic background. It was found that the WAIS-III was not measurement invariant between the South African and British students. This implied that the WAIS-III measured different constructs between the groups.

Similarly, Miller et al. (2013) in their study conducted in Canada involving 145 older adults administered both the WAIS-IV and the Older Adult version of the WMS-IV to their participants. In their analysis these researchers combined both the WAIS-IV and WMS-IV Older Adults battery and conducted a factor analysis using the data for their study. The factor analysis provided evidence for the higher-order model of the combined WAIS-IV and WMS-IV Older

Adults battery. This means that their data provided a better fit to the model. Their findings implied that the factor analysis models developed from the American normative samples for both the WAIS-IV and WMS-IV are reliable. These researchers found significant positive correlations between the subtests of both the WAIS-IV and WMS-IV. It was also found that there were significantly higher correlations between subtest scores of the WAIS-IV and WMS-IV that were part of the same index.

In a related study, Weiss, Keith, Zhu and Chen (2013) attempted to provide evidence for the construct validity of the WAIS-IV and also to examine if the WAIS-IV measures the same constructs among different samples. These researchers used the American normative data of the WAIS-IV consisting of 1,800 healthy adults and 411clinical sample adults for their analysis. Through the use of factor analysis both the four and five-factor models of the WAIS-IV were tested. After using all the 15 WAIS-IV subtests in the analysis, both the four and five-factor models fitted the data well. However, the five-factor model provided a better fit to the data than the four-factor model. The researchers also found that the WAIS-IV measured the same constructs between both the clinical and healthy samples used in the study.

Cheramie, Stafford, Boysen, Moore, and Prade (2012) undertook a pilot study to examine whether there will be significant correlations between the Wechsler Adult Intelligence Scale Fourth Edition (WAIS-IV) and the Woodcock-Johnson-III: Tests of Cognitive Abilities (WJ-III COG). A sample of thirty adults comprising of 15 males and 15 females were tested in this study. They found a significant and stronger relationship (r =.71) between the WAIS-IV Full Scale IQ and the WJ-III COG General Intellectual Ability. This finding supported the construct validity of the WAIS-IV.

Bowden, Saklofske and Weiss (2011a) in their study examined the measurement invariance of the four-factor model underlying the Wechsler Adult Intelligence Scale–IV (WAIS-IV) in the U.S. (N = 2,200) and the Canadian (N = 680) standardization samples. The found that the four-factor model underlying the Wechsler Adult Intelligence Scale–IV (WAIS-IV) satisfied the assumption of invariance across the samples and subtest scores reflected similar construct measurement in both samples.

It can be seen from the literature review that, the construct validity of the WAIS-IV has been widely studied since it was published in 2008. However, only a few studies have tried to investigate the construct validity of the WAIS-IV by correlating it with other standardised intelligence tests. Most published studies have used confirmatory factor analysis in an attempt examine the construct validity of the WAIS-IV. Therefore, much is not known from the literature about how well the WAIS-IV correlate with other standardised intelligence tests. It is also obvious from the literature that most published validation studies on the WAIS-IV have used the U.S standardisation data for their analysis. Hence, only a little is known about performance of different standardisation samples on the WAIS-IV. Therefore, the current study will address these issues.

Rationale for the study

Although the Wechsler Intelligence scales are widely used worldwide including Africa, it appears only a few countries have conducted research to validate and develop norms on them to use in their own countries. The original American versions of the Wechsler tests have been adapted and used in some countries like the Netherlands (Van der Heijden, Van den Bos, Mol, & Kessels, 2013), Japan (Murayama et al.,2013), Finland (Roivainen, 2013), France (Lecerf, Golay, & Reverte, 2012), South Africa (Grieve & Van Eeden, 2010), Canada (Lange, 2007),

Spain (Melendez, 1994), and China (Lynn & Dai, 1993). To date, the only study in Ghana that has worked on validating and developing norms on Wechsler intelligence tests for the Ghanaian population is that of Edwin (2001). Edwin (2001) in her study on the standardisation of the WISC-III^{uk} for use in Ghana involving 200 children found that Ghanaian children perform poorer than British children on almost all the subtests of the WISC-III^{uk} except the Digit Span subtest when British norms were used instead of the Ghanaian norms. Edwin's (2001) study focused on only children since it standardised the WISC-III^{uk} which was developed for only children. This implies that her study did not develop norms on a neuropsychological test for assessing Ghanaian adults. Thus, Ghanaians have still not developed or standardised a neuropsychological test for assessing both crystallised and fluid intellectual abilities among adults. Again, in Edwin's (2001) study no attempt was made at statistically controlling for any extraneous variable such as education when she tested for age and gender differences in intelligence. Yawson (2008) has developed norms on SPM which can be used for neuropsychological assessment among Ghanaian adults. However, the SPM measures only fluid intelligence. Although Wechsler Adult Intelligence tests are widely used in Ghanaian Hospitals and schools for testing and assessment purposes, no study has worked on validating and developing norms on them. Therefore experts who use the Wechsler Adult intelligence scales in Ghana have no option than to use the American published norms for interpreting the test results. Edwin (2001) reported that the discrepancies between the norms she developed from her study and that of the British published norms on the WISC-III^{uk} were due to differences in the cultural background of the British and the Ghanaian setup. This implies a need for Ghanaians to develop norms on the WAIS-IV and validate it for use in Ghana since it measures both crystallised and fluid intelligence. If the validity of the WAIS-IV is not tested in Ghana, it may lead clinicians to

make misdiagnosis and invalid decisions concerning the intellectual abilities of their clients due to cross cultural differences. This situation implies that there is need for clinicians to develop norms on the WAIS-IV for the Ghanaian population and also to validate the WAIS-IV in Ghanaian cultural setup.

Statement of Hypotheses

1. There will be statistically significant age-related differences in performance on the WAIS-IV indices after controlling for education. Thus:

    a. The younger age groups (16-17, 18-19, 20-24) will obtain higher mean raw scores than the older age groups (25-29, 30-34) on the WAIS-IV WMI, PSI and PRI after controlling for education.

    b. The younger age groups (16-17, 18-19, 20-24) will obtain lower mean raw scores than the older age groups (25-29, 30-34) on the WAIS-IV VCI after controlling for education.

2. There will be statistically significant differences in the performance of males and females on the WAIS-IV indices after controlling for education. Thus:

    a. Males will obtain higher mean raw scores than females on the WAIS-IV PRI and WMI after controlling for education.

    b. Females will obtain higher mean raw scores than males on the WAIS-IV PSI and VCI after controlling for education.

3. Standard progressive matrices which is a non-verbal test of intelligence will correlate significantly and strongly with WAIS-IV indices (PRI and PSI) that measure non-verbal intelligence than with WAIS-IV indices (VCI and WMI) that measure verbal intelligence.

4. Ghanaians will get lower mean scaled scores on the WAIS-IV when the American WAIS-IV published norms are used for scoring than when Ghanaian WAIS-IV norms are used.

CHAPTER THREE

METHODOLOGY

Introduction

This chapter presents information on how the study was conducted. The chapter covers description of the target population of the study, the sample size and sampling technique employed, the measures used in collecting the data, the research design and a description of the data collection procedures used in the study as well as some ethical considerations that were adhered to.

Population for the study

The population for the study comprised both adolescents and adults in the Greater Accra Region of Ghana from 16 to 34 years old. This population is estimated to be 1,646,931(Ghana Statistical Service, 2012). The population was chosen because the Greater Accra region is the capital city of Ghana and comprises people from all parts of the country. As a result, the population provides a cross-section of people representing different ethnic and economic groups.

Sample and Sampling procedure

The participants for this study were 251 healthy Ghanaian individuals in the Greater Accra Region of Ghana aged between 16 and 34 years mostly in high schools and universities. The sample size of 251 was calculated by using the formula developed by Krejcie and Morgan (1970).Using the target population of 1,646,931, 95% confidence level and 5% Margin of Error, the required sample size should have been 384. The sample size of two hundred and fifty one (251) for this study formed 65% of the required sample size of 384. The researcher was not able to include older adult age groups to this study due to limited time allowed for the completion of this thesis. The participants of this study stated that they have not been previously assessed using

the WAIS-IV or the Standard Progressive Matrices (SPM). The purposive sampling technique was used in order to meet a set criterion of participants who can read and understand the English language between the ages of 16 and 34 years. All participants volunteered to be in the study after they were contacted personally or through advertisements on radio stations or posters. There were three groups of participants. One group of participants was recruited from two senior high schools, a private and a public school. Forty four students were recruited from the private high school whiles 25 students were recruited from the public high school. The researcher was not able to recruit more of the high school students since most of the authorities of the schools who were contacted were reluctant to allow such a study which involved neuropsychological testing of each student for over two hours to be conducted in their schools. This issue encountered mostly among the public high schools explains why the researcher was able to recruit only 25 students from the public high school within the limited time for a study of this nature. This reason in addition to the limited time for completion of this thesis did not allow the researcher to recruit more of the high school students. The second group was recruited from the University of Ghana, Legon and the third group was recruited from volunteers who lived and worked around the University of Ghana. This third group have been referred to as non-students (*N*=39) in the table showing the demographic characteristics of the participants of this study (Table 1). They were recruited for this study to help assess the performance on the WAIS-IV of individuals who were not currently schooling. The University of Ghana, Legon was chosen because it is the largest public University in Ghana and in the Greater Accra Region of Ghana. It is therefore likely to be representative of the students in the Greater Accra Region of Ghana. The participants of the study were grouped into five age categories (16:0-17:11, 18:0-19:11, 20:0-24:11, 25:0-29:11, 30:0-34:11). This was done in conformity with the age groups stated in the

American WAIS-IV published norms in order to facilitate cross-cultural comparison. The characteristics of the participants in the study are summarised in Table 1.

Table 1: Demographic characteristics of the Sample

Variable	**Frequency**	**Percentage (%)**
Sex		
Male	135	53.8
Female	116	46.2
Age group		
16:0-17:11	45	17.9
18:0-19:11	32	12.7
20:0-24:11	63	25.1
25:0-29:11	52	20.7
30:0-34:11	59	23.5
Educational Years		
15 years below	98	39.0
16 years above	153	61.0
Educational Level		
Senior High school	92	36.7
Tertiary	159	63.3
School Type		
Private High School	44	17.5
Public High School	25	10.0
University of Ghana	143	57.0
Non-students	39	15.5

Measures

Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV)

The WAIS-IV is an individually administered test battery for individuals aged 16 to 90 years old. The WAIS-IV was normed on 2,200 people. It consists of 15 subtests, namely Block Design (BD), Similarities (SI), Digit Span (DS), Matrix Reasoning (MR), Vocabulary (VC), Arithmetic (AR), Symbol Search (SS), Visual Puzzle (VP), Information (IN), Coding (CD), Letter Number Sequencing (LN), Figure Weights (FW), Comprehension (CO), Cancellation (CA), and Picture Completion (PC).The WAIS-IV subtests are grouped into core and supplemental subtests. The first ten subtests are the core subtests and the last five (i.e. LN, FW,

CO, CA, and PC) are the supplemental subtests (Wechsler, 2008a). The WAIS-IV provides an assessment of general intellectual functioning (FSIQ) and four index scores. The four index scales include Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed (Wechsler, 2008b). The Verbal Comprehension scale includes three core subtests (SI, VC and IN) and one supplemental subtest (CO). The Perceptual Reasoning Scale includes three core subtests (BD, MR, and VP) and two supplemental subtests (FW and PC). The Working Memory scale includes two core subtests (DS and AR) and one supplemental subtest (LN). The Processing Speed scale includes two core subtests (SS and CD) and one supplemental subtest (CA). Average internal consistency reliability estimates of the WAIS-IV range from .78 to .94 for subtests, from .90 to .96 for factor index scores, and .98 for the FSIQ.

For the purposes of this study, a test-retest reliability study was conducted on a sample of 21 students over a period of 21 days. This was done in order to assess stability of performance on the WAIS-IV over time. Thus, this approach helped the researcher to determine whether the WAIS-IV measures the same constructs over time among the Ghanaian population. The results of the reliabilities have been presented in Appendix F (Table 25). The test retest reliability estimates of the 10 WAIS-IV core subtests ranged from .47 to .87. Test retest reliability results for the Digit span forward, backward and sequencing which are subsections of the Digit span subtest of the WAIS-IV ranged from .22 to .63. Lower test retest reliability estimates were found for the Similarities subtest (r=.47), Digit span forward (r=.47) and Digit span sequencing (.22). There was further re-training of testers to control for inter-assessor variability and to improve reliability especially on the Digit span test. Only the 10 core subtests of the WAIS-IV and the Standard progressive matrices (SPM) were administered to the participants in this study. Only the 10 core subtests of the WAIS-IV were administered to participants of this study because it

was realised during the pilot study that even when breaks were given to participants in between testing periods still all of them complained about fatigue as a result of long testing hours. The decision to use only the 10 core subtests of the WAIS-IV for the study was therefore taken when the researcher realised that the participants performed poorly whenever they became tired during testing periods.

Raven's Standard Progressive Matrices (SPM) - Classic Edition

The SPM was first developed by John C. Raven in 1938. It is used for the assessment of non-verbal intelligence, especially logical reasoning and is applicable to people ages 5 years and over. The SPM booklet comprises five sets (A to E) of 12 items each. The internal consistency (reliability estimates) of the SPM ranges between r=.77 and r=.96. The Raven's Standard Progressive Matrices (SPM) test was constructed to measure the educative component of *g* as defined in Spearman's theory of cognitive ability (Raven & Court, 1989). Kaplan and Saccuzzo (2008) and Jensen (1998) have reported that the Raven Standard Progressive Matrices is a measure of fluid reasoning. The version of SPM used for this study was the Raven's Standard Progressive Matrices (SPM) - Classic Edition which was published in 1998. The Raven's Standard Progressive Matrices has been previously standardised in Ghana by Yawson (2008). Its inclusion in this study was to help estimate construct validity for the non-verbal component of the WAIS-IV. The Raven's Standard progressive matrices(SPM) was chosen for this purpose since it is the only adult neuropsychological test that had its construct validity tested previously in Ghana by Yawson (2008). Therefore, the SPM was chosen in accordance with the view of Anastasi and Urbina (1997) that the correlation of scores of a new test with a scores on an existing test for which construct validity has been previously established in a particular place is one method of establishing construct validity.

Piloting of Instruments

The ten core subtests of the Wechsler Adult intelligence Scale-Fourth Edition (WAIS-IV) were piloted using 21 students who were selected from a high school (*N*=8) (mean age =16) and from the University of Ghana, Legon (*N*=13) (mean age =20) over a period of 21 days. The test-retest reliability coefficients are shown in Table 25 (Appendix F).

Based on the results from the pilot study, some modifications were made to the information subtest of the WAIS-IV as shown in Table 2.

Table 2. Information Subtest item modifications

Original Item	Modified Item
8.Who wrote Hamlet	8. Who wrote the story book entitled "Things fall apart''?
18. Who was Sacagawea?	18. Who was Adolf Hitler?
22. Who was Catherine the Great?	22. Who was Marcus Garvey?
23. Who created the character Sherlock Holmes?	23. Who Created the Character Harry Potter?
25. Who wrote Alice in wonderland?	25.Who wrote the story book entitled "The Marriage of Anansewa''

Both the original items and the modified items of the information subtest were administered during the main study to the 251 participants. A decision was made after main study whether to replace the original item of the information subtest with the modified item. If the frequency of people who got the modified item of the information subtest correct in the main study was higher than that of the original item, the modified item was used to replace the original item. Therefore, the information subtest modified items 8, 18, 22 and 25 were used to replace their respective original items. The frequency of people who got both the information subtest modified and original items correct and incorrect is shown in Table 26 (Appendix F). Some of

the people in the main study could not attempt these questions due to the discontinue criteria in the WAIS-IV.

Based on the pilot study it was found that the contents of some items of the Arithmetic subtest were confusing to most of the students and therefore they kept asking for clarification when the questions were being read to them. Minor alterations were therefore made to the content of these items to make them more appropriate to the Ghanaian context. These minor alterations had to do with names that sounded too foreign to the Ghanaian students or some words that they were not familiar with and therefore had to be replaced. Table 5 shows the original items of the Arithmetic subtest and the alterations that were made to them which have been italicised.

Table 3. Arithmetic Subtest item Alterations

Original Item	Alteration
6. Lee has four blankets….	6. *Kofi* has four blankets…
7. Scott has 9 pens…	7. *Yaw* has 9 pens…
8. Bill has 4 children and 20 toys…	8. *Kwame* has 4 children and 20 toys…
9. Sue is 35 years old. Rob is 18 years old…	9. *Kojo* is 35 years old. *Kwesi* is 18 years old…
14. Ying runs 22 minutes each day…	14. *Abena* runs 22 minutes each day…
15. Beth stands in line behind 160 people. She lets 20 more people in line ahead of her…	15. *Adjoa* stands in line behind 160 people. She *allows* 20 more people in line ahead of her…
17. Doug sells two-thirds the number of maps that Kim sold…	17. *Kweku* sells two-thirds the number of maps that *Kwabena* sold…
19. Chris has twice as many pies as Ron…	19. Chris has twice as many pies as *Akosua*…
20. Pam usually rides her horse…	20. *Esi* usually rides her horse…

Research design

The study employed a cross sectional survey design. This design was selected because the study was intended to take place at a single point in time. The time dimension was also cross-sectional in nature as Senior high school students and University students and workers' performance on WAIS-IV and SPM were assessed by taking a cross-section of the students' performance in a relatively limited time and cost effective manner (Oppenheim, 1992).

Training of the Assessors

The researcher and two research assistants were trained on how to administer the neuropsychological tests by his supervisor who is a Clinical Psychologist. One of the research assistants was a graduate student in clinical psychology and the other research assistant had a degree in psychology. This team was trained for two weeks on how to administer the psychological tests and were made to undertake the test-retest pilot study.

Data Collection Procedure

The participants from the University of Ghana were recruited using advertisements in the form of announcements on the University's radio station, at lectures and through posters. The participants from the two senior high schools volunteered after the purpose of the study had been explained to them. The researcher made efforts to ensure that rooms used for testing in the University and the senior high schools had no external distraction and that the place was quiet or without interruptions during test administration. We contacted potential participants and explained the purpose of this study to them. If a potential participant agreed to participate, we set an appointment to administer the tests. Before the test was administered, all participants provided written informed consents. The WAIS-IV was administered in its prescribed order and demographic data were also collected from the participants. All items in all the ten (10) core

subtests of the WAIS-IV were administered, and discontinue rules were applied during testing and scoring. Raven's Standard Progressive Matrices (SPM)-Classic Edition (1998) was also administered to all participants in the study.

Ethical Considerations

This study was approved by the Ethics Committee for Humanities (ECH) in the University of Ghana. A letter of Introduction was collected from the Department of psychology and sent to the various schools to seek for permission from their authorities before the study began. Consent forms were given to the research participants to seek their informed consent before testing began. Any student who chose not to participate on the day of testing was thanked for his or her time allowed to withdraw from the study. For the Senior High School students, assessments took place after normal school hours in a quiet room away from the participant's normal classroom environment. The participants were made to go on breaks whenever they were tired. They required approximately 120 minutes to go through the assessment. The information provided by research participants were kept confidential. Measures were put in place to ensure that no physical or psychological harm occurred to the research participants.

Inclusion and Exclusion Criteria

The inclusion and exclusion of participants from this study was based on a number of criteria. The following inclusion criteria were used:

1. Individuals between the ages of 16 and 34 years.
2. Individuals with Junior high school as their minimum educational level.
3. Proficiency in English Language.
4. Could read and write in order to complete the tests.

The following exclusion criteria were used:

1. Had a history of DSM-IV-TR axes I and II disorders.

2. Speech or language disorders.

3. Already tested with any intelligence test in the past six months

4. History of neurological disorders

5. Presently taking medication that could affect performance on cognitive tests (e.g., antidepressants, antipsychotics)

CHAPTER FOUR

RESULTS

Introduction

This chapter contains results of the analyses done with the data collected. To test the stated hypotheses, the SPSS version 20.0 was used to analyse the data. Following the assumptions required for parametric test selection, the hypotheses were tested with Pearson product moment correlation coefficient, Two-way Analysis of Variance Covariance(ANCOVA) and Paired Samples t-test. The chapter will present on descriptive statistics, hypotheses testing and summary of findings.

Preliminary Analysis

The dataset was screened for possible missing data and outliers. The normality of the distribution of raw scores for the WAIS-IV ten core subtests, four indexes, Full scale IQ and Raven's Standard Progressive Matrices was examined. This was done to help determine whether the distribution of scores was normally distributed or not and to determine whether to use either parametric or nonparametric statistical tests for analysing the data. The summary of the means, standard deviations, skewness and kurtosis for the WAIS-IV ten core subtests, four indices, Full scale IQ and Raven's Standard Progressive Matrices are presented in Table 4. The skewness and kurtosis values for all the tests shown in Table 4 fell between the range of -1 and +1. Therefore the raw scores for the WAIS-IV ten core subtests, four indexes, Full scale IQ and Raven's Standard Progressive Matrices were normally distributed.

Table 4. Descriptive Statistics based on raw scores

Variables	Mean	SD	Skewness	Kurtosis
Block design	34.94	7.98	.26	-.04
Similarities	24.37	4.51	-.34	-.17
Digit Span	30.08	5.50	.20	-.47
Matrix reasoning	15.55	4.88	-.21	-.85
Vocabulary	32.25	9.71	-.45	-.82
Arithmetic	14.73	3.22	-.27	-.33
Symbol Search	30.82	6.93	.26	-.01
Visual puzzles	13.17	3.81	.28	-.36
Information	12.53	4.95	.12	-.85
Coding	65.87	12.97	.54	.68
Standard Progressive Matrices	42.75	6.85	-.51	.95
Full scale IQ	274.34	45.71	-.14	-.22
Verbal comprehension Index	69.15	17.07	-.32	-.63
Perceptual reasoning Index	63.67	13.66	.09	-.24
Working Memory Index	44.82	7.50	-.09	-.37
Processing Speed Index	96.69	17.23	.45	.39

Correlation matrix of the variables

The correlations between years of education, age, the constructs and subtests are presented in Table 5.This analysis was done using the Pearson product-moment correlation coefficient since the data was normally distributed. The raw scores for the various tests were used for this analysis. The raw scores were used for this analysis because the scaled scores have been adjusted for age differences and could have significantly influence the analysis if they were used.

Table 5: Intercorrelation of Variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	EDU																		
2	AGE	.57**																	
3	VCI	.48**	0.06																
	4. SI	.39**	0.1	.81**															
	5. VC	.49**	0.05	.94**	.65**														
	6. IN	.32**	0	.84**	.59**	.70**													
7	PRI	.18**	-0.08	.55**	.47**	.46**	.57**												
	8. BD	.12**	-0.06	.43**	.38**	.36**	.42**	.89**											
	9. MR	.17**	-.14**	.53**	.47**	.44**	.54**	.77**	.50**										
	10. VP	.18**	0.03	.40**	.27**	.35**	.44**	.71**	.46**	.44**									
11	WMI	.16**	-.17**	.60**	.53**	.53**	.53**	.63**	.48**	.62**	.47**								
	12. DS	.09	-.20**	.46**	.45**	.40**	.40**	.48**	.37**	.49**	.31**	.92**							
	13. AR	.23**	-0.05	.60**	.46**	.55**	.55**	.64**	.48**	.59**	.55**	.75**	.43**						
14	PSI	.13**	-.37**	.53**	.40**	.51**	.45**	.52**	.42**	.51**	.33**	.58**	.51**	.48**					
	15. SS	.17**	-.16**	.34**	.26**	.32**	.30**	.43**	.32**	.43**	.32**	.47**	.41**	.39**	.73**				
	16. CD	.09	-.40**	.52**	.39**	.50**	.44**	.46**	.39**	.45**	.26**	.52**	.46**	.43**	.93**	.44**			
17	FSIQ	.31**	-.17**	.84**	.68**	.77**	.74**	.81**	.66**	.73**	.56**	.80**	.66**	.72**	.83**	.61**	.77**		
18	SPM	.00**	-.29**	.46**	.39**	.39**	.44**	.57**	.47**	.53**	.40**	.60**	.51**	.52**	.58**	.42**	.54**	.66**	

***= Correlation is significant at the 0.001 level (2-tailed). *=Correlation is significant at the 0.003 level (2-tailed). EDU=Educational years; VCI= Verbal Comprehension Index; SI= WAIS-IV Similarities Subtest; VC=WAIS-IV Vocabulary Subtest; IN=WAIS-IV Information Subtest; PRI =Perceptual Reasoning Index; BD=WAIS-IV Block design Subtest; MR=WAIS-IV Matrix Reasoning Subtest; VP=WAIS-IV Visual Puzzles Subtest; WMI=Working Memory Index; DS=WAIS-IV Digit Span subtest; AR=WAIS-IV Arithmetic Subtest; PSI=Processing Speed Index; SS=WAIS-IV Symbol Search Subtest; CD=WAIS-IV Coding Subtest; FSIQ=Total WAIS-IV raw scores; SPM=Raven's Standard Progressive Matrices.*

In order to control for Type I error the Bonferroni correction was used by dividing the significance levels of 0.01 and 0.05 by 18 (number of tests in the analysis). The obtained values were adjusted to be 0.001 and 0.003. It was observed from the correlations that WAIS-IV subtests that measure the same construct had relatively high inter-item correlations than they did with other WAIS-IV subtests measuring different constructs. For instance, the correlation between Similarities and Vocabulary subtests is 0.65 while it correlated 0.38 with Block design. The correlations also showed there were significant positive correlations between the Standard Progressive Matrices (SPM) and the WAIS-IV and all its subtests. For example, there was a significant correlation between the SPM and the Full Scale IQ of the WAIS-IV (r = .66, p <.001).

Factor analysis of the WAIS-IV

As part of the preliminary analysis, exploratory factor analysis was done in order to assess the factor structure of the WAIS-IV. A Principal Axis Factoring (PAF) with a Varimax rotation of the ten compulsory WAIS-IV subtests raw scores was conducted on the data gathered from the 251 participants of this study. The results shown in Table 6, revealed a one-factor structure of the WAIS-IV. Since only one factor was extracted the Varimax rotation could not be performed. This finding suggests that the WAIS-IV measures only a single construct in the Ghanaian population (Full Scale IQ or *g*) since all the WAIS-IV subtests loaded onto just one factor.

Table 6: Factor Structure and Factor loadings of the WAIS-IV

Component	1
Percentage of total variance	49.99
Eigenvalue	4.99
Factor loadings	
VCI	
SI	.67
VC	.73
IN	.76
PRI	
BD	.61
MR	.74
VP	.57
WMI	
DS	.62
AR	.78
PSI	
SS	.52
CD	.63

VCI=Verbal Comprehension Index; SI= WAIS-IV Similarities Subtest; VC=WAIS-IV Vocabulary Subtest; IN=WAIS-IV Information Subtest; PRI =Perceptual Reasoning Index; BD=WAIS-IV Block design Subtest; MR=WAIS-IV Matrix Reasoning Subtest; VP=WAIS-IV Visual Puzzles Subtest; WMI=Working Memory Index; DS=WAIS-IV Digit Span subtest; AR=WAIS-IV Arithmetic Subtest; PSI=Processing Speed Index; SS=WAIS-IV Symbol Search Subtest; CD=WAIS-IV Coding Subtest;

To examine the priori factor structure of the WAIS-IV, another factor analysis was performed. A Principal Axis Factoring (PAF) restricting the number of factors extracted to four with a Varimax rotation was performed on the ten compulsory WAIS-IV subtests. The results shown in Table 7, revealed a four-factor structure of the WAIS-IV.

Table 7: Factor Structure and Factor loadings of the WAIS-IV using Rotation Method: Varimax with Kaiser Normalization

Components	1	2	3	4
Percentage of total variance	49.99	9.89	8.97	6.19
Eigenvalues	4.99	.99	.89	.61
Factor loadings				
VCI				
SI	**.59**	.17	.22	**.48**
VC	**.90**	.21	.28	.03
IN	**.60**	**.40**	.22	.25
PRI				
BD	.17	**.48**	**.31**	.23
MR	.23	**.47**	**.43**	**.36**
VP	.15	**.74**	.17	.02
WMI				
DS	.22	.22	**.52**	**.31**
AR	**.35**	**.58**	**.33**	.18
PSI				
SS	.11	.25	**.59**	.04
CD	**.32**	.16	**.62**	.10

VCI=Verbal Comprehension Index; SI= WAIS-IV Similarities Subtest; VC=WAIS-IV Vocabulary Subtest; IN=WAIS-IV Information Subtest; PRI =Perceptual Reasoning Index; BD=WAIS-IV Block design Subtest; MR=WAIS-IV Matrix Reasoning Subtest; VP=WAIS-IV Visual Puzzles Subtest; WMI=Working Memory Index; DS=WAIS-IV Digit Span subtest; AR=WAIS-IV Arithmetic Subtest; PSI=Processing Speed Index; SS=WAIS-IV Symbol Search Subtest; CD=WAIS-IV Coding Subtest;

From Table 7, it is observed that almost each of the subtests of WAIS-IV loaded onto more than one factor. This finding suggests that almost each of the WAIS-IV subtests measures more than one construct in the Ghanaian population. The findings from both of the factor analysis performed suggest that the traditional four-factor model of the WAIS-IV was not supported.

Results on Standardisation

The normative data from this study on the WAIS-IV were stratified by age group following the data from the American published norms. Thus, there were five age groups (16-17 years, 18-19 years, 20-24 years, 25-29 years, and 30-34 years). This was done to facilitate cross cultural comparisons of the American published norms and the Ghanaian norms. Thereafter, the raw scores were converted to scaled scores using both the American published and the Ghanaian norms developed from this study for the purpose of cross cultural comparison. The norms for the Ghanaian sample were established by scaling it to the level of the American norms.

For each of the 10 WAIS-IV core subtests used in this study, the raw scores for each age group were converted to z-scores. The z-scores for each age group were subsequently converted into scaled scores (standard scores) with a mean of 10 and a standard deviation of 3 as was the case with the American published norms. This was done by multiplying the z-scores for each age group by a standard deviation of 3 and adding a mean of 10 (Kline, 2000). Five tables (Table 20,21,22,23 and 24) showing the scaled score equivalents of raw scores for each age group and subtests just as in the American WAIS-IV published norms are in Appendix E. The values were extrapolated to include values below the minimum and values above the maximum for each age group. The analysis for this study was done partly by using the scaled scores (standard scores) and partly by using raw scores whenever it was necessary. The WAIS-IV Subtests, Indexes and Full scale IQ were scored according to the WAIS-IV manual (Wechsler, 2008a) for each of the participants of this study by using both the American published norms and the Ghanaian norms developed from this study before using them in the analysis whenever it became necessary. Thus, the WAIS-IV Full scale IQ was derived by summing up the scaled scores of the 10 WAIS-IV core subtests [Block design, Similarities, Digit Span, Matrix reasoning, Vocabulary, Arithmetic,

Symbol Search, Visual puzzles, Information and Coding] used in this study. Also, the WAIS-IV Verbal Comprehension Index was derived by summing up the scaled scores of Similarities, Vocabulary and Information subtests. The WAIS-IV Perceptual Reasoning Index was derived by summing up the scaled scores of Block Design, Matrix Reasoning and Visual Puzzles subtests. Processing Speed Index of the WAIS-IV was obtained by summing up the scaled scores of Symbol Search and Coding subtests. Working Memory Index of the WAIS-IV was obtained by summing up the scaled scores of the Digit Span and Arithmetic subtests.

Hypotheses Testing

The following hypotheses were tested:

Hypothesis one: There will be statistically significant age-related differences in performance on the WAIS-IV indices after controlling for education. Thus:

a. The younger age groups (16-17, 18-19, 20-24) will obtain higher mean raw scores than the older age groups (25-29, 30-34) on the WAIS-IV WMI, PSI and PRI after controlling for education.

b. The younger age groups (16-17, 18-19, 20-24) will obtain lower mean raw scores than the older age groups (25-29, 30-34) on the WAIS-IV VCI after controlling for education. Hypothesis two: There will be statistically significant differences in the performance of males and females on the WAIS-IV indices after controlling for education. Thus:

a. Males will obtain higher mean raw scores than females on the WAIS-IV PRI and WMI after controlling for education.
b. Females will obtain higher mean raw scores than males on the WAIS-IV PSI and VCI after controlling for education.

In order to test both hypotheses one and two, Two-way Analysis of Covariance (ANCOVA) was used. The independent variables were age and sex. Number of years of education was the covariate. The dependent variables were the WAIS-IV indices. The results are presented for each of the dependent variables (VCI, PRI, WMI and PSI). Raw scores of the WAIS-IV indices were used for this analysis. Scaled scores were not used for the analysis since they have already been adjusted for age-related differences in performance on the WAIS-IV. The score for each WAIS-IV index was a sum of the raw scores of the respective subtests. Table 8 is a summary of means and standard deviations for the WAIS-IV and SPM based on raw scores. Table 9 is summary of mean raw scores and standard errors for the WAIS-IV indices after the effect of years of education was controlled statistically through the use of the Two-way Analysis of Covariance (ANCOVA).

Table 8. Summary of Means and Standard deviations for the WAIS-IV and SPM based on raw scores

Tests	Sex		Age				
	Male	Female	16-17	18-19	20-24	25-29	30-34
	N=135	*N*=116	*N*=45	*N*= 32	*N*= 63	*N*= 52	*N*=59
	Mean(*SD*)	Mean(*SD*)	Mean(*SD*)	Mean(*SD*)	Mean (*SD*)	Mean(*SD*)	Mean(*SD*)
VCI	71.38(17.07)	66.56(16.78)	68.13(19.13)	57.03(20.13)	72.44(17.70)	76.98(8.92)	66.10(14.13)
SI	24.94(4.49)	23.70(4.46)	24.33(4.57)	21.71(5.49)	24.68(5.14)	25.53(2.92)	24.47(3.85)
VC	32.69(9.68)	31.73(9.77)	30.91(10.44)	25.46(11.25)	34.58(10.01)	37.32(4.96)	29.98(8.15)
IN	13.74(4.97)	11.12(4.55)	12.88(6.22)	9.84(5.30)	13.17(5.57)	14.11(3.39)	11.64(3.24)
PRI	65.80(13.38)	61.19(13.62)	64.95(14.23)	61.56(17.80)	66.69(15.51)	62.98 (10.57)	61.22(10.27)
BD	35.90(7.89)	33.81(7.96)	34.93(8.63)	34.75(8.82)	36.82(9.88)	33.84(6.07)	34.00(5.80)
MR	16.30(4.61)	14.68(5.05)	16.77(4.82)	14.34(6.10)	16.49(5.65)	15.90(4.02)	13.96(3.36)
VP	13.59(3.95)	12.69(3.59)	13.24(4.35)	12.46(5.26)	13.38(4.05)	13.23(2.71)	13.25(3.00)
WMI	45.62(7.47)	43.88(7.45)	46.75(7.62)	41.78 (9.97)	47.42(7.61)	45.13(5.88)	41.93(5.35)
DS	30.28(5.39)	29.85(5.65)	31.37(5.24)	28.96 (7.07)	31.84 (5.73)	30.00(4.88)	27.89 (4.10)
AR	15.34(3.19)	14.03(3.12)	15.37 (4.01)	12.81(3.93)	15.58(3.34)	15.13(1.92)	14.03(2.30)
PSI	96.11(15.80)	97.37 (18.81)	103.24(16.91)	97.65(18.42)	101.92(18.34)	98.73(11.77)	83.81 (12.82)
SS	30.17(6.46)	31.57 (7.40)	30.91(7.33)	31.65(5.62)	32.15 (8.47)	31.94(5.65)	27.89(5.71)
CD	65.94 (12.54)	65.79 (13.51)	72.33(13.08)	66.00 (14.64)	69.76(13.95)	66.78(7.68)	55.91(8.40)
SPM	43.61 (6.80)	41.75 (6.80)	45.42(7.26)	40.21(9.61)	46.38(6.14)	41.46(4.87)	39.37 (3.91)

VCI=Verbal Comprehension Index; SI=WAIS-IV Similarities Subtest; VC=WAIS-IV Vocabulary Subtest; IN=WAIS-IV Information Subtest; PRI =Perceptual Reasoning Index; BD=WAIS-IV Block design Subtest; MR=WAIS-IV Matrix Reasoning Subtest; VP=WAIS-IV Visual Puzzles Subtest; WMI=Working Memory Index; DS=WAIS-IV Digit Span subtest; AR=WAIS-IV Arithmetic Subtest; PSI=Processing Speed Index; SS=WAIS-IV Symbol Search Subtest; CD=WAIS-IV Coding Subtest; SPM=Raven's Standard Progressive Matrices.

Table 9. Summary of Mean Raw Scores and Standard Errors for the WAIS-IV Indices after Years of Education was controlled

Tests	Sex		Age				
	Male	Female	16-17	18-19	20-24	25-29	30-34
	N=135	*N=116*	*N=45*	*N= 32*	*N=63*	*N= 52*	*N=59*
	Mean(*SE*)	Mean(*SE*)	Mean(*SE*)	Mean(*SE*)	Mean (*SE*)	Mean(*SE*)	Mean(*SE*)
VCI	71.98(1.19)	65.25(1.31)	78.71(2.65)	68.19(2.60)	70.50(1.68)	62.59(2.34)	63.09(1.75)
PRI	66.65(1.12)	60.83(1.23)	70.55(2.49)	67.75(2.44)	65.82(1.58)	55.01 (2.20)	59.58(1.64)
WMI	45.78(.60)	43.75(.66)	49.55(1.35)	44.69 (1.32)	47.00(.85)	41.44(1.19)	41.12(.89)
PSI	97.04(1.28)	98.60 (1.41)	113.01(2.85)	105.94(2.79)	100.35(1.81)	88.25(2.52)	81.55 (1.88)

VCI=Verbal Comprehension Index; PRI =Perceptual Reasoning Index; WMI=Working Memory Index; PSI=Processing Speed Index

The ANCOVA results, presented in Table 10 showed that the covariate, number of years of education was significantly related to scores on the Verbal comprehension index ($F_{(1, 240)} = 97.34$, $p < .05$). Following the effect of the covariate, there was a significant main effect for sex on the verbal comprehension index ($F_{(1, 240)} = 14.58$, $p < .05$). Examination of the means on Table 9 revealed that males (M=71.98) had a higher mean raw score than females (M=65.25) on the Verbal comprehension index.

Table 10. Summary table of Two-way ANCOVA of Effect of Sex and Age on Verbal Comprehension Index (VCI)

Source	sum of squares	df	F	Sig.	Partial Eta Squared
Years of Education	17074.53	1	97.34	.000*	.28
Sex	2558.80	1	14.58	.000*	.05
Age	4851.20	4	6.91	.000*	.10
Sex * Age	4015.55	4	5.72	.000*	.08
Error	42098.67	240			

*p<.05

There was significant main effect for age on the Verbal Comprehension Index ($F_{(4, 240)}$ = 6.91, p< .05). Post-hoc comparisons using the Least Significant Difference test (Table 11) showed that the mean score for the 16–17 years age group (M = 78.71) was significantly higher than that of the 18-19 age group(M = 68.19), 20-24 age group (M = 70.50), 25-29 group (M =62.59) and the 30-34 group (M =63.09). The mean score of the 20-24 years age group (M = 70.50) was significantly different from the 25-29 age group (M =62.59) and 30-34 age group (M =63.09). It can be seen that the younger age groups had higher mean scores than the older age groups on the VCI.

There was a significant interaction effect between sex and age ($F_{(4, 240)}$ = 5.72, p< .05) in performance on the Verbal Comprehension Index (Figure 1). An examination of the Graph in Figure 1 showed that males scored higher than females on the VCI from age 16 to 29 but after age 29 where the interaction effect occurred males' scores started declining while female's scores increased. This means age influenced sex in predicting performance on the VCI.

The hypothesis that there would be significant age-related differences in performance on the WAIS-IV VCI was supported. However, the hypothesis that younger age groups will obtain lower mean raw scores than the older age groups on the WAIS-IV VCI was not supported. The hypothesis that there will be significant differences in the performance of males and females on the WAIS-IV VCI was supported. The hypothesis that females will obtain higher mean raw scores than males on the WAIS-IV Verbal comprehension index was not supported.

Table 11.Summary of Post Hoc Analysis (LSD)for Age on Verbal Comprehension Index(VCI)

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.
16-17	18-19	10.52*	3.22	.00
	20-24	8.21*	3.25	.01
	25-29	16.12*	4.11	.00
	30-34	15.62*	3.32	.00
18-19	16-17	-10.52*	3.22	.00
	20-24	-2.30	3.18	.46
	25-29	5.60	3.94	.15
	30-34	5.10	3.24	.11
20-24	16-17	-8.21*	3.25	.01
	18-19	2.30	3.18	.46
	25-29	7.91*	2.77	.00
	30-34	7.41*	2.40	.00
25-29	16-17	-16.12*	4.11	.00
	18-19	-5.60	3.94	.15
	20-24	-7.91*	2.77	.00
	30-34	-.49	2.77	.85
30-34	16-17	-15.62*	3.32	.00
	18-19	-5.10	3.24	.11
	20-24	-7.41*	2.40	.00
	25-29	.49	2.77	.85

*$p<.05$

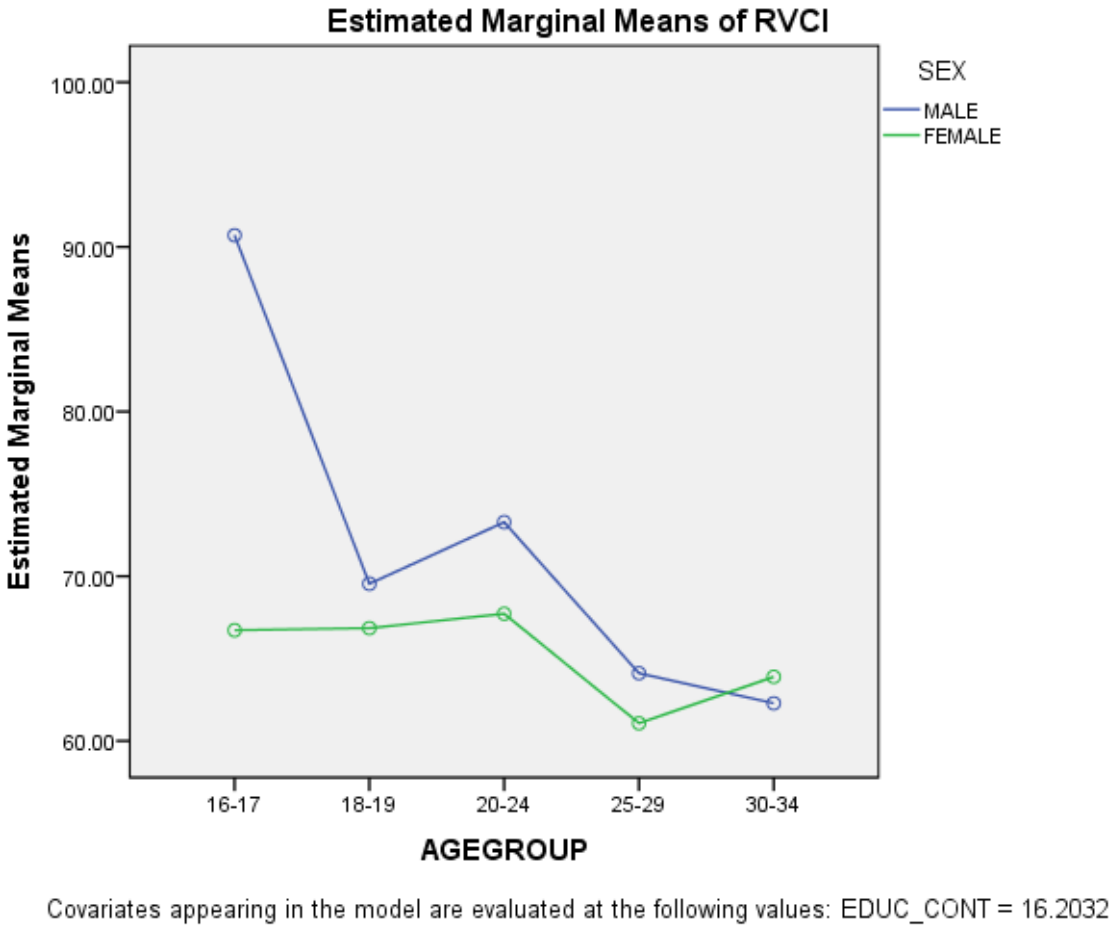

Figure 1: Interaction Effect between Sex and Age on VCI

With respect to PRI, the ANCOVA results presented in Table 12 showed that the covariate, number of years of education was significant ($F_{(1, 240)} = 33.82$, $p < .05$). Following the effect of the covariate, there was a significant main effect for sex on the Perceptual reasoning index ($F_{(1, 240)} = 12.32$, $p < .05$). Examination of the means on Table 9 revealed that males (M=66.65) had a higher mean raw score than females (M=60.83) on the PRI.

Table 12. Summary table of Two-way ANCOVA on Perceptual Reasoning index (PRI)

Source	sum of squares	df	F	Sig.	Partial Eta Squared
Years of Education	5249.59	1	33.82	.000*	.12
Sex	1912.15	1	12.32	.001*	.04
Age	3774.44	4	6.08	.000*	.09
Sex * Age	2007.25	4	3.23	.013*	.05
Error	37247.81	240			

*p<.05

There was significant main effect for age on the Perceptual reasoning index ($F_{(4, 240)}$ = 6.08, p< .05). Post-hoc comparisons using the LSD (Table 13) showed that the mean score for the 16–17 years age group (M = 70.55) was significantly different from that of the 25-29 age group (M = 55.01) and the 30-34 age group (M =59.58). The mean score of the 18-19 years age group (M = 67.75) was significantly different from the 25-29 age group (M = 55.01) and 30-34 age group (M =59.58). The mean score of the 20-24 years age group (M = 65.82) was significantly different from the 25-29 age group (M = 55.01) and 30-34 age group (M =59.58). It was observed that the younger age groups had higher mean scores than the older age groups on the Perceptual reasoning index (PRI).

There was a significant interaction effect between sex and age ($F_{(4, 240)}$ = 3.23, p< .05) in performance on the PRI (Figure 2). An examination of the Graph in Figure 2 showed that males scored higher than females on the PRI from age 16 to 29 but after age 29 where the interaction effect occurred females started scoring higher than male's. This means age influenced sex in predicting performance on PRI.

The hypothesis that there would be significant age-related differences in performance on the WAIS-IV PRI was supported. The hypothesis that younger age groups will obtain higher mean raw scores than the older age groups on the WAIS-IV PRI was supported. The hypothesis that there will be significant differences in the performance of males and females on the WAIS-IV PRI was supported. The hypothesis that males will obtain higher mean raw scores than females on the WAIS-IV Perceptual reasoning index was supported.

Table 13.Summary of Post Hoc Analysis (LSD) for Perceptual Reasoning index (PRI)

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.
16-17	18-19	2.80	3.02	.35
	20-24	4.73	3.05	.12
	25-29	15.54*	3.87	.00
	30-34	10.97*	3.12	.00
18-19	16-17	-2.80	3.02	.35
	20-24	1.93	2.99	.51
	25-29	12.73*	3.71	.00
	30-34	8.17*	3.05	.00
20-24	16-17	-4.73	3.05	.12
	18-19	-1.93	2.99	.51
	25-29	10.80*	2.61	.00
	30-34	6.24*	2.26	.00
25-29	16-17	-15.54*	3.87	.00
	18-19	-12.73*	3.71	.00
	20-24	-10.80*	2.61	.00
	30-34	-4.56	2.60	.08
30-34	16-17	-10.97*	3.12	.00
	18-19	-8.17*	3.05	.00
	20-24	-6.24*	2.26	.00
	25-29	4.56	2.60	.08

*p<.05

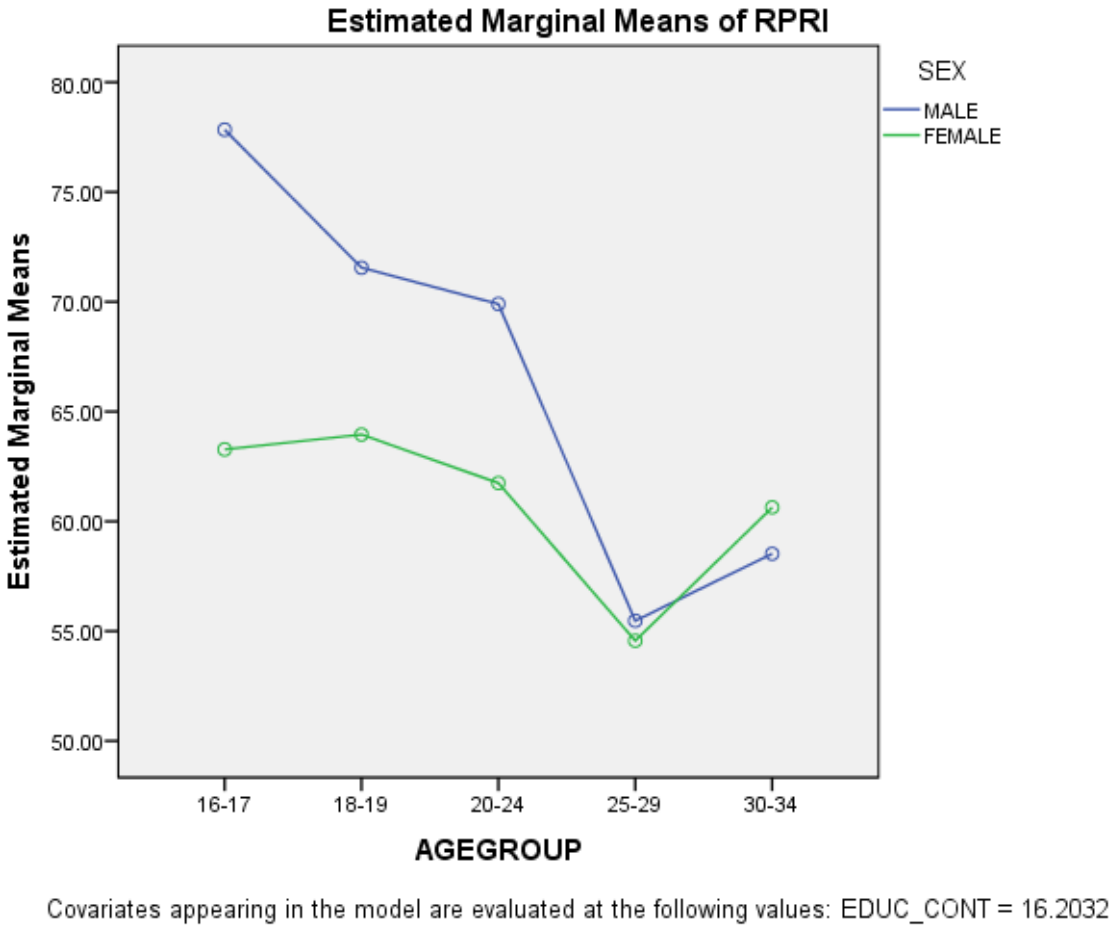

Figure 2: Interaction Effect between Sex and Age on PRI

The ANCOVA results presented in Table 14 showed that the covariate, number of years of education was significantly related to scores on the Working Memory index ($F_{(1, 240)} = 25.55$, $p < .05$). Following the effect of the covariate, there was a significant main effect for sex on the Working Memory index ($F_{(1, 240)} = 5.11$, $p < .05$). Examination of the means on Table 9 revealed that males (M=45.78) had a higher mean raw score than females (M=43.75) on the Working Memory index.

Table 14. Summary table of Two-way ANCOVA on Working Memory Index (WMI)

Source	sum of squares	df	F	Sig.	Partial Eta Squared
Years of Education	1160.86	1	25.55	.00*	.09
Sex	232.33	1	5.11	.02*	.02
Age	1784.12	4	9.82	.00*	.14
Sex *Age	460.74	4	2.53	.04*	.04
Error	10900.37	240			

*p<.05

There was significant main effect for age on the Working Memory Index ($F_{(4, 240)} = 9.82$, $p < .05$). Post-hoc comparisons using the Least Significant Difference test (Table 15) showed that the mean score for the 16–17 years age group ($M = 49.55$) was significantly different from that of the 18-19 age group ($M = 44.69$), 25-29 age group ($M = 41.44$,) and the 30-34 age group (M =41.12). Also, the mean score of the 18-19 years age group ($M = 44.69$) was significantly different from the 30-34 age group (M =41.12). The mean score of the 20-24 years age group ($M = 47.00$) was significantly different from the 25-29 age group ($M = 41.44$) and 30-34 age group (M =41.12). It was observed that the younger age groups had higher mean scores than the older age groups on the Working Memory index.

There was a significant interaction effect between sex and age ($F_{(4, 240)} = 2.53$, $p < .05$) in performance on the Working Memory index (Figure 3). An examination of the Graph in Figure 3 indicated that males scored higher than females on the WMI from age 16 to 29 but after age 29 where the interaction effect occurred male's scores decreased more than that of females. However, at age 30 to 34 males start to score higher again whiles female scores decreased. This means age influenced sex in predicting performance on the WMI.

The hypothesis that there would be significant age-related differences in performance on the WAIS-IV WMI was supported. The hypothesis that younger age groups will obtain higher mean raw scores than the older age groups on the WAIS-IV WMI was supported. The hypothesis that there will be significant differences in the performance of males and females on the WAIS-IV WMI was supported. The hypothesis that males will obtain higher mean raw scores than females on the WAIS-IV WMI was supported.

Table 15.Summary of Post Hoc Analysis (LSD) for Working Memory Index (WMI)

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.
16-17	18-19	4.86*	1.63	.00
	20-24	2.55	1.65	.12
	25-29	8.11*	2.09	.00
	30-34	8.43*	1.69	.00
18-19	16-17	-4.86*	1.63	.00
	20-24	-2.31	1.61	.15
	25-29	3.25	2.00	.10
	30-34	3.56*	1.65	.03
20-24	16-17	-2.55	1.65	.12
	18-19	2.31	1.61	.15
	25-29	5.56*	1.41	.00
	30-34	5.88*	1.22	.00
25-29	16-17	-8.11*	2.09	.00
	18-19	-3.25	2.00	.10
	20-24	-5.56*	1.41	.00
	30-34	.31	1.41	.82
30-34	16-17	-8.43*	1.69	.00
	18-19	-3.56*	1.65	.03
	20-24	-5.88*	1.22	.00
	25-29	-.31	1.41	.82

*p<.05

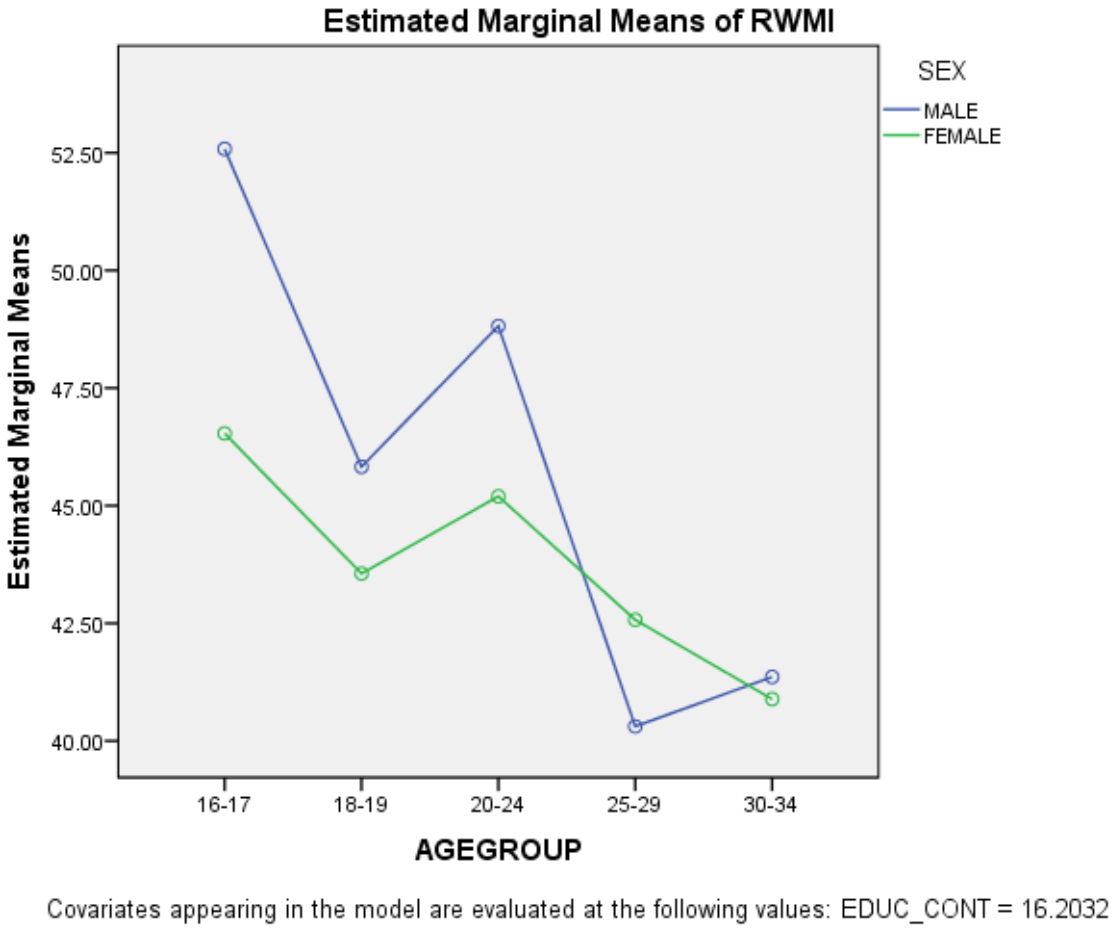

Figure 3: Interaction Effect between Sex and Age on WMI

The ANCOVA results presented in Table 16 showed that the covariate, number of years of education was significantly related to scores on the Processing Speed Index ($F_{(1, 240)} = 46.47$, $p < .05$). Following the effect of the covariate, the main effect for sex on the Processing Speed Index ($F_{(1, 240)} = .67$, $p > .05$) was not significant. This finding means that there was no significant difference between the mean scores of males and females on the Processing Speed Index.

Table 16.Summary table of Two-way ANCOVA on Processing Speed Index(PSI)

Source	sum of squares	df	F	Sig.	Partial Eta Squared
Years of Education	9417.74	1	46.47	.000*	.16
Sex	137.30	1	.67	.411	.00
Age	19974.65	4	24.64	.000*	.29
Sex * Age	2186.65	4	2.69	.031*	.04
Error	48638.48	240			

*p<.05

There was significant main effect for age on the Processing Speed Index ($F_{(4, 240)}$ = 24.64, p< .05). Post-hoc comparisons using the LSD (Table 17) showed that the mean score for the 16–17 years age group (M = 113.01) was significantly different from that of the 18-19 age group (M = 105.94), 20-24 age group (M = 100.35), 25-29 age group (M = 88.25) and the 30-34 age group (M = 81.55). The mean score of the 18-19 years age group (M = 105.94) was significantly different from the 25-29 age group (M = 88.25) and 30-34 age group (M = 81.55). Moreover, the mean score of the 20-24 years age group (M = 100.35) was significantly different from the 25-29 age group (M = 88.25) and the 30-34 age group (M = 81.55). Furthermore, the mean score of the 25-29 age group (M = 88.25) was significantly different from the 30-34 age group (M = 81.55).It was observed that the younger age groups had higher mean scores than the older age groups on the Processing Speed Index.

There was a significant interaction effect between sex and age ($F_{(4, 240)}$ = 2.69, p< .05) in performance on the Processing Speed Index (Figure 4). An examination of the Graph in Figure 4 indicated that females scored higher than males on the PSI from age 16 to 34 but after age 34 where the interaction effect occurred female's scores started to decrease whiles males scores started to increase .This means age influenced sex in predicting performance on the PSI.

The hypothesis that there would be significant age-related differences in performance on the WAIS-IV PSI was supported. The hypothesis that younger age groups will obtain higher mean raw scores than the older age groups on the WAIS-IV PSI was supported. The hypothesis that there will be significant differences in the performance of males and females on the WAIS-IV PSI was not supported. The hypothesis that females will obtain higher mean raw scores than males on the WAIS-IV PSI was not supported.

Table 17.Summary of Post Hoc Analysis (Least Significant Difference) for Processing Speed Index(PSI)

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.
16-17	18-19	7.06*	3.46	.04
	20-24	12.65*	3.49	.00
	25-29	24.75*	4.42	.00
	30-34	31.45*	3.57	.00
18-19	16-17	-7.06*	3.46	.04
	20-24	5.59	3.41	.10
	25-29	17.69*	4.23	.00
	30-34	24.39*	3.48	.00
20-24	16-17	-12.65*	3.49	.00
	18-19	-5.59	3.41	.10
	25-29	12.10*	2.98	.00
	30-34	18.80*	2.58	.00
25-29	16-17	-24.75*	4.42	.00
	18-19	-17.69*	4.23	.00
	20-24	-12.10*	2.98	.00
	30-34	6.70*	2.98	.02
30-34	16-17	-31.45*	3.57	.00
	18-19	-24.39*	3.48	.00
	20-24	-18.80*	2.58	.00
	25-29	-6.70*	2.98	.02

*p<.05

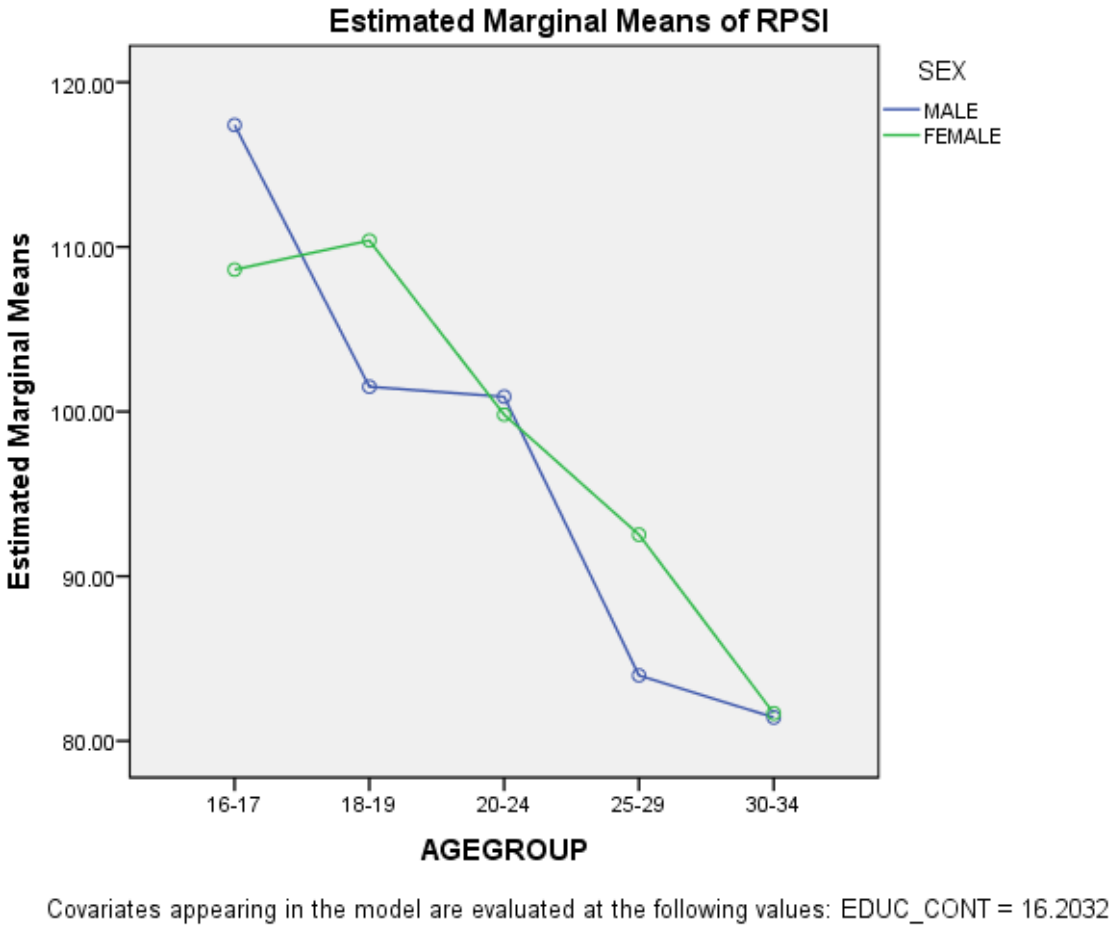

Figure 4: Interaction Effect between Sex and Age on PSI

Hypothesis Three: Standard Progressive Matrices which is a non-verbal test of intelligence will correlate significantly and strongly with WAIS-IV indices (PRI and PSI) that measure non-verbal intelligence than with WAIS-IV indices (VCI and WMI) that measure verbal intelligence.

In order to test this hypothesis, Pearson Product Moment Correlation Coefficient was used to find out if the SPM which is a non-verbal intelligence test will correlate significantly and strongly with WAIS-IV PSI and PRI (non-verbal tests) than with WAIS-IV VCI and WMI (verbal tests). The raw scores for the various tests were used for this analysis. The raw scores were used for this analysis because the scaled scores have been adjusted for age differences and

may significantly influence the analysis if used. The results are presented in Table 5. Fisher's r-to-z transformation (Table 18) was used to test the difference between the pairs of correlation coefficients.

From Table 5, the Standard Progressive Matrices (SPM) correlated significantly with the Perceptual Reasoning Index(r=.57) and the Processing Speed Index(r=.58) of the WAIS-IV. The SPM correlated significantly with the Verbal Comprehension Index(r=.46) and the Working Memory Index(r=.60).

When Fisher's r-to-z transformation was used it was found that the correlations of SPM with the PRI and VCI were significantly different (Z = 1.97, p < .05).This means that the SPM correlated significantly and strongly with PRI (r=.57) than with VCI (r=.46).It was also found that the correlations of SPM with the PSI and VCI were significantly different (Z = 2.16, p < .05). This implies that the SPM correlated significantly and strongly with PSI (r=.58) than with VCI (r=.46). There was no significant difference between the correlations of the SPM with the PRI and WMI. There was also no significant difference between the correlations of the SPM with the PSI and WMI. The hypothesis that SPM will correlate significantly and strongly with WAIS-IV indices (PRI and PSI) that measure non-verbal intelligence than with WAIS-IV indices (VCI and WMI) that measure verbal intelligence was partially supported.

Table 18.Fisher's r-to-z transformation

Pairings of correlations with SPM	Z-Score	Sig.
SPM versus PRI and SPM versus VCI	1.97	0.04*
SPM versus PSI and SPM versus VCI	2.16	0.03*
SPM versus PRI and SPM versus WMI	-0.58	0.56
SPM versus PSI and SPM versus WMI	-0.39	0.69

*$P<.05$

Hypothesis Four: Ghanaians will get lower mean scaled scores on the WAIS-IV when the American WAIS-IV published norms are used for scoring than when Ghanaian WAIS-IV norms are used.

Paired samples t-test was used to test this hypothesis in order to find out if any significant differences existed between the WAIS-IV American published norms and the Ghanaian norms developed from this study. Scaled scores from both the WAIS-IV American published norms and the Ghanaian norms were used to convert the raw scores of all the 251 participants of this study. Thus, each of the 251participants had both an American scaled score and a Ghanaian scaled score. The differences between the mean scaled scores derived through using the WAIS-IV American published norms and the mean scaled scores derived through using the Ghanaian WAIS-IV norms were tested by using the Paired samples t-test. The results are presented in Table 19. Scaled scores were used for this analysis to facilitate cross-cultural comparisons of the American WAIS-IV published norms and the Ghanaian WAIS-IV norms developed from the present study.

Table 19.Summary table for the Paired samples t-test

	American norms		Ghanaian norms				
Tests	Mean(*M*)	*SD*	Mean(*M*)	*SD*	*t*	*df*	Sig.
Verbal comprehension	29.78	7.34	28.86	7.22	6.92	250	.00*
Perceptual reasoning	24.78	7.39	25.94	6.68	-3.14	250	.00*
Working memory	21.76	5.73	20.18	4.94	16.83	250	.00*
Processing speed	17.81	4.11	18.01	4.42	-1.49	250	.13
Full scale IQ	93.77	18.21	93.00	19.37	1.96	250	.05*

**P<.05*

There was a significant differences between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Full scale IQ ($t_{(250)}$ =1.96, p=.05). A lower mean scaled score was found on the WAIS-IV Full scale IQ when the Ghanaian norms (M=93.00, SD=19.37) were used instead of the American published norms (M=93.77, SD=18.21). There was a significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Verbal Comprehension Index ($t_{(250)}$ =6.92, p<.05). A lower mean scaled score was found on the WAIS-IV Verbal Comprehension Index when the Ghanaian norms (M=28.86, SD=7.22) were used instead of the American published norms (M=29.78, SD=7.34). There was a significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Working Memory Index ($t_{(250)}$ =16.83, p<.05). A lower mean scaled score was found on the WAIS-IV Working Memory Index when the Ghanaian norms (M=20.18, SD=4.94) were used instead of the American published norms (M=21.76, SD=5.73).

There was a significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Perceptual reasoning index ($t_{(250)}$ =-3.14, p<.05).A higher mean scaled score was found on the WAIS-IV Perceptual reasoning index when the Ghanaian norms (M=25.94, SD=6.68) were used instead of the American published norms (M=24.78, SD=7.39). There was no significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Processing speed index ($t_{(250)}$ =-1.49, p>.05).

The hypothesis that the Ghanaians will have lower mean scaled scores on the WAIS-IV and its indices when the American published norms are used than when Ghanaian norms are used was partially supported.

Summary of Findings

In this study four main hypotheses were tested. A summary of the findings is presented below:

- It was found that there were significant age-related differences in performance on the WAIS-IV indices when the effect of education was statistically controlled. The younger age groups obtained higher mean raw scores than the older age groups on the WAIS-IV WMI, PSI, PRI and VCI after the effect of education was statistically controlled.
- Significant differences were found between the performance of males and females on the WAIS-IV indices after the effect of education was statistically controlled. Males had higher mean raw scores than females on the WAIS-IV PRI, WMI and VCI. However, there was no significant difference between the mean scores of males and females on the WAIS-IV PSI.
- It was found that the Standard Progressive Matrices which is a non-verbal test of intelligence correlated significantly and strongly with WAIS-IV PRI that measure non-verbal intelligence than with WAIS-IV VCI that measure verbal intelligence. It also was observed from the correlations that in most cases WAIS-IV subtests that measure the same construct had relatively high inter-item correlations than they did with other WAIS-IV subtests measuring different constructs.
- It was also found that there were significant differences between the norms developed from this study on the WAIS-IV and that of American published norms.

CHAPTER FIVE

DISCUSSION

The main aims of this study were to develop local norms on the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) for the Ghanaian population and to test for group differences on the various WAIS-IV indices. The specific objectives of the study were: to standardise the WAIS-IV on a sample of Ghanaians; to examine gender differences in performance on the WAIS-IV; examine age differences in performance on the WAIS-IV; to test for differences between the WAIS-IV American published norms and the Ghanaian norms developed from the current study, and to examine the relationship between the WAIS-IV and the Raven's Standard Progressive Matrices (SPM).

Age and Sex-related Differences in Performance on the WAIS-IV

Age and Sex-related Differences in Performance on the Verbal Comprehension Index (VCI) of the WAIS-IV

In examining the age-related effects on VCI, the researcher found Years of education to be a significant covariate implying there was a strong association between one's education and performance on the VCI. Beyond that, age-related differences in performance on the VCI was also found. Specifically, younger people were found to score higher on the VCI than older people, an indication that there were declines in verbal abilities with increase in age after the effect of education was statistically controlled. It was observed that mean scores on the VCI were higher from age 16 to 24 but started declining after age 24. However, when mean scores for both young and older adults which were unadjusted for the effect of education were examined, the older adults scored higher than the younger adults. Of particular interest in this study, is the

finding that the effect of the covariate, years of education was stronger than both age and sex. This means, most of the variance in VCI may be attributed to education than to any of the factors examined in the study. This is not surprising when one examines the tests that make up the VCI. VCI subtests such as vocabulary, similarities and information are all made up of tasks that people who have higher education are more likely to perform better on. For instance, the vocabulary subtest task comprises of words and their meaning.

The finding that younger people scored higher on the VCI than older people may be explained by many factors. Such finding may be attributed to age-related declines in the auditory processes that support word recognition (McCoy et al., 2005).It may also be attributed to age-related declines in cognitive functions such as working memory, attentional control, and processing speed (DeDe, Caplan, Kemtes, & Waters, 2004). Moreover, such a finding may attributed to age-related declines in both auditory and cognitive functions (Wingfield & Tun, 2001). The findings of this study seem to be at variance with the finding by Kaufman (2001) that when education was controlled, there were no significant differences between the mean scores of the younger and older age groups on the VCI of the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III). Kaufman's (2001) finding seems to support the view that variance in VCI is explained mainly by education than by age. In contrast this study's finding is supported by that of Salthouse and Saklofske (2010). They reported that the mean score for the younger age group was higher than that of the older age group on the verbal comprehension index of the WAIS-IV.

It was also found that there were significant sex-related differences between the mean raw scores of males and females on the Verbal comprehension index (VCI). Males had a higher mean score than females on the VCI which contradicted the prediction that females would have superior scores than males. In addition to these findings, there was a significant interaction effect

between sex and age in performance on the VCI such that males scored higher than females on the VCI from age 16 to 29 but after age 29 where the interaction effect occurred males' scores started declining while female's scores increased. The prediction of this study was based on the fact that females consistently show superior verbal skills than males (Maccoby & Jacklin, 1974). While this finding is unexpected, there is some evidence that suggest that female advantage may not span across all ages (Weiss et al., 2003). In other studies, it has been shown that males perform better than females in terms of general intelligence (Lynn, 1994; Rushton, 1992). Lynn (1994), for example, argued that although females on average mature somewhat earlier than males, males do show slight but consistent cognitive advantage over females once adulthood is reached. The maturational advantage of females therefore disappears in adulthood. The issue of males and females difference on the VCI have not quite resolved. This study's finding is supported by Heaton et al. (2003) who reported higher mean scores for males than females on VCI of the WAIS-III after adjusting for age and education in their study. On the contrary, the findings of the current study are not supported by Van der Sluis et al. (2006) who found no sex differences on the Verbal comprehension Index of the Dutch WAIS-III.

Age and Sex differences in performance on the Perceptual Reasoning Index (PRI) of the WAIS-IV

The study examined whether there were sex and age-related differences in performance on the Perceptual reasoning index (PRI) with number of years of education as a covariate. Years of education was found to be a significant covariate implying there was a strong association between one's education and performance on the PRI. In addition, there were age-related differences in performance on the PRI. It was observed that younger people scored higher on the PRI than older people. This means that there were declines in perceptual reasoning abilities with

increase in age. It was found that mean scores on PRI were higher from age 16 to 24 but started declining after age 24. Even, when mean scores for both young and older adults which were unadjusted for the effect of education were examined, the younger adults still scored higher than the older adults on the PRI. Another interesting finding in this study was that the effect of the covariate, years of education was stronger than both age and sex. This means, most of the variance in PRI may be attributed to education than to any of the factors examined in the study. This is not surprising when one examines the tests that make up the PRI. The finding that younger people scored higher on the PRI than older people may be explained by using the Socio-Emotional Selectivity Theory (Carstensen, Fung, & Charles, 2003).This theory postulates that adults at different ages may have different goals such that younger adults may be more focused on acquiring information whereas older adults may be more focused on emotion regulation and positive emotion as well as addressing practical needs of everyday life. According this theory these different goals among adults can impact on how adults with different ages approach and perform on cognitive tests. The study's finding is corroborated by the finding of Suwartono et al. (2014).These researchers found significant age-dependent declines in the PRI of the Indonesian WAIS-IV.

In addition to the findings on age, it was found that there were significant sex-related differences between the mean raw scores of males and females on the Perceptual reasoning index (PRI) when the effect of educational years was controlled. Specifically, males scored higher than females on the PRI. These findings supported the hypothesis that there will be significant differences in the performance of males and females on the WAIS-IV PRI. Moreover, the hypothesis that males will obtain higher mean raw scores than females on the WAIS-IV Perceptual reasoning index was supported. In addition to these findings, there was a significant

interaction effect between sex and age in performance on the PRI such that age influenced sex in predicting performance on PRI. Various researchers have suggested that gender differences in spatial ability may be transmitted as a recessive characteristic on the X chromosome, that these differences are related to a male sex hormone (Bergvall et al., 1994). This explanation could account for why males scored higher than females on the PRI in this study. This study's finding is supported by Van der Sluis et al. (2006).These researchers reported higher mean scores for males than females on Perceptual organisation index (currently called PRI on the WAIS-IV) of the Dutch WAIS-III. However, the finding of this study is inconsistent with that of Suwartono et al. (2014) who found that there were no significant differences in the mean scores of males and females on the Perceptual reasoning index of the WAIS-IV.

Age and Sex differences in performance on the Working Memory Index (WMI) of the WAIS-IV

The study examined sex and age-related differences in performance on the Working Memory Index with number of years of education as a covariate. Years of education was found to be a significant covariate implying there was a strong association between one's education and performance on the WMI. Furthermore, there were age-related differences in performance on the WMI. It was observed that younger people were found to score higher on the WMI than older people. This meant that there were declines in working memory abilities with increase in age. It was observed that scores on WMI were higher from age 16 to 24 but started declining after age 24. Even, when mean scores for both young and older adults which were unadjusted for the effect of education were examined, the younger adults still scored higher than the older adults on the WMI. An interesting finding in this study is that the effect of the covariate, years of education was stronger than sex but not age. This means that most of the variance in WMI may be attributed to age than to any of the factors examined in the study. The hypothesis that there

would be significant age-related differences in performance on the WAIS-IV WMI was supported. In addition, the hypothesis that younger age groups will obtain higher mean raw scores than the older age groups on the WAIS-IV WMI was supported. The finding that younger people scored higher on the WMI than older people may be explained by the inhibitory deficit hypothesis (Hasher, Zacks, & May, 1999). This theory proposes that a reduction in inhibitory ability causes older adults to perform worse than younger adults on working memory tasks. Thus, according to this theory the inability to reduce interference from task-irrelevant information is responsible for age differences in working memory. The finding of the current study is supported by Daseking and Petermann (2013) who reported that there were declines in the Working Memory Index of the WAIS-IV as age increases.

Apart from the findings on age, it was also found that there were significant sex-related differences between the mean raw scores of males and females on the WMI when the effect of educational years was controlled. Males had a higher mean score than females on the WMI. The hypothesis that there will be significant differences in the performance of males and females on the WAIS-IV WMI was supported. Further, the hypothesis that males will obtain higher mean raw scores than females on the WAIS-IV WMI was supported. In addition to these findings, there was a significant interaction effect between sex and age in performance on the WMI such that age influenced sex in predicting performance on WMI. The finding that males scored higher than females on the WMI have been attributed to the fact males perform better than females in visuo-spatial tasks (Vecchi & Girelli, 1998).This study's finding is supported by Heaton et al. (2003) who reported higher mean scores for males than females on WMI of the WAIS-III after adjusting for age and education in their study.

Age and Sex differences in performance on the Processing Speed Index (PSI) of the WAIS-IV

The study examined sex and age-related differences in performance on the Processing Speed Index (PSI) with number of years of education as a covariate. Years of education was found to be a significant covariate implying there was a strong association between one's education and performance on the PSI. Beyond that, there were age-related differences in performance on the PSI. Specifically, younger people were found to score higher on the PSI than older people, an indication that there were declines in processing speed abilities with increase in age. It was observed that mean scores on PSI were higher from age 16 to 24 but started declining after age 24. Even, when mean scores for both young and older adults which were unadjusted for the effect of education were examined, the younger adults still scored higher than the older adults on the PSI. In the present study, it was found that the effect of the covariate, years of education was stronger than sex but not age. This means, most of the variance in PSI may be attributed to age than to any of the factors examined in the study. The hypothesis that there would be significant age-related differences in performance on the WAIS-IV PSI was supported. In addition, the hypothesis that younger age groups will obtain higher mean raw scores than the older age groups on the WAIS-IV PSI was supported. Neurobiological explanations for age-related declines in processing speed focused initially on cortical declines in neuropil and myelin (Miller, 1994). However, current neurobiological explanations for age-related declines in processing speed have associated it with whole brain gray matter volume and white matter fractional anisotropy (Schiavone et al., 2009). Such findings seem in part to be due to structural declines in attention-related neural systems, especially within prefrontal cortex (Kennedy & Raz, 2009). In addition structural declines in motor and sensory cortex may contribute to age-related declines in processing speed (Welford, 1981). The finding of the present study is supported by

Daseking and Petermann (2013). Findings from their study indicated that WAIS-IV Processing Speed Index showed significant age-dependent lost.

Apart from age, it was found that there were no significant sex-related differences between the mean raw scores of males and females on the PSI when the effect of educational years was controlled. The hypothesis that there will be significant differences in the performance of males and females on the WAIS-IV PSI was not supported. The hypothesis that females will obtain higher mean raw scores than males on the WAIS-IV PSI was also not supported. However, there was a significant interaction effect between sex and age in performance on the PSI such that age influenced sex in predicting performance on PSI. Perhaps there were no significant sex-related differences on the processing speed index because this study's sample size of 251 was not large enough to detect such differences if any existed. This present study's finding is corroborated by Suwartono et al. (2014). Suwartono et al. (2014) found no significant differences in the mean scores of males and females on the WAIS-IV processing speed index. However, the finding of this study is inconsistent to that of Irwing (2012. Irwing (2012) found that females had a higher mean score than males on the processing speed index of the WAIS-III.

Evidence for the construct validity of the WAIS-IV

To examine and test for construct validity of WAIS-IV among Ghanaians, the association between performance on the Raven's Standard Progressive Matrices (SPM), a non-verbal test of fluid intelligence and the WAIS-IV indices (PRI and PSI) that measure non-verbal intelligence was tested. The expectation, based on prior literature and data on intelligence was that SPM will correlate significantly and strongly with WAIS-IV PRI and PSI which are measures of non-verbal intelligence and therefore may not be heavily influenced by cultural factors. This makes the WAIS-IV PRI and PSI more relevant measures of fluid abilities while the other WAIS-IV

indices of VCI and WMI reflect more of crystallized abilities. It was found that the Standard Progressive Matrices which is a non-verbal test of intelligence correlated significantly and strongly with WAIS-IV PRI that measure non-verbal intelligence than with WAIS-IV VCI that measure verbal intelligence. In addition, the SPM correlated significantly and strongly with WAIS-IV PSI than with WAIS-IV VCI. The findings strengthen the fact that Raven's Progressive Matrices measure an innate ability which is reflected in non-verbal abilities. By this it also validates the WAIS-IV PSI and PRI as culture-fair measures. However, it has been suggested that non-verbal tests may not necessarily be completely devoid of cultural influence (Dugbartey et al., 1999). It is possible that the hypothesis was partially supported because some of the WAIS-IV indices and subtests do not measure the constructs that the publisher claim they measure in the Ghanaian cultural context. Such differences may be attributed to social factors (Neisser et al., 1996), English proficiency (Beiser & Gotowiec, 2000), environmental factors (Neisser et al., 1996), socio-economic status (Beiser & Gotowiec, 2000; Suzuki & Valencia, 1997), cultural factors (Beiser & Gotowiec, 2000; Neisser et al., 1996), and test content bias (Suzuki & Valencia, 1997). These findings of the current study partially support the construct validity of the WAIS-IV in the Ghanaian context, especially that it measures fluid intellectual abilities.

The findings of this study that provided evidence on the construct validity of the WAIS-IV and its subtests are consistent with previous studies. Cheramie et al. (2012) reported a significant and strong relationship between the WAIS-IV Full Scale IQ and the Woodcock-Johnson-III: Tests of Cognitive Abilities (WJ-III COG) General Intellectual Ability. In addition, Miller et al. (2013) found that all correlations among the WAIS-IV subtests were positive and

almost all were statistically significant .They also found high correlations between WAIS-IV subtest scores that are part of the same index.

Cross-cultural comparison of the WAIS-IV American published norms and the Ghanaian norms

Another objective of this study was to find out whether there will be any significant differences between the WAIS-IV American published norms and the Ghanaian norms developed from this study. There was a significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Full scale IQ. A lower mean scaled score was found on the WAIS-IV Full scale IQ when the Ghanaian norms were used instead of the American published norms. In addition, a significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Verbal comprehension index was found. A lower mean scaled score was found on the WAIS-IV Verbal Comprehension Index when the Ghanaian norms were used instead of the American published norms. Moreover, there was a significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Working Memory Index. A lower mean scaled score was found on the WAIS-IV Working Memory Index when the Ghanaian norms were used instead of the American published norms. Further, there was a significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Perceptual Reasoning Index. A higher mean scaled score was found on the WAIS-IV Perceptual Reasoning Index when the Ghanaian norms were used instead of the American published norms. There was no significant difference between the mean scores of the American published norms and the Ghanaian norms on the WAIS-IV Processing Speed Index. It was observed that the Ghanaian sample scored lower using the Ghanaian norms on all WAIS-IV

indices (VCI and WMI) that measure verbal intelligence (crystallised intelligence) which are mostly prone to cultural bias. In contrast, the Ghanaian sample scored higher on WAIS-IV indices (PRI) that measure nonverbal intelligence when the Ghanaian norms were used. This implies that the performance of the Ghanaian sample was affected more by cultural factors on the WAIS-IV indices (VCI and WMI) that measure verbal intelligence. Therefore the difference between the Ghanaian and American published norms can be attributed to cultural differences between the American cultural setup where the WAIS-IV was developed and Ghanaian cultural setup. The findings of current study on the discrepancies between both the American and Ghanaian normative data is consistent with previous studies. Harrison et al. (2014) found that when the Canadian norms of the WAIS-IV were used, their sample gets lower IQ, Index, and subtest scores than when the American published norms were used. Such a finding is also corroborated by Harrison et al. (2015). In contrast, Miller et al.(2013) found significantly higher scaled scores for their Canadian sample on the WAIS-IV Information, Coding and Vocabulary subtests when norms derived from their sample was used as opposed to American published norms. In a related study in Ghana, Edwin (2001) found that when WISC-III^{UK} British published norms were used Ghanaian children obtained lower mean scores on most of the WISC-III^{UK} subtests than when Ghanaian norms were used.

Implications for Clinical Practice and Research

The findings of this study have very important implications for clinical practice. The findings give an indication that clinicians will obtain different scores on the WAIS-IV for their clients whether they use the Ghanaian norms or the American published norms due to cultural differences between the two countries. Ghanaian clinicians are therefore likely to make inaccurate diagnosis and decisions on their clients if they use the American published norms

instead of the Ghanaian norms. The Ghanaian clinicians are therefore encouraged to use the Ghanaian WAIS-IV norms which was developed based on a Ghanaian sample to avoid making inaccurate diagnosis.

Also, the findings of this study on the age and sex differences on the WAIS-IV have implications for clinical practice. Thus, knowing that sex and age differences exist on the WAIS-IV, clinicians will take this into consideration when interpreting clients scores and also when writing reports concerning their clients. Further, the results of this study that provided evidence on the construct validity of the WAIS-IV in the Ghanaian setting will encourage clinicians to be confident in using the WAIS-IV for psychological assessments in the Ghanaian setting. Through the pilot study conducted during the initial stages of this main study, it was found that information subtests and arithmetic subtests were culturally biased to the Ghanaian setting. Although an attempt has been made by the researcher to make changes to these tests in order to reduce the potential cultural bias in these two subtests, Clinicians will have to bear this in mind when interpreting such tests after administering it to their clients.

Limitations and Recommendations for Future Research

The purposive sampling technique used in this study may limit the representativeness of the sample to the Ghanaian population. It is therefore likely that the sizes of the subgroups in Ghanaian sample were either overrepresented or underrepresented in the sample. Such a situation may affect the generalisability of the findings of this study. It was the intention of the researcher to use stratified sampling technique to ensure various subgroups were accurately represented in the sample but the difficulty of getting people to volunteer for such a study to be tested for over two hours made it difficult for such a sampling technique to be used. Another limitation of this

study is the fact that the researcher could not recruit older age groups due to limited time for the completion of this thesis.

The researcher was not the only one who administered the neuropsychological instruments used in this study. Two research assistants were trained to assist in testing the participants of this study. This has the potential of confounding the results. Also, the sample size of 251 participants used in this study is not large enough and may therefore not be representative of the Ghanaian population.

On the basis of the limitations of this study it is recommended that future studies should be conducted on the WAIS-IV using a larger sample from the Ghanaian population to ensure representativeness. It is also recommended that future studies should use stratified sampling technique to ensure that the various subgroups within the Ghanaian population are well represented in the sample. Future studies should focus on extending this research to clinical samples as the present study focused on only healthy samples. Moreover, future studies should extend this research to study other variables apart from education that affect intelligence test scores.

Conclusions

The results of the study indicated that there were both significant age-related differences and sex differences on the WAIS-IV. It is therefore concluded on the basis of this study that, there were age and sex-related differences in cognitive abilities such as verbal comprehension, perceptual reasoning, working memory and processing speed. Thus, there were declines in cognitive abilities with aging not only in fluid intellectual abilities but also in crystallised intellectual abilities during adulthood.

Due to the differences found in the scores of the Ghanaian sample when both the Ghanaian norms and American published norms were used in this study, it is obvious that the norms that accompany Western standardised psychological tests are not applicable to the Ghanaian setting. It can therefore be concluded that there are potential cultural biases in western standardised psychological tests due to cross cultural differences. Hence, there is a need for Western imported psychological tests to be validated before being used in a country with a different cultural background like Ghana.

This study indicated that the Standard Progressive Matrices which is a non-verbal test of intelligence correlated significantly and strongly with WAIS-IV indices that measure non-verbal intelligence than with WAIS-IV indices that measure verbal intelligence. It also was observed from the current study that in most cases WAIS-IV subtests that measure the same construct had relatively high inter-item correlations than they did with other WAIS-IV subtests measuring different constructs. Such findings provided evidence for the construct validity of the WAIS-IV. This suggests that the WAIS-IV has the attribute of measurement invariance and measures the construct it claims to measure in different cultural contexts.

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APPENDICES
APPENDIX A
Ethical Clearance Letter

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)
P. O. Box LG 74, Legon, Accra, Ghana

My Ref. No.....

18th July, 2014

Mr. Daniel Miezah
Department of Psychology
University of Ghana
Legon

Dear Mr. Miezah,

ECH 086/13-14 VALIDATION OF WECHSLER ADULT INTELLIGENCE SCALE-FOURTH EDITION (WAIS-IV) IN THE GHANAIAN POPULATION

This is to advise you that the above reference study has been presented to the Ethics Committee for the Humanities and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	08/01/15
On Agenda for:	Initial Submission
Description:	26/06/14
ECH Action:	Approved
Reporting:	Quarterly

UG/ISSER/ECH VALID UNTIL 08 JAN 2015 APPROVED DOCUMENT

Please accept my congratulations.

Yours Sincerely,

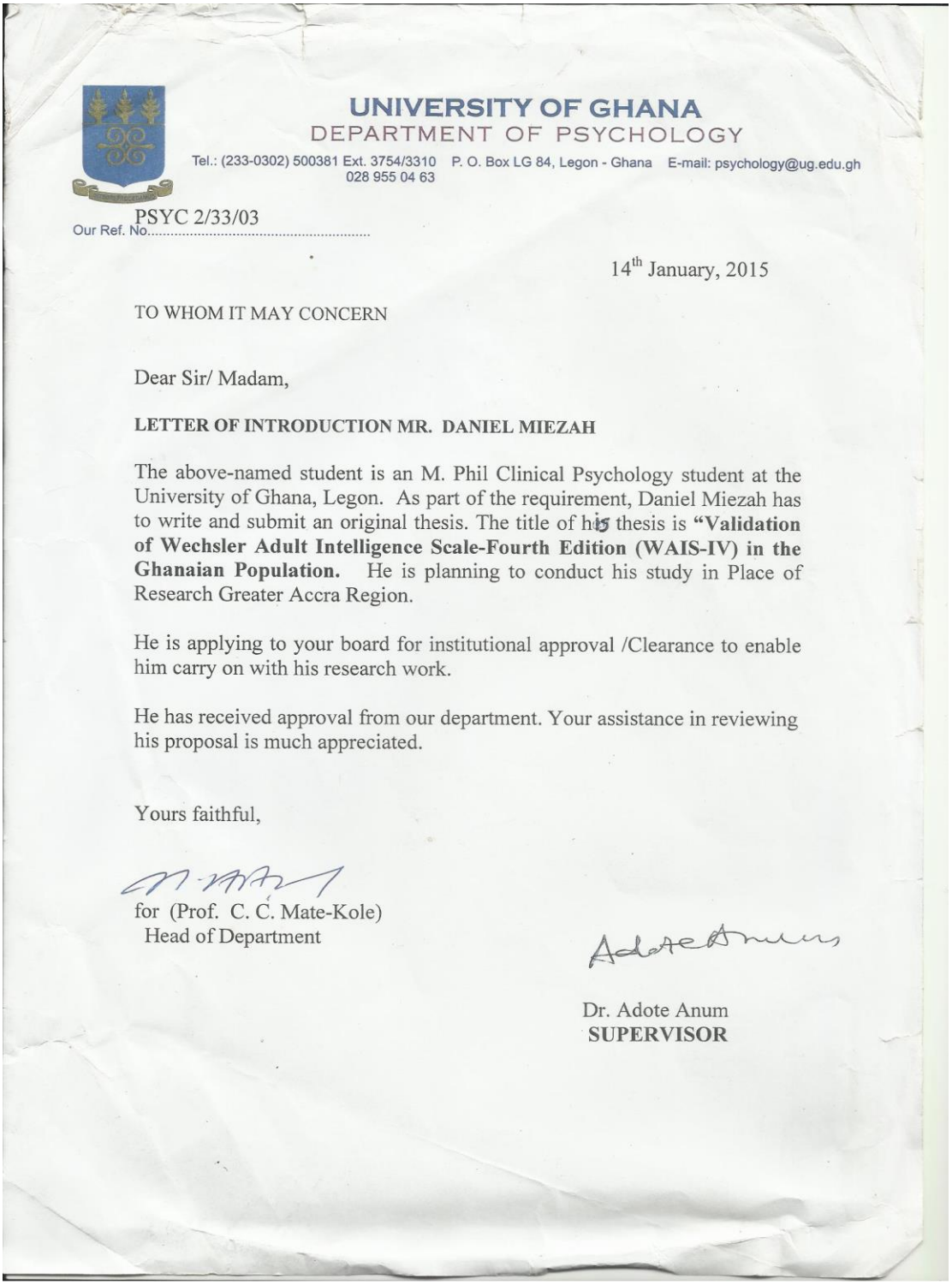
Rev. Prof. J. O. Y. Mante
ECH Chair

CC: Director, ISSER

Tel: +233-303933866 Email: ech@isser.edu.gh

APPENDIX B

Letter of Introduction



UNIVERSITY OF GHANA
DEPARTMENT OF PSYCHOLOGY

Tel.: (233-0302) 500381 Ext. 3754/3310 P. O. Box LG 84, Legon - Ghana E-mail: psychology@ug.edu.gh
028 955 04 63

Our Ref. No. PSYC 2/33/03

14th January, 2015

TO WHOM IT MAY CONCERN

Dear Sir/ Madam,

LETTER OF INTRODUCTION MR. DANIEL MIEZAH

The above-named student is an M. Phil Clinical Psychology student at the University of Ghana, Legon. As part of the requirement, Daniel Miezah has to write and submit an original thesis. The title of his thesis is **"Validation of Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) in the Ghanaian Population.** He is planning to conduct his study in Place of Research Greater Accra Region.

He is applying to your board for institutional approval /Clearance to enable him carry on with his research work.

He has received approval from our department. Your assistance in reviewing his proposal is much appreciated.

Yours faithful,

for (Prof. C. C. Mate-Kole)
Head of Department

Dr. Adote Anum
SUPERVISOR

APPENDIX C

UNIVERSITY OF GHANA

Official Use only Protocol number

OFFICE OF RESEARCH, INNOVATION AND DEVELOPMENT

Ethics Committee for Humanities (ECH)

PROTOCOL CONSENT FORM

Section A- BACKGROUND INFORMATION

Title of Study:	Validation Of Wechsler Adult Intelligence Scale-Fourth Edition(WAIS-IV) In The Ghanaian Population
Principal Investigator:	Daniel Miezah
Certified Protocol Number	

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

The title of the study in which you are being invited to participate is "Validation Of Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) In The Ghanaian Population". The purpose of this study is to develop norms for the Wechsler Adult Intelligence Scale (WAIS-IV) in the Ghanaian population and to examine the Construct validity of the WAIS-IV in the Ghanaian population. You will be given tasks relating to the measurement of intelligence to perform. I hope the doing of these takes will not take more than two hours of your time.

Benefits/Risk of the study

Possible risks: This study will not expose you to any higher risks than you would normally face in the course of carrying out your tasks. You may experience fatigue as a result of the long period involved in doing the tasks given to you. You will be given ample time in the form of a break to prevent fatigue. Some of the tasks may be easy, while others may be difficult. You are not required to answer all the questions correctly or to perform all the tasks perfectly.

Possible Benefits: Upon completion, you may not derive direct benefits from the study. However, this study will generate normative data on the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) which can be used within clinical settings in Ghana for diagnostic, placement and treatment purposes.

Confidentiality

Any information you give will be stored to ensure anonymity and treated as confidential and will be used for research purposes only. Where quotations are used, every attempt will be made to ensure anonymity of the subject, otherwise they will not be used at all. The information and responses you provide will be treated with utmost confidentiality. Only the researcher and

approved research assistants will have access to the individual data you will provide. Under no circumstances will any individual participant be identified in a publication or presentation describing this study.

Compensation

This study will not include any compensation apart from a verbal appreciation of your valued time and efforts.

Withdrawal from Study

Your participation in this study is voluntary (not compulsory), and you may choose not to participate, in which case there will be absolutely no negative consequences to you. You may also choose to stop participation at any time during the study without any negative consequences to you. We also respect your right to ask us further questions to clear any doubt you may have about any aspect of the study before agreeing to participate.

We are grateful for your valuable effort and time and appreciate this very much. Results of the study may be presented at various conferences and reported in various academic journals so as to reach decision and policy makers. Thank-you for your time. Please sign below if you choose to participate

Contact for Additional Information

The following numbers can be contacted in case of any discomfort, explanation or further information.

Student researcher: Daniel Miezah (# 024 9569150)

Supervisor: Dr. Adote Anum (#0249107770)

Supervisor: Prof. Joseph Yaw Opoku (#0208180435)

Section C- VOLUNTEER AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and am willing to give consent for me, my child/ward to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____

Name of Volunteer

_____

_____

Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_____

Name of witness

_____

_____

Signature of witness Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____

Name of Person who Obtained Consent

_____

_____

Signature of Person Who Obtained Consent Date

APPENDIX D

Background Questionnaire

1. Gender (circle one): Male Female
2. What is your date of birth and age?
3. What is the highest level of education you have attained?

a. JHS b. SHS c. Tertiary (University, Polytechnic, Training College)

4. How many years have you been through formal education?
5. Where in the Greater Accra Region have you lived in the last five years?
6. Are you employed? Yes/No
7. Which of the following categories best describes your area of employment?

a. Education b. Health Care c. Business d. Other

8. How much do you earn in a month?

a. 500-1000Ghc b.1100-2000Ghc c. Over 2000Ghc d. below 500

9. Do you have any chronic illness? Yes/No

a. If yes, do you take any medications currently?

10. Do you have any history of head injury? Yes/No

a. If yes, how long?

11 .Have you ever been diagnosed with any psychiatric disorder? Yes/No

a. If yes, how long?

Tested by:

NOTE: Because permissions for copyright to copy the neuropsychological tests (WAIS-IV and SPM) used in this study were not attained, the researcher could not scan them as an attachment in this section. Also, the researcher could not attach the neuropsychological tests because they are very bulky.

APPENDIX E

GHANAIAN Normative Conversion Tables of WAIS-IV Subtests

Table 20. Scaled Score Equivalents of Total Raw Scores for Subtests, by Age group

Ages 16:0-17:11										
Scaled Score	BD	SI	DS	MR	VC	AR	SS	VP	IN	CD
1	0-7	0-7	0-14	0-2	0-2	0-3	0-8	0-1	0	0-30
2	8-10	8-9	15-16	3	3-5	4	9-11	2-3	1	30-34
3	11-16	10-12	17-18	4-5	6-9	5	12-14	4	2	35-40
4	17-19	13-14	19-20	6-7	10-11	6-7	15-17	5	3	41-46
5	20-21	15-16	21-22	8-9	12-14	8	18-20	6	4	47-52
6	22-24	17-18	23-24	10-11	15-17	9-10	21-22	7-8	5-6	53-58
7	25-27	19-20	25-26	12-14	18-20	11	23-25	9-10	7	59-61
8	28-30	21-22	27-28	15-16	21-23	12	26-27	11-12	8-9	62-67
9	31-33	23	29-30	17-18	24-25	13-14	28-29	13-14	10-11	68-70
10	34-36	24-25	31-32	19	26-29	15	30-32	15-16	12	71-74
11	37-41	26	33	20	30-32	16	33-34	17	13-14	75-78
12	42-45	27-28	34-35	21	33-35	17	35-36	18-19	15	79-83
13	46-48	29	36-37	22	36-39	18	37-38	20	16-17	84-89
14	49-50	30	38	23	40-42	19	39-41	21	18-19	90-93
15	51-54	31	39-40	24	43-45	20	42-44	22	20	94-100
16	55-57	32	41	-	46-48	-	45-46	23	21	101-107
17	58-62	33	42	25	49-50	21	47-48	24	22	108-112
18	63-64	34	43	-	51-52	-	49-50	25	23	113-115
19	65-66	35-36	44-48	26	52-57	22	51-60	26	24-26	116-135

Table 21. Scaled Score Equivalents of Total Raw Scores for Subtests, by Age group

Ages 18:0-19:11										
Scaled Score	BD	SI	DS	MR	VC	AR	SS	VP	IN	CD
1	0-6	0-5	0-10	0-1	0	0-2	0-10	0	0	0-25
2	7-9	6-7	11-12	2	1-2	3	11-13	1	1	26-30
3	10-13	8-9	13-14	3	3-5	4	14-16	2-3	2	31-36
4	14-19	10-11	15-16	4	6-9	5	17-19	4	3	37
5	20-23	12-13	17-18	5-6	10	6	20-22	5	4	38-44
6	24-27	14-15	19-20	7-8	11-13	7-8	23-25	6	5-6	45-48
7	28-30	16-17	21-22	9	14-17	9	26-28	7-8	7	49-56
8	31-33	18-19	23-24	10-11	18-20	10	29-31	9-10	8-9	57-60
9	34-37	20	25-26	12-13	21-24	11-12	32-34	11-12	10-11	61-63
10	38-42	21-22	27-28	14-15	25-28	13	35-37	13-14	12	64-68
11	43-45	23-24	29-30	16-17	29-32	14	38-39	15	13-14	69-75
12	46-49	25	31	18	33-36	15-16	40-42	16-17	15	76-82
13	50-53	26-27	32-33	19	37-40	17	43-45	18	16-17	83-88
14	54-55	28	34-35	20	41-44	18	46-47	19	18-19	89-94
15	56-57	29	36	21	45-47	19	48-49	20	20	95-99
16	58-60	30-31	37-38	22	48-49	-	50-51	21	21	100-103
17	61	32	39	23	50-51	20	52-53	22	22	104-106
18	62	33	40-41	24	52	21	54-55	23	23	107-109
19	63-66	34-36	42-48	25-26	53-57	22	56-60	24-26	24-26	110-135

Table 22. Scaled Score Equivalents of Total Raw Scores for Subtests, by Age group

	Ages 20:0-24:11									
Scaled Score	BD	SI	DS	MR	VC	AR	SS	VP	IN	CD
1	0-7	0-9	0-13	0-2	0-4	0-4	0-9	0-1	0	0-30
2	8-10	10-11	14-15	3	5-7	5	10-12	2-3	1	31-35
3	11-14	12-13	16-17	4	8-11	6	13-15	4	2	36-41
4	15-19	14-15	18-19	5-6	12-15	7	16-17	5	3	42-44
5	20-24	16-17	20-21	7	16-19	8-9	18-20	6-7	4-5	45-50
6	25-30	18-19	22-23	8-9	20-23	10	21-23	8	6	51-56
7	31-35	20-21	24-25	10-11	24-27	11	24-26	9-10	7-8	57-62
8	36-40	22-23	26-27	12-13	28-31	12	27-29	11-12	9-10	63-67
9	41-45	24-25	28-29	14-15	32-34	13-14	30-33	13-14	11-12	68-72
10	46-49	26-27	30-31	16	35-38	15	34-36	15-16	13-14	73-76
11	50-53	28-29	32-33	17	39-41	16	37-38	17	15	77-82
12	54-57	30	34-35	18	42-45	17	39-41	18	16-17	83-86
13	58-60	31	36-37	19	46-48	18	42-44	19-20	18-19	87-92
14	61	32	38	20	49-51	19	45-46	21	20	93-96
15	62	33	39-40	21	52-53	20	47-48	22	21-22	97-100
16	63	34	41	22	54	-	49-50	23	23	101-104
17	64	35	42-43	23-24	55	21	51-52	24	24	105-109
18	65	-	44	25	56	-	53-54	25	25	110-112
19	66	36	45-48	26	57	22	55-60	26	26	113-135

Table 23. Scaled Score Equivalents of Total Raw Scores for Subtests, by Age group

	Ages 25:0-29:11									
Scaled Score	BD	SI	DS	MR	VC	AR	SS	VP	IN	CD
1	0-6	0-10	0-14	0-5	0-9	0-4	0-9	0-4	0-1	0-30
2	7-9	11-12	15-16	6	10-12	5	10-14	5-6	2	31-39
3	10-14	13-14	17-18	7-8	13-16	6	15-17	7	3	40-46
4	15-19	15-16	19-20	9-10	17-20	7	18-20	8	4-5	47-52
5	20-24	17-18	21-22	11	21-24	8-9	21-23	9	6-7	53-58
6	25-29	19-20	23-24	12-13	25-28	10	24-26	10-11	8	59-64
7	30-35	21-22	25-26	14-15	29-32	11	27-29	12-13	9	65-70
8	36-39	23	27-28	16-17	33-36	12	30-32	14-15	10-11	71-75
9	40-44	24-25	29-30	18	37-39	13	33-35	16	12-13	76-80
10	45-49	26-27	31-32	19	40-43	14	36-37	17-18	14	81-86
11	50-53	28-29	33-34	20	44-45	15	38-40	19-20	15-16	87-91
12	54-56	30	35-36	21	46-47	16-17	41-43	21	17-18	92-95
13	57-59	31	37-38	22	48-49	18	44-45	22	19	96-100
14	60-61	32	39	23	50-51	19	46-47	23	20-21	101-104
15	62	33	40-41	24	52	20	48-49	24	22	105-108
16	63	34	42	-	53	21	50-51	25	23	109-111
17	64	-	43-44	25	54	-	52-53	-	24	112-114
18	65	35	45	26	55	22	54-55	26	25	115-117
19	66	36	46-48	-	56-57	-	56-60	-	26	118-135

Table 24. Scaled Score Equivalents of Total Raw Scores for Subtests, by Age group

	Ages 30:0-34:11									
Scaled Score	BD	SI	DS	MR	VC	AR	SS	VP	IN	CD
1	0-9	0-9	0-13	0-1	0-3	0-6	0-5	0-4	0-2	0-23
2	10-15	10-11	14-15	2-3	4-6	7	6-7	5	3	24-28
3	16-20	12-14	16-17	4-5	7-10	8	8-10	6	4	27-32
4	21-23	15-16	18-19	6-7	11-14	9	11-14	7	5	33-39
5	24-27	17-18	20-21	8-9	15-18	10	15-17	8-9	6	40-43
6	28-32	19-20	22-23	10-11	19-20	11	18-20	10-11	7-8	44-46
7	33-37	21-22	24-25	12-13	21-23	12	21-23	12-13	9	47-48
8	38-42	23-24	26-27	14-15	24-25	13-14	24-26	14	10-11	49-54
9	43-47	25-27	28-29	16	26-28	15	27-29	15-16	12-13	55-57
10	48-51	28	30-31	17-18	29-31	16	30-32	17	14	58-59
11	52-54	29	32-33	19	32-36	17	33-34	18-19	15-16	60-65
12	55-57	30	34-35	20	37-39	18	35-36	20	17-18	66-71
13	58-60	31	36	21	40-42	19	37-39	21	19	72-77
14	61-62	32	37-38	22	43-45	-	40-42	22	20	79-80
15	63	33	39	23	46-47	20	43-44	23	21-22	81-84
16	64	34	40-41	-	48	-	45-46	24	23	85-91
17	65	35	42	24	49	21	47-48	25	24	92-97
18	-	-	43	25	50	-	49-50	-	25	98-104
19	66	36	44-48	26	51-57	22	51-60	26	26	105-135

APPENDIX F

Additional Tables

Table 25. Test-Retest Reliability coefficients between first and second testing

WAIS-IV Subtests	Pearson Correlation(*r*)
Block Design	.77
Similarities	.47
Digit span	.66
Digit span forward	.47
Digit span backward	.63
Digit span sequencing	.22
Matrix Reasoning	.82
Vocabulary	.87
Arithmetic	.76
Symbol search	.85
Visual puzzles	.73
Information	.87
Coding	.66

Table 26.Information Subtest

Item Number	(Frequency)Correct	(Frequency)Incorrect
8.Original Item	90	50
8.Modified Item	125	15
18. Original Item	25	90
18. Modified Item	60	55
22. Original Item	30	92
22. Modified Item	53	69
23 Original Item	31	115
23. Modified Item	36	110
25 Original Item	17	99
25. Modified Item	50	66