NORMATIVE DATA ON THE RAVEN'S STANDARD PROGRESSIVE MATRICES AND THE SLOSSON INTELLIGENCE TEST AMONG GHANAIAN CHILDREN

BY

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DECLARATION

I hereby declare that this dissertation is my original work and that it has not been submitted for any award in any institution.

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CERTIFICATION BY SUPERVISOR

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DEDICATION

To the memory of my late father, who gave me an amazing childhood and provided all I needed to enjoy optimum mental health as a child, and is the reason I am where I am today…

And to the children of Africa whose tenacity and resilience in the face of adversity, inspires me to dedicate my life every day to improving their well-being and give them a better future…

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It is said that the great heights that men attained was upon the shoulders of giants they stood- you were my giants upon whose shoulders I stood to see so far. The Lord bless you and keep you, the Lord cause His face to shine upon you and be gracious to you, and give you peace.

From the depths of my heart,

Kwabena

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KEY TO ABBREVIATIONS (ACRONYMS)

ANOVA	Analysis of Variance
CRP	Calculated Real Proportion
fMRI	Functional Magnetic Resonance Imaging (fMRI)
ICT	Information and Communication Technology
IQ	Intelligence Quotient
IWI	International Wealth Index
K-ABC	Kaufmann Assessment Battery for Children
KMA	Kumasi Metropolitan Assembly
LAMIC	Low and Middle Income Countries
PHQ-9	Patient Health Questionnaire-9
RPM	Raven's Progressive Matrices
RSPM	Raven's Standard Progressive Matrices
SIT	Slosson Intelligence Test
SPM	Standard Progressive Matrices
WAIS	Wechsler Adult Intelligence Scale
WISC	Wechsler Intelligence Scale for Children

ABSTRACT

Background: Intelligence as a construct is difficult to define and measure. In non-Western populations, it is even more difficult to do so. The lack of locally derived normative data on most available intelligence testing instruments results in inaccurate assessments due to unfair comparisons between Western and non-Western populations. In addition, various factors that affect cognitive ability have scarcely been elucidated in most sub-Saharan African countries. This has impeded the understanding of intelligence, why it appears to differ among various segments of the population, and how it can be improved. The link between risk factors such as poverty and low educational attainment in a caregiver, and the lowering of cognitive ability has been well established. Furthermore, mental health problems are fairly common in the extremes of the intelligence spectrum: among the intellectually gifted and those with intellectual disability. Data from a recent meta-analysis showed an unusually high prevalence (2-3%) of Intellectual Disability in developing countries as compared to high-income countries, a situation likely due to poor obstetric and antenatal care. There is therefore the need to develop accurate and locally acceptable means of assessing intelligence among the local population of children of developing countries such as Ghana. There is also the need to examine factors associated with performance on intelligence testing to enhance our understanding of intelligence and introduce interventions as much as is possible.

Objective: This study aimed to provide normative data for the Raven's Standard Progressive Matrices (RSPM) and the Slosson Intelligence Test (SIT) among Ghanaian children and adolescents aged 6-19 years to allow for more accurate local assessment of intelligence, and to assess sociodemographic factors most predictive of intelligence scores on these tests.

Methodology: In a cross-sectional survey, 619 children and adolescents aged 6-19 years were recruited into the study from 11 randomly selected schools (7 public schools and 4 private schools) located in rural and urban Kumasi in the Ashanti region of Ghana. Participants with known cognitive deficits were excluded from the study. Sampling was by multi-stage random sampling. Once informed consent was obtained and socio-demographic data was collected, screening for depression and anxiety symptoms was done using the Patient Health Questionnaire-9. Finally, the intelligence instruments were administered to the participants. Instruments used to establish

normative values of intelligence were the Raven's Standard Progressive Matrices (RSPM), a nonverbal performance test, and the Slosson Intelligence Test (SIT), which measures the domains of verbal intelligence. The RSPM (nonverbal test) was administered to all participants who completed the study while the SIT (verbal test) was administered only to urban children who were fluent in spoken English. The collected data was then analysed using the Statistical Package for Social Science version 20 (SPSS-20).

Results: A total of 614 participants, 278 males (45.3%) and 336 (54.7%) females with a mean age of 12.7 (SD: 3.8) and an age range of 6 to 19 years completed the tests. Five participants did not complete the intelligence tests and were excluded from the final analysis. There were 396 (64.8%) subjects from urban settings and 363 (59.1%) from public schools. Only 14 participants (2.3%) screened positive for depression and/or anxiety symptoms. There were 259 (42.2%) participants who reported primary level as the highest level of education of their caregiver, 493 (80.3%) did not speak English at home, and 303 (49.3%) did not have an active leisurely reading habit or watch educational programmes regularly. English was the language of instruction for 517 (84.2%) participants and 322 (52.4%) reported having access to information by way of well-stocked libraries and ICT centres with Internet access.

The internal consistency for the 60-item RSPM was 0.954 (standardized item alpha= 0.950). The Pearson's Correlation Coefficient between the RSPM and the SIT was strongly positive at 0.722 ($p<0.001$). For the normative data for the RSPM, the lowest mean score was 13.46 among 6-year-olds and the highest mean score was 40.42 among the 19-year-olds. There was a general increase in scores with advancing age. Children and adolescents in urban schools scored higher than those in rural schools and participants from private schools scored higher that those in public schools, except at age 6 where they all scored a mean of around 13.

All local mean scores were lower than British norms in each age-cell. Among the urban sample, the mean score of 6-year-olds was not significantly different from that of British 6-year-olds (t-test= 1.505, p= 0.153). Significant differences in the mean scores on the RSPM began to show from age 7 years onwards. For participants in the private schools in affluent neighbourhoods, there was no statistical difference in mean scores on the RSPM compared to British norms in every age-cell except at ages 12 and 14 years which was lower than the British norms.

Multiple linear regression models revealed that children in private schools had an over 5 point increase in scores compared to public schools independent of all other variables (95% CI 1.58 to 9.36). Children with a reading habit had a 3.39 point increase in scores (95% CI 1.55 to 5.24), and teachers with higher levels of training were associated with 4.44 point increase in scores (95% CI 1.15 to 7.73).

Conclusions: This study reports the first attempt to standardize the RSPM and SIT in Ghana across the wide age range of 6-19 years. The different normative values obtained from western standards underscore the need for local norming of psychometric instruments to be able to use them meaningfully. The vastly different scores obtained for different sub-groups within the population appeared to be largely connected to standard of living. These significant differences appear to justify the calls for establishing different normative data for different subsets of the population within the national population of developing countries for the same reason local normative data are recommended rather than importing western norms. This will help to avoid unfair comparisons across widely disparate socio-demographic sub-groups. Also the strong case for the effect of environmental factors on intelligence scores over and above genetic factors has been enhanced by this study. Interventions for improving the quality of education and the standard of living of developing countries are thus desirable for the improvement of cognitive ability of children.

Keywords: Intelligence, Intelligence testing, Raven's Standard Progressive Matrices, Slosson Intelligence Test, Kumasi Ghana

CHAPTER ONE- INTRODUCTION

1.1 BACKGROUND

How intelligent is this person? This is a simple yet difficult question to answer accurately, whether in the context of educational placement, employment, military recruitment, and mental health care or just plain every day usage (Robert M. Kaplan & Saccuzzo, 2005a). Indeed, it is a question that mankind has tried to answer in various ways from time immemorial. From a purely scientific point of view, even the scientific community has not achieved perfect success in answering that question (Robert M. Kaplan & Saccuzzo, 2005a).

Charles Spearman in 1904 postulated a 'general factor of intelligence' (which he labelled as *g*) defined as the ability that is reflected in all tests (C Spearman, 1904) which explains the correlation found among diverse tests taken by an individual. Since then various measures have been derived for this General Intelligence, chief among which have been the "Performance subtests" (or Nonverbal measures), and the "Verbal subtests" of cognitive ability (Robert M. Kaplan & Saccuzzo, 2005a). These measures of general intelligence are believed to give a fairly accurate depiction of the test subject's ability with abstract reasoning and logical thinking (John Raven, Court, & Raven, 1998). This is supposed to help give a fair and objective basis for comparing one individual to another in terms of these cognitive abilities.

For professionals working in the field of child and adolescent mental health (CAMH), assessing the intelligence of a child or adolescent is a task that is grappled with on a regular basis. Intellectual Disability (ID) as a condition on its own or as co-morbid with many neuro-developmental and mental disorders constitutes a huge morbidity burden in sub-Saharan Africa (Maulik, Mascarenhas, Mathers, Dua, & Saxena, 2011). In a meta-analysis published in 2011, the worldwide prevalence of ID was put at 10.37/1000 population (about 1%) with developing countries said to have about twice that rate of prevalence (Maulik et al., 2011). A small community-based pilot study of child and adolescent mental disorders carried out in Ghana obtained an ID prevalence of about 1%, although this is likely an underestimation due to the limited sample size of 304 in that study (Donnir, Kusi-Mensah, Owusu-Antwi, Wemakor, & Omigbodun, 2016) .

Despite improvements in child health in most countries in sub-Saharan Africa as a result of working towards the Millennium Development Goals (MDGs) (UN, 2015), there are still problems of poor obstetric care with perinatal injuries, problems with childhood nutrition and other aetiological factors. Sub-Saharan Africa still had the highest Child mortality rates, but also the highest absolute decline in child mortality rates by the close of the era of MDG 4 and 5 (UN, 2015). This means more and more African children are surviving beyond infancy because of improved healthcare. Evidence of the link between obstetric complications and child mental health problems including intellectual disability has been documented in Nigeria in a study of children and adolescents presenting at a tertiary child and adolescent psychiatric clinic (O. O. Omigbodun & Bella, 2004). Even though there is no hard evidence to establish this, Ghana, it may be reasonably conjectured, will be no exception to these observations, given the similar health and socioeconomic profile she shares with her West African neighbour.

The concern however is not only with the accurate identification of problems of intellectual ability in children, but also with associated risk factors that are predictive of intellectual ability. Sameroff and colleagues demonstrated the fascinating link between the accumulation of risk factors (such as poverty, absence of a parent, drug abuse, mental illness in a parent, low educational attainment in a parent, child abuse, exposure to racism and large family size) and the lowering of Intelligence Quotient (IQ) scores among four-year-olds (Sameroff, Seifer, Barocas, Zax, & Greenspan, 1987).

In this seminal study, it was demonstrated that when none of these factors was present in the child, the average IQ score was 119, but with one risk factor IQ dropped to 116; with two risk factors, to 113 and with four and eight risk factors it dropped to 93 and 85 respectively (Sameroff et al., 1987). Of the factors identified in Sameroff's paper, poverty alone is still a major problem in sub-Saharan Africa as indicated by failure to meet the just ended MDG-era Goal 1: the halving of poverty by 2015 (UN, 2015). Another of the factors identified, education, is also still a problem with sub-Saharan Africa again failing to meet the MDG 2 targets (UN, 2015). It is in this light that the urgent need there is for a suitable screening instrument for intelligence and also for teasing out some of the sociodemographic factors most predictive of low IQ scores in the local context, to help CAMH workers in the sub-region to begin to address some of these challenges becomes apparent.

PROBLEM STATEMENT

The issue of accurate measurement of intelligence, has become problematic in the settings of sub-Saharan Africa because of various challenges with using Western-derived intelligence scales locally (Wicherts, Dolan, & van der Maas, 2010). The reasons why these scales are difficult to use *de integro* include (but are not limited to) problems of literacy, wide variations in socio-demographic factors within the local population, differences in cross-cultural concepts used in questions on these scales, and a lack of normative data for local populations (Grieve & van Eeden, 2010; Wicherts et al., 2010). As such, in most countries in sub-Saharan Africa, there are no accurate ways of measuring intelligence because most psychometric scales currently available were developed for Western populations based on western normative data and socio-economic demographics (Grieve & van Eeden, 2010).

There is therefore a need to develop ways of accurately assessing intelligence among African populations by first of all developing norms for appropriate and adapted western scales, with a view to developing and validating local intelligence scales based on African concepts of 'intelligence' in the long term. This project represents a step in this endeavour, by proposing the development of normative data for two popular, widely used and validated Western intelligence tests to aid in the accurate interpretation of results obtained when used within the population of Ghanaian children and adolescents.

The Raven's Standard Progressive Matrices scale was chosen because it is one of the most widely used and validated measures of Nonverbal Intelligence that purports to eliminate the biases of language and culture in the measurement of the two main components of *g*, i.e. *eductive ability* (from the Latin ***'educere'***: which means *"to draw out"*- the ability to make meaning out of confusion and generate high-level schemata to handle complexity) and *reproductive ability* (the ability to recall and reproduce information that has been made explicit) (John Raven, 2000). This is expected to give a fairer estimation of intelligence in children who have limited exposure to Western education in Ghana in both rural and urban settings, and also do not have a good grasp of the English language or Western concepts. However the matrix tests do not give a lot of detail concerning other aspects or domains of intelligence such as 'Verbal comprehension' and 'Working Memory' (John Raven et al., 1998; Robert M. Kaplan & Saccuzzo, 2005a). These in some ways better reflect a subject's cognitive abilities and potential, and also have their own advantages such as being less susceptible to emotional states and being more stable compared to the Non-verbal tests (Robert M. Kaplan & Saccuzzo, 2005a). For this reason, the Slosson Intelligence Test (SIT), which tests for components in Verbal Intelligence, was included in this project to give a fairer assessment of intelligence in the Ghanaian context.

1.2 JUSTIFICATION/RATIONALE

There is currently no normative data for any of the widely used intelligence scales available for all age-groups of children in Ghana. It is therefore not possible to assess intelligence in Ghanaian children accurately and based on Ghanaian norms at the moment. In addition, socio-demographic and other factors correlated with performance on intelligence testing are unknown in this setting. This study seeks to bridge that knowledge gap on intelligence and intelligence testing for Ghanaian children and adolescents by the provision of accurate Ghanaian norms to help clinicians accurately assess children they see in their clinics and thus place them in the best institutions for optimum outcomes. Within the educational sector, the specific areas of weakness in intellectual ability can be obtained and this will provide vital information to mainstream and special education teachers on how best to help children in their care. The tests would be able to localize the specific mental ability or disability such as verbal comprehension or eductive reasoning) and thus the child can have targeted help.

The problem of misdiagnosis of children by teachers and clinicians in Ghana as having ID or borderline intelligence due to the use of Western normative data should be reduced since locally relevant normative data would now be available. The current trend advocating inclusive education for children with disabilities can be pursued with more vigour, as normative values are made available in this setting.

Furthermore, truly 'gifted' children with superior intellectual ability based on accurate Ghanaian norms can be identified and appropriately provided for. It is known that gifted children placed in regular classes can also develop mental health problems as a result of boredom and under-stimulation and as such, identifying and meeting their mental health needs will be another benefit. Also, given that high Intelligence Quotient (IQ) is a known protective factor for many CAMH problems, having an accurate way of assessing intellectual ability will be a useful tool in CAMH research in Ghana and will help stimulate further interest in the area.

1.3 AIM

To provide normative data for the Raven's Standard Progressive Matrices (RSPM) and the Slosson Intelligence Test (SIT) among Ghanaian children and adolescents aged 6-19 years and to determine sociodemographic factors most predictive of IQ scores on these tests.

1.4 RESEARCH QUESTIONS

1. What is the mean score and standard deviation for the Raven's SPM and SIT for each age group in Ghana?
2. Is there a correlation between Raven's SPM scores and SIT scores?
3. Is there a correlation between RSPM scores and education related factors?:
    a. Socioeconomic status using International Wealth Index as an indicator
    b. Student-teacher ratio
4. How well is IQ score on SPM predicted by *"home factors"* (such as average household income, English spoken at home by at least 1 caregiver, leisurely reading of books/watching of educational shows) over and above *"school factors"* (such as teacher-student ratio, English as language of educational instruction, presence of library/ICT centre at school)
5. Is there a difference in the IQ as measured by scores of the following groups:
    a. Children from homes where at least 1 caregiver uses English regularly with them versus children from homes where only local language is spoken?
    b. Children who report leisurely reading of at least 1 book per term OR watch 1 educational children's TV show per week, versus those who do not?

c. Children who attend schools where English is the predominant functional language of instruction versus those who do not?

d. Children who attend schools which have functioning libraries OR ICT centres versus those who do not?

1.5 SPECIFIC OBJECTIVES

For Ghanaian children and adolescents aged 6-19 years attending school in rural and urban Kumasi:

1. To determine the internal consistency and validity of the Raven's Standard Progressive Matrices (RSPM), by comparing the performance of children and adolescents on the RSPM with the Slosson Intelligence Test (SIT)
2. To determine normative values for the RSPM and SIT
3. To compare the mean of the raw scores on the RSPM according to age and with normative scores of similar aged children in the United Kingdom
4. To determine the association between the means of the raw scores on the RSPM according to socio-demographic variables

1.6 NULL HYPOTHESIS

1. There will be no differences between the normative data derived in Ghana and western normative data for all samples
2. There will be no correlation between the performance on the Non-verbal Raven's SPM scale and the performance on the Verbal SIT by the same subjects.
3. There will be no correlation between scores on the SPM and SIT on the one hand, nor an association with any socio-demographic factors analysed on the other hand

1.7 ALTERNATIVE HYPOTHESIS

1. There will be differences between the normative data derived in Ghana and western normative data
2. There will be a correlation between performance on the Non-verbal Raven's SPM scale and the Verbal SIT scale by the same subjects
3. The will be correlates between scores on the SPM and SIT and some socio-demographic factors analysed

1.8 PRIMARY OUTCOME MEASURES

Primary outcome measures will be the scores on the SPM and the modified SIT scales administered to the subjects.

CHAPTER TWO- LITERATURE REVIEW

2.1 INTELLIGENCE

2.1.1 DEFINITIONS, TYPES AND DOMAINS OF INTELLIGENCE

'Intelligence' is a term that is widely used; as a concept, it is difficult to define even by the most proficient experts in the field (Robert M. Kaplan & Saccuzzo, 2005a). Indeed, till date, a working consensus has not been reached on a universally accepted definition of the concept among scholars in the field. One of the pioneers of studies on intelligence, Alfred Binet defined intelligence as: "*the tendency to take and maintain a definite direction; the capacity to make adaptations for the purpose of attaining a desired end, and the power of auto-criticism" (Binet and Simon (1905)).* Another titan of intelligence testing, David Wechsler spoke of intelligence as a capacity to "*act purposefully, to think rationally, and to deal effectively with [one's] environment"* (Wechsler, 1939). Other useful definitions include that which emphasise the ability to resolve problems as they are encountered (Gardner, 1993) and goal-directed adaptive behaviour (Sternberg & Salter, 1982).

Tying all these descriptions together, the diagram below (Figure 2.1) is an attempt to succinctly depict the complex concept of intelligence.

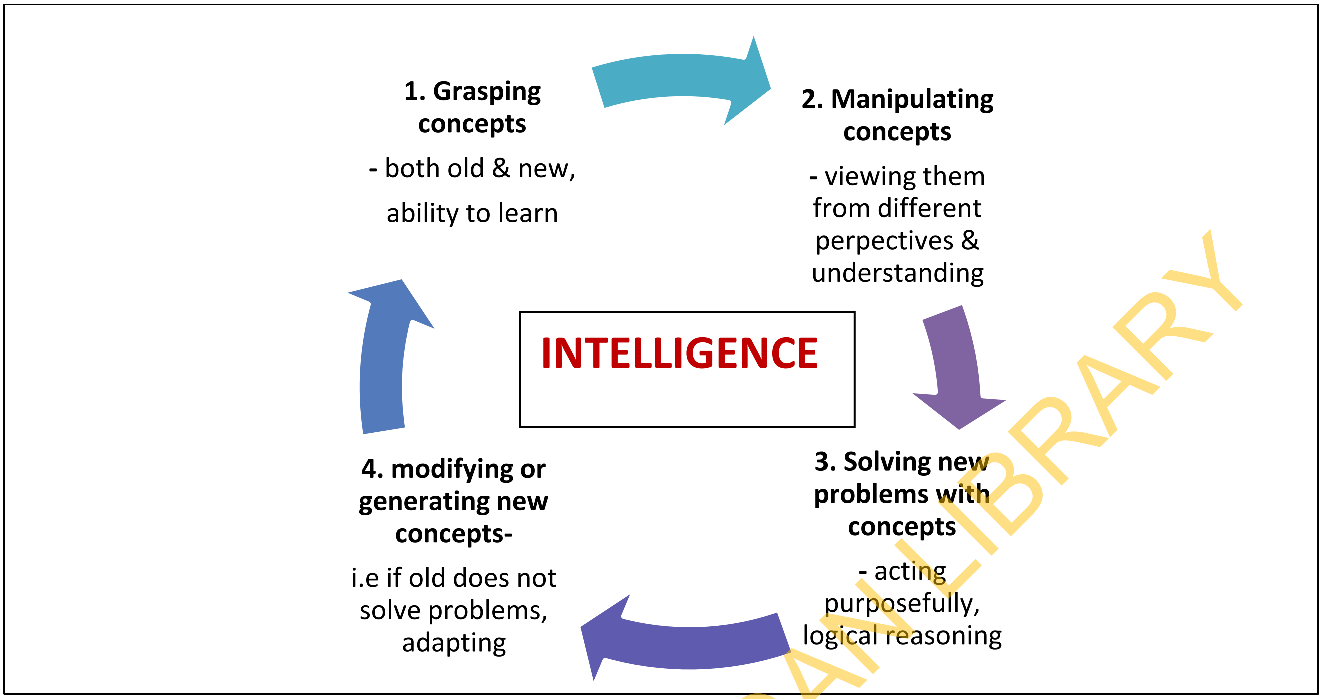

Figure 2.1: Depicting the complex concept of intelligence as a cycle involving first the intuitive grasping of concepts (i.e. learning, point 1), which are then manipulated mentally (point 2) in order to solve new problems (point 3), and where problems are unable to be solved with the old concepts, new schemata are generated (point 4) by modifying the old concepts or imbibing entirely new concepts which feeds back into the cycle of learning.

Source: Author

Unfortunately, even this seemingly succinct diagrammatic representation of intelligence is problematic. If intelligence is problem solving, knowledge acquisition and adaptability to new environments, then where do things like ‘musical genius’ or ‘art genius’ fit in that definition? We frequently describe great people as Mozart and Da Vinci as artistic geniuses, and yet the works for which they are so described cannot be said to have “solved” any problems or adapted to any hostile environment. There is no doubt though, that such creative mental ability is properly so described as ‘’genius’’ hence the development of the concept of ‘creative intelligence’ (Sternberg & Salter, 1982).

Expanding further on the scope of what it means to exhibit “intelligent behaviour’’, how do we describe those who are intuitively able to perceive, understand and manage the emotions of others and themselves towards achieving a desired goal (whether it be simply harmonious relationships or the efficient functioning of an organisation)? Thus we come to the concept of ‘emotional intelligence’ which was first characterised as a form of intelligence in the early nineties (Salovey & Mayer, 1990).

Along the line as these theories of intelligence gained ground, Wechsler expanded upon the concepts of fluid and crystallized intelligence (see sub-section on ‘Theories of Intelligence’) eventually culminating in the following domains in the latest version of his scales- the Wechsler Adult Intelligence Scale (WAIS) and the Wechsler Intelligence Scale for Children (WISC): **Verbal Comprehension** (a measure of Crystallized Intelligence), **Perceptual Organization** (measures Fluid Intelligence), **Working Memory** and **Processing Speed** (Robert M. Kaplan & Saccuzzo, 2005b). Each of these domains has specific sub-groups of tasks that are designed to test those domains. Various other intelligence scales have different variations of these basic domains set out by Wechsler.

2.1.2 HISTORICAL PERSPECTIVES OF INTELLIGENCE

The history of Man’s recognition of intelligent behaviour goes back to the dawn of time. However the first recorded history of an attempt to characterise the nature of intelligence suggests Francis Galton’s (Galton, 1869) attempt to measure it in the 1800s, shortly after the work of his more famous cousin Charles Darwin as probably the first. Galton (1869) was the first to create the statistical method of correlation and apply it to the study of human differences and the inheritance of intelligence. Indeed he is credited with the phrase “*nature versus nurture” (Galton, 1874)*. He was however an advocate of 'Eugenics' (Galton, 1883) - the principle of breeding to bring out only superior human traits and make a master race of super intelligent people- and indeed was the person who coined the word. Tragically this concept would go on to find cruel expressions in various movements through history including the famous example of the Nazi regime in the early 20th century.

Nevertheless, any discussion of the modern concept of 'intelligence' will have to start with the work of Alfred Binet. He was a French scholar who devised one of the first modern tests of intelligence for children (Binet & Simon, 1905) and came up with concept of Mental Age, which was hitherto used to estimate mental ability. The concept of 'mental-age' based Intelligence Quotient (IQ) scoring is however now discredited because intelligence does not increase indefinitely with increasing age. Therefore the IQ measure while useful among growing children is problematic among adults where mental ability becomes static in spite of increasing age. Another objection to the concept of 'Mental Age' is the fact that intelligence may not follow a natural Gaussian curve distribution (John Raven et al., 1998). Although it is assumed, it is simply not known for sure that it does.

Following the work of Binet and colleagues, the first documented mass use of intelligence testing was orchestrated by Lewis Terman (another Eugenicist), a Stanford University professor who revised the Binet Scale as the *Stanford-Binet Scale* in 1916 (Terman, 1916), and got the United States (US) government to do the first mass testing during the first World War.

The historical contributions of the likes of Thurstone, Spearman, Raven, Cattell and Horn to the evolution of the concept of intelligence and intelligence testing are expanded upon in the next section.

2.1.3 THEORIES OF INTELLIGENCE

Given the varied and complex evolution of the definition and concept of intelligence outlined above, the very many theories that have been promulgated concerning intelligence can only be imagined. However in spite of the sheer number of theories, they can generally be grouped into two main camps: The first group are the theories that espouse one basic underlying 'general intelligence' that manifest itself in various domains, while the second embraces the presence of multiple separate types of "intelligences" that exist from birth and have little or no bearing on each other. Below is a more detailed elucidation of these two broad historic camps of intelligence theory.

Following the pioneering work of Binet, Simon, Thurstone and colleagues, one of the first to evolve a comprehensive theory of intelligence was Charles Spearman. Spearman introduced a new conception when he defined intelligence as one overall (mental) ability which manifests in different ways (C Spearman, 1904). He further described an ability to "*educe relations or correlates*", i.e. to make meaning out of confusion and generate high-level schemata to handle complexity (C Spearman, 1904). Spearman also developed Factor Analysis to see which specific abilities tend to cluster with each other, for example doing well in spatial skills might also go with being good with numbers, which he called "spatial numeric reasoning" (Charles Spearman, 1927). This observation has been confirmed with recent data (John Raven et al., 1998) and has been offered as supporting proof of this concept of ***g-*** i.e. that those who do well in one domain of intelligence, tend to do relatively well in other very different domains as well.

This idea of Spearman's ***g*** has endured to the modern ages albeit in other forms. The first theory that sought to modify and expand upon this idea was that by John C. Raven (John C Raven, 1938) a student of Spearman. Spearman (at the turn of the century) and Eysenck (Eysenck, 1940) through to Matarazzo in the 1990s (Matarazzo, 1992) have shown that the measures of apparently different aspects of intellectual ability are either so highly correlated with each other or so unreliable that only two underlying factors can be usefully distinguished. That is what Raven has called EDUCTIVE and REPRODUCTIVE ABILITY. Eductive mental ability: (from latin: ***educere***- *'to draw out'*) refers to drawing out or squeezing new insights out of that which is already known; forming non-verbal constructs which facilitate the handling of complex problems (John Raven et al., 1998). These are the abilities required by children in developing a sense of the unwritten rules of language for example (in other words this is the reason why Arabic script does not make sense to an English speaker but does to an Arab child- that child would have used eductive ability to make sense out of the chaos of "random squiggly lines" on paper). It is this same 'eductive ability' that is used by managers of international businesses in their decision-making processes.

Reproductive ability refers to mastering, recalling and reproducing verbal material which forms a cultural store of explicit verbalised knowledge (John Raven et al., 1998). Both forms interact: perception and thought are generally dependent on acquired constructs (reproductive ability) and the ability to absorb information is often dependent on being able to make meaning out of confused area of discourse (eductive ability).

As a challenge to Spearman's concept of ***g*** Thurstone was the first to suggest that instead of one single 'general ability' ***g*** there were rather several different types of basic intelligence unrelated to each other that existed from birth or developed later (Thurstone, 2013) in his seminal paper originally published in 1924. He proposed seven clusters of mental abilities which have been revised variously by modern psychologists to different numbers of clusters principally Cattell (Raymond B Cattell, 1963), Gardner (Gardner, 1993), Hunt (Hunt, 1995) and Horn (J. L. Horn, 1968; J. L. Horn & Cattell, 1966; Shucard & Horn, 1973). This theory, the *gf-gc theory* first proposed by (Raymond B Cattell, 1963) as an expansion of Thurstone's ideas, proposed two basic types of intelligence: fluid intelligence (*gf*) and crystallized intelligence (*gc*). Fluid intelligence was described as the raw or natural intelligence that allows one to reason, think and acquire knowledge. It is conceptualized as one's raw potential for intelligent behaviour. Crystallized intelligence on the other hand describes old, acquired knowledge that informs intelligent behaviour. This is mostly influenced by exposure, environment and learning. This is believed by Cattell to arise later from 'fluid intelligence'. This concept of Fluid and Crystallized intelligence has since been further developed by other scholars and has become so ingrained in the field that Cattell is hardly routinely credited whenever the concepts are discussed. Fluid intelligence as the "natural intelligence'' is believed to be more affected by brain injury and organic insults (Raymond Bernard Cattell, 1987). As supporting evidence for this idea of multiple intelligences, proponents have pointed to the phenomenon of savants, who clearly have impaired mental ability generally speaking and yet seem to be extraordinarily gifted in one area of intelligence e.g. music, or maths. In spite of this assertion though, researchers into Thurstone's seven domains found that even in that, those who did well in one area tended to do well in others, supporting Spearman's ***g*** (John Raven et al., 1998). Later work done by Horn (J. Horn, 1994) reviewing all the evidence for their model of the gf/gc intelligence seemed to support the claims of those in the eductive-reproductive camp. He reviewed research conducted into 'fluid' and 'crystallized' intelligence (J. Horn, 1994) and concluded that: a) they are distinct at an early age, so the crystallized does not arise from fluid intelligence (as proposed by the theory) b) they are both heritable but with different genetic origins c) they are influenced by different aspects of environment d) they predict different types of life performance e) they change differentially with age f) their neurological locals are different.

2.1.4. THE DISTRIBUTION OF INTELLIGENCE IN POPULATIONS

For most of its history, the study of intelligence measurement has been premised on the assumption that it is a characteristic of human expression that follows the normal Gaussian distribution curve in any given population. However this assumption has never really been proven, and has been challenged in recent years by some psychologists (John Raven et al., 1998) who contend that intelligence may not be a static characteristic after a certain age- like height or blood pressure- which follows a Gaussian distribution, but rather an ever changing characteristic which may actually be skewed in different directions for different populations, or at different times for the same population. This has yet to be proven in a systematic way though.

Researchers have observed a difference in the distribution of IQ scores for different populations based on ethnic, racial, socioeconomic, geographical (rural/urban) and age-related characteristics (Skuy, Taylor, O'Carroll, Fridjhon, & Rosenthal, 2000). For example, the most recent comprehensive systematic review of all published data by Wicherts reports an average IQ of 82 for sub-Saharan Africa using standardised British norms, and combining different testing instruments (Wicherts et al., 2010). Prior to this, Lynn had estimated it at much lower- IQ of 70- in several papers published over three decades (Lynn, 1978, 1991; Lynn & Vanhanen, 2006) although there are some concerns about Lynn's methodology which will be discussed in greater detail in section 2.2.6 Intelligence Testing in Sub-Saharan Africa.

Several different factors have been proposed for these observed differences in the distribution of intelligence. Lynn (Lynn & Vanhanen, 2006), Rushton (Rushton & Jensen, 2010; Rushton & Skuy, 2000), and Kanazawa (Kanazawa, 2004) have proposed evolutionary theories to explain the relatively low scores of Africans on IQ tests (Wicherts et al., 2010), implying therefore that intelligence is mostly genetic and immutable, and therefore that the observed racial differences between Blacks, Caucasians, Mongoloids and Asians is a true and immutable fact of the genetics of the various races. Rushton (Rushton, 1998) has proposed naming this racial effect on IQ scores "*the Jensen Effect"* after Arthur Jensen, the American Psychologist whose work first pioneered this theory (A. Jensen, 1969; Arthur R Jensen, 1984; Arthur Robert Jensen, 1998; Arthur R Jensen & Munro, 1979; Rushton & Jensen, 2010).

Others have pointed out the strong evidence for environmental factors playing a more major role (than genetics) in the expression of intelligent behaviour by different populations. For example, Wicherts et al. observed that even within western populations, it has been clearly shown that IQ scores have generally **increased** from generation to generation, an observation known as "*the Flynn Effect"* after James Flynn, the psychologist who first described this phenomenon (Flynn, 1987, 2007). Indeed, this increase in many cases is as much as one standard deviation above the previous generation. Wicherts (Wicherts et al., 2010) astutely observed that the current average IQs found for sub-Saharan Africans (IQ 82) is roughly around the same level found for the Dutch population in the 1950s as reported by Flynn (Flynn, 1987, 2007). He therefore makes the argument that in African countries with a level of development roughly equivalent to western countries a generation or two ago, it would be rather misleading to ascribe these observed differences to genetic factors and thus impliedly, the inherent lower mental ability of African populations in terms of IQ scores. He opined that the lower IQs observed could very well be due to environmental factors such as poor nutrition, disease, level of stimulation and overall quality of life, which factors might have similarly accounted for the relatively low scores among western populations a generation or two ago (Wicherts et al., 2010). These environmental factors could also presumably explain the differences in mean IQ scores for different populations based on the other characteristics listed above.

2.1.5. CONCEPTUAL PROBLEMS ARISING IN INTELLIGENCE AND INTELLIGENCE TESTING

The challenge in coming to a comprehensive and appropriate conceptualization of what it means to be "intelligent" is not so easily resolved, in spite of the significant scholarly work that has gone on toward that end, as outlined above. The problem with intelligence scales is that they do not just test one's "ability to learn" for example, but one's ability to learn *certain specific things* that the test item happens to be asking about; they do not simply assess one's ability to "solve problems", but solve *certain specific problems* (Serpell, 1974). Of course, factors such as prior exposure to those specific types of tasks or problems can inherently confound the accuracy and internal validity of instruments used to measure intelligence. Issues arise when the qualities of mind and of behaviour that are valued the most and are therefore considered "intelligent behaviour" differ from culture to culture and from society to society are considered. The primary purpose of intelligent behaviour is positioning the subject for likely survival through adaptability to different environments and ability to solve problems (Sternberg & Salter, 1982; Wechsler, 1939)It stands to reason that perhaps different societies, having different sets of challenges, might have significant variations in their understanding of what it means to be intelligent. What makes one adaptable in one environment may be different from what makes one adaptable in another. The truth is, culture shapes intelligence both qualitatively (in terms of what it is) and quantitatively (in terms of how it is measured and how much of it people ultimately develop) (John Raven et al., 1998; Serpell, 1974).

Indeed, in ground-breaking work done among the rural Chewa-speaking people of Zambia, it was demonstrated that "intelligence" was not viewed only in terms of the quality of being "clever", but more so in terms of other qualities of cooperation, obedience and the disposition to use one's capacity in a socially productive way, as forming an integral part of what was valued as intelligence in that community (Serpell, 1974). These qualities might be better captured as 'emotional intelligence' in western thought, but as of yet have not been reliably measured in a quantitatively comparable manner. In that study, adults of the community were asked a series of questions concerning which of the children in the village they would choose for certain tasks (such as entrusting an important message to be sent to the next village, or recounting an event that happened when the story from the other children was coming out in a garbled confused manner), and then were further asked why they would pick that particular child for that task. Their answers were then subjected to Factor Analysis and the trend that emerged grouped into broad categories. This was what demonstrated the interesting finding that qualities of mind which the members of the community valued as measures of what in Western thought would be considered 'intelligence' consisted of much more than pure cognitive ability. Indeed, the response of one participant, when asked which he would prefer in a child as a measure of intelligence- *cleverness* or *responsibility*- summed up the prevailing notion aptly: "I would prefer him to be responsible because if he isn't responsible, he won't be of help to me. In any case a child who is clever is able to behave responsibly" (Serpell, 1974). This clearly highlights the point of interest here: intelligence tests from Western individualistic cultures emphasize 'individual qualities' such as cognitive ability because these are suited to the competitive Western educational system and are therefore highly predictive of academic success; but in African collectivistic cultures, social cohesion and cooperation are valued above more technical ability and may be an important predictor of adaptability (and therefore success) in such cultures. But, for the moment, there is yet to be developed a comprehensive instrument that measures this form of 'collectivistic intelligence'.

Another mediating role that culture can have on the definition of intelligence is the different emphasise that different cultures place on different cognitive abilities thus promoting the rapid development of those abilities over and above others. For example children in rural Kenya in one study were considered to be 'intelligent' based on their deep knowledge of local herbs (perhaps a measure of WISC's Verbal Comprehension domain), as opposed to say speed of giving answers (measured by WISC's Processing Speed domain) which would be more valued in a Western-style educational system (Sternberg & Grigorenko, 2004). Another example was reported among the Kpelle people of Liberia (Glick, 1975) where when participants were asked to sort, they tended to group knife with oranges because "*the knife is used to cut the oranges*" (functional) rather than the expected response of grouping knife with other tools such as machetes and hoes (metonymical). These are but a few examples of the difficulties that arise when one tries to provide a universal definition of what it means to be "intelligent".

2.1.6 FACTORS INFLUENCING INTELLIGENCE

The broad themes of various factors, which may have an influence on the development of intelligence, can be basically categorized into the 'inherent' or genetic factors, and the more environmental factors.

Vygotsky was among the first to describe learning as a social process and ascribe the development of cognition to social interaction in his 'Sociocultural theory' (Vygotsky, 1978). Nutrition and hygiene and democratic child-rearing practices in the home and at school have also been shown to influence eductive ability (John Raven et al., 1998). Iodine deficiency and intestinal parasites were found in a study in the US (surprisingly) to also have an effect on IQ scores (Brown & Pollitt, 1996), as well as low oxygen pressure found in a study done in a remote mountain area of Peru (John Raven et al., 1998). Furthermore, ill-health, stress and fatigue have been found to adversely affect speed of accurate work the most, intellectual capacity (in untimed RPM scores) next, and vocabulary test the least (John Raven et al., 1998).

Interestingly, Hess (Hess & Shipman, 1965), and Brandis (Brandis & Bernstein, 1974) have also demonstrated the relationship between discipline strategies at school and at home and the development of eductive ability.

All of these above named factors do not however preclude the influence of genetics on intelligence (as will be demonstrated better in the following section). However, the point here is this: varying relevant aspects of the environment can always alter the expression of inherited characteristics. *"Heritability does not imply immutability"* (John Raven et al., 1998)

2.1.7 NATURE VERSUS NURTURE

This then brings us to one of the oldest controversies in all of biology, particularly human biology: which has a greater effect- *nature* or *nurture*?

In the *nature* corner of evidence stands the evidence brought to bear by various Twin studies into the heritability of mental ability. Identical twins raised together have the highest rate of correlation in IQ scores (Hunt, 1995). In fact this correlation increases with age (Flynn, 2007). Next highest level of correlation is identical twins raised apart from each other, then followed by fraternal twins raised together (Bouchard Jr, 1997; Bouchard, 1983; Hunt, 1995). Also certain brain regions responsible for specific functions are structurally similar in identical twins (Lenroot & Giedd, 2008).

Furthermore, an interesting finding from genetic research, which Mackintosh (Mackintosh, 1998) mentions, only in passing, as posing a problem in the estimation of the heritability of ***g***, is that there is greater assortative mating for ***g*** than for any other behavioural trait; that is, spouse correlations are only ».1 for personality and only ».2 for height or weight, but the correlation for assortative mating for ***g*** is ».4. In addition to indicating that people are able to make judgments about ***g*** in real life, this finding suggests that assortative mating may contribute to the substantial increase in genetic variance for ***g***, because positive assortative mating for a character can increase its additive genetic variance (Mackintosh, 1998). This may provide a reasonable potential nature/heredity-based (rather than environmentally-based) explanation for the Flynn effect. However as noted in the previous subsection (see **Factors influencing Intelligence**) there is a host of evidence backing up the strong influence of environmental factors in intelligence development. Further discussion on some of these specific factors is pursued in subsequent sections.

2.2 INTELLIGENCE TESTING

2.2.1. ETHICS IN INTELLIGENCE ASSESSMENT

The field of intelligence testing has been a highly controversial area, largely because of the many ethical issues surrounding the measurement of human intelligence. Issues of racism, eugenics and other forms of discrimination using IQ testing as the basis have been very well documented throughout the twentieth century, with Nazi Germany being one of the more famous examples of this (Fritzsche, 2011). Indeed some eminent scientists like Stephen Gould (renowned palaeontologist and evolutionist) have gone as far as denying entirely that an objective entity that can be measured like an 'IQ' really exists (Gould, 1996). The use of IQ scores in assigning resources, school placement, career progression among other such opportunities for social advancement have not helped matters either, especially so since this type of discrimination tend to take on racial/ethnic overtones in most times it is applied. As noted by Raven (John Raven et al., 1998), these controversies are likely to continue plaguing the field if steps are not taken to clearly define the very specific mental abilities being measured by any particular test/domain (for example 'Eductive ability' measured by Raven's SPM) and to stress the context within which this score is being assigned, rather than the current practice of giving a broad interpretation to test scores as indicative of *all* mental ability, and attempting to make wild predictions of future success based on these.

2.2.2. CLASSIFICATION, TYPES AND USES

Controversial conceptualizations notwithstanding, as the concept of intelligence became better fleshed out in Western society, scholars began devising ways of measuring it, although the accuracy was not always the best. Broadly speaking intelligence testing is divided into two general types: achievement tests (measuring what one has already learned) and aptitude tests (predicting your capacity to learn new things). Achievement tests would include all school-based examinations and assessments covering specific subjects. Aptitude tests would include all tests that are typically thought off when one mentions 'intelligence tests' such as the WISC, RSPM etc. Details of the strengths, uses and interpretation of each specific type of test are discussed in later sub-sections.

2.2.3. VARIOUS STANDARDISATION PROCESSES: RELIABILITY AND VALIDITY

Standardization basically means comparison to a defined population. As stated by Aina and Morakinyo (2005) in their work on standardising the Bayley Scales of Infant Development in Nigeria, western norms are not universally applicable but at best only useful for comparisons, hence the need for standardisation in each unique population.

Validity can be defined as the agreement between a test score or measure and the quality it is believed to measure (Robert M. Kaplan & Saccuzzo, 2005a). This problem is ascertained by using systematic studies to confirm whether the conclusion by test results is justified by evidence. This includes testing the instrument against a standard instrument widely known to measure the quality of interest, or comparing different sections of the same test that are purported to measure the same quality to see the level of agreement between them.

Reliability on the other hand refers to how consistently a test measures what it purports to measure when administered at different times or by different people to the same person (Robert M. Kaplan & Saccuzzo, 2005a). This is done by comparing the scores obtained by the same person on the different occasions the same test is administered for how closely they agree. Another test of reliability, the internal consistency of an instrument looks at how closely each item on a scale is related to all the others and to the total and this is measured by Cronbach's Alpha.

2.2.4. INTERPRETING INTELLIGENCE TESTS

Intelligence tests have tended to be matters of controversy in part because of the wide interpretation its results have been given. Different users of these tests historically have frequently ascribed far greater significance to IQ figures than is warranted often leading to a general mistrust of intelligence tests. In the words of Raven, "*it is a misuse of the word 'objective' to say that an assessment of an individual is 'objective' if it records that the person concerned is not good at any of the things which have been assessed but fails to record what he or she is good at- or with a little practice, easily become good at*" (John Raven et al., 1998).

Further, interpretation of the results of intelligence tests churn out should be interpreted only within the context of the specific ability that that test is designed to assess. For example, if Raven's Progressive Matrices are used, it should be made clear that whatever results are obtained is only a measure of 'eductive ability' (i.e. ability to see patterns and create order out of chaotic or confusing situations) rather than as a measure of overall ability or of other types of mental abilities such as the ability to recollect stored information and to use it- which would be Reproductive ability.

The issue of motivation is also another reason to exercise caution in the interpretation of test results. Every intelligence test presents a set of problems for the subject to solve. The level to which the subjects will apply themselves in solving these challenges depends on their level of motivation for those types of problems. For example if the same subject is asked to take a particular test first without and then later with an offer of a monetary reward, their test results are likely to be different. A subject's performance on a particular test may be influenced by their motivation to solve those types of problems, and whether they are used to solving problems of that kind in their everyday life (John Raven et al., 1998).

Tests of general intelligence ***g*** have predictive validities of .7 in 'academic areas'. But their predictive validity to occupational performance is generally only about .35, so only accounts for about 10% of variance (John Raven et al., 1998). This is thought to be due to the observation that the most important abilities required to be successful at one's occupation- like initiative, resourcefulness, perseverance, the ability to manage emotions and motivate others to go along with a set course- are abilities that are intangible and not easily measured by these intelligence tests.

Raven believes human abilities do not follow a normal Gaussian distribution, and discourages the fitting of Gaussian curves to normative data (John C Raven, Raven, & Court, 1989). This applies as well to intelligence, according to Raven. Dockrell (Brand, Freshwater, & Dockrell, 1989) makes the same argument with the observation that the same child answering the same test and judged against the same normative sample can be shown to have an IQ of 47 if the results are treated according to one set of statistical assumptions, or an IQ of 60 if normative data are processed making another set of assumptions.

In summary, as important as intelligent tests are in 'objectively' assessing certain mental abilities, the information they provide often needs to be supplemented by other forms of evaluation to give a comprehensive picture of the subject. Unfortunately though, not much progress has been made in developing tools for assessing other talents and abilities till date.

2.2.5. PROBLEMS OF TESTING IN NON-WESTERN CULTURES

Within the context of non-Western societies such as in Africa, accurately measuring intelligence has been at quite difficult (Wicherts et al., 2010). This has been due to the lack of appropriate instruments which take into consideration peculiar socio-demographic factors which have the tendency to confound results, as well as the lack of normative data based on local populations.

The need for locally based norms for any Western-developed instrument is made even more stark when one considers the fact that even in neurologically healthy people living in Low and Middle Income Countries (LAMICs), it has been demonstrated that neurocognitive development is often below the optimum (Shuttleworth-Edwards et al., 2004; Skuy et al., 2000) because of such factors as malnutrition, perinatal injuries and insults to the brain, infectious diseases like Malaria and Meningitis, poor medical services and limited exposure to cognitively stimulating environments- factors which can all be traced to the problems of extreme poverty endemic in these regions (Bellamy & UNICEF, 2005; OLNESS, 2003). This may be one reason why comparative studies consistently show lower IQ scores of children from developing countries when compared to their Western counterparts. This is therefore one good reason why any assessment of a child in a developing region based on norms from developed countries will most likely rate him/her low, often within the range considered as 'intellectual disability' per Western standards (i.e. 2 standard deviations below the Western mean) limiting the discriminability of the tests when used in such local contexts (Alcock, Holding, Mung'ala-Odera, & Newton, 2008; Ruffieux et al., 2009). Indeed, the validity of IQ scores among African populations in terms of western samples has been questioned by some (Barnett & Williams, 2004; Ervik, 2003; Hunt & Carlson, 2007; Hunt & Sternberg, 2006); Some reject even the possibility of getting valid measures of 'g' in Africans with western IQ tests (Berry, 1974) while others see no problem doing so (Hernstein & Murray, 1994; Lynn & Vanhanen, 2006; Rushton & Jensen, 2005)

Another problem with using Western scales locally is that of the cross-cultural utility of such scales (Shuttleworth-Edwards et al., 2004). Unlike Western societies where populations of children are relatively homogenous, African children are not one monolithic group. Various socio-demographic factors separate them into very distinct groups with real differences that impinge upon their performance on (and therefore the suitability of) Western scales imported *de integro* into the local context. Such factors include but are not limited to: degree of urbanization, exposure/acculturation to western concepts, home language and language of educational instruction, socioeconomic status of parents, educational level of parents, access to and quality of education, exposure to test-taking experiences and cultural relevance of tasks (Braga, 2007; Brickman, Cabo, & Manly, 2006; Fortuny et al., 2005; Manly, 2008; Ostrosky-Solis et al., 1985). In a recent paper authored from South Africa, it was demonstrated that quality of education was the biggest predictor of test performance on a battery of verbal and nonverbal (so-called "culturally fair") tests, and that even apparent racial differences in scores dramatically reduced with higher levels and better quality of education (Ferrett et al., 2014). The only major shortcoming of the above analysis was the failure to control for other possible confounding factors such as level of parental education, use of English at home and/or in school, and exposure to western concepts.

The only other variables analysed in that study were age, sex and primary language spoken (English versus Afrikaans), a shortcoming which this present study hopes to improve upon by controlling for such confounders. That notwithstanding, their findings were in keeping with other earlier work done in South Africa which found that acculturation to western culture, proficiency in English, greater urbanization and exposure to quality education enhanced performance on neuropsychological tests to comparable levels with normative data from England and North America (Cave & Grieve, 2009; Grieve & van Eeden, 2010; Rushton & Skuy, 2000; Rushton, Skuy, & Bons, 2004; Shuttleworth-Edwards et al., 2004; Shuttleworth-Jordan, 1996; Skuy et al., 2002).

A strong argument was therefore made for the stratification of normative data according to not just age, but also other socio-demographic factors (specifically quality of education into 'advantaged' and 'disadvantaged') in order to increase the power of the tests in question to discriminate between those with "normal" intelligence (given their peculiar socio-demographic context) and those who are truly within a clinical range of intellectual disability and thus in need of professional intervention (Ferrett et al., 2014). This was to guard against clinicians using tests based on Western norms from making false positive misdiagnosis of patients as intellectually impaired (when they really may not be), as well as not being able to pick out those with truly above average or superior intellectual ability. This was probably a sound approach to take for the above stated reason, however given the fact that other important potential confounders were not controlled for. It very well may be that the variable upon which stratification should be based may not be 'quality of education' per se, but perhaps one of the other possible confounders (such as level of parental education, socioeconomic status or exposure to western concepts).

In an experimental study into the effects of stereotype threats (Aronson et al., 1999) on intelligence test performance, Klein (Klein, Pohl, & Ndagijimana, 2007) administered the Culture Fair Intelligence Test to African immigrants in Belgium under different conditions. These conditions differed in the degree to which negative stereotypes concerning the cognitive ability of Africans were made salient for the test takers. In the conditions in which the stereotypes were stressed, the Africans (N=30) averaged an IQ of 74.9 (SD=13.6), while Africans (N=28) in the control condition (i.e., no stereotype threat induced) averaged an IQ of 89.5 (SD=12.0).

The explanation for the differences in scores in different ethnicities and that the test does not engage the concerns of people from disadvantaged backgrounds and demands thought processes unfamiliar to them is untenable because there is a correlation of over .99 in item difficulty across diverse cultures. This implies the test is working the same way in all these cultures and ethnic groups (i.e. what is difficult in China is difficult in South African blacks and is difficult in Slovenia Caucasians of the same age) (John Raven et al., 1998).

It is hoped that this present study will be able to shed light on which of these potential confounding variables will be the strongest predictor of scores in neuropsychological testing and therefore accurately recommend a framework upon which stratified norming should be done within the African context.

2.2.6. INTELLIGENCE TESTING IN SUB-SAHARAN AFRICA

A comprehensive systematic review on papers published on IQ testing in Africa (Wicherts et al., 2010) obtained an average IQ of 82, measured against UK norms.. Even then, the majority of papers included in this review used Draw-A-Man test which has serious problems concerning its use in African rural populations due to conceptual differences in the perception of “appropriate” features for a man and woman, affecting the scoring of this test among rural populations. Prior to this Lynn and Vanhanen estimated it to be 70 (Lynn & Vanhanen, 2006), based on convenience sampling (Barnett & Williams, 2004; Hunt & Sternberg, 2006) and not based on the systematic review of the literature. Lynn had a penchant for excluding the tests with higher scores without explaining why and failed to explicate the inclusion and exclusion criteria they employed in their choice of studies (Wicherts et al., 2010). Further, in a highly cited paper (Lynn, 1991), Lynn dismisses the higher IQs found among African Americans of 85 (approximately 1 standard deviation below the Caucasian mean) by asserting that "almost all American negroids are negroid-caucasoid hybrids". This was implying that the increased scores were as a result of the near-universal mixed-breeding, which had improved the genetic pool of African-Americans with respect to intelligence. Rushton (Rushton & Skuy, 2000) quoting in agreement from Hernstein and Murray makes a similar argument using as reference their controversial book *The Bell Curve*, (Hernstein & Murray, 1994)). Lynn does not substantiate this sweeping assumption about the extent of mixed-breeding between African-American slaves and their white slave masters, nor does he give room for the possibility that the differences in scores of African-Americans (85) and Africans (70) could possibly be due rather to environmental factors. Factors such as the significantly improved standard of living that African-Americans enjoy over Africans particularly in the rural areas, which explanation would be supported by empirical observations such as the Flynn Effect (Flynn, 2007). Indeed, the Flynn effect has even been recently documented among an African population where in Kenya a gradual rise in IQ scores has been demonstrated from previous generations, presumably due to improved environmental factors since the genetic pool has remained largely the same (Daley, Whaley, Sigman, Espinosa, & Neumann, 2003). Other prominent studies published by Lynn on racial IQ differences (Lynn, 1978, 1991; Lynn & Owen, 1994; Lynn & Vanhanen, 2006) all suffered from the same deficiencies observed by Wicherts

(Wicherts et al., 2010) -lack of systematization of review, lack of explanation of inclusion criteria and a tendency to select papers with either grossly outdated testing instruments or almost exclusively lower test scores for African populations.

Consistently, IQ figures from Africa using general populations are reported to be low. This was true regardless of the country or the instrument used. Senegalese children with a history of malaria using the Kaufmann Assessment Battery for Children (K-ABC) instrument recorded an average IQ of 82 (Boivin, 2002), with Black South African children scoring 103 using the same instrument (Skuy et al., 2000). In a study in Lagos, Nigeria, the Similarities subtest of the WISC-R was administered to a sample of aggressive and pro-social boys (Ani & Grantham-McGregor, 1998) and the prosocial boys achieved an average score equivalent to an IQ of 87, while the aggressive boys' average was around 77. Average Similarities score of the entire sample was equivalent to a mean IQ of 81.8 (SD=14.3). In the Ghanaian capital of Accra, using the Cattell's Culture Fair Intelligence test (Raymond Bernard Cattell & Cattell, 1973) results showed and average IQ of 82.2 (Buj, 1981). Owen (Owen, 1992) working in South African blacks (IQ 72), Zindi (Zindi, 1994) among Zimbabweans IQ 72) and Glewwe & Jacoby (Glewwe & Jacoby, 1992) (sample of 1639 adolescents from Ghana- IQ 60) did not depart from this trend.

The only exceptions to these were found in Crawford-Nutt (CrawfordNutt, 1976) who found that in a sample of 228 African high school students in Johannesburg, when instructions were properly explained to subjects mean IQ scores were equal to that of whites (IQ 100). Rushton (Rushton & Skuy, 2000) rightly pointed to the lack of a control group in the latter study who did not receive instructions, as well as the possibility of the good performance being attributable to the selectivity of this particular high school. Finally, Rushton also reports on another study with higher average IQs for Africans. First, in a study in Zimbabwe, (Wilson, Mundy-Castle, & Sibanda, 1991) administered the full PMA to fifty-two Black school girls aged nine. In terms of US norms, their average IQ was approximately 96. Second researchers administered a translated version of the McCarthy Scale of Children's Abilities to a sample of (N=128) "well-to-do" and poor children from rural and urban areas in Nigeria (Ashem & Janes, 1978). The sample included normally nourished, reasonably nourished, and malnourished children. The average IQ of the entire sample was 92.6 (SD=19.5).

Most of the remaining data available on Africa were comparative studies pitching one cohort against another and not normative studies based on a general sampling of the population per se. For example a comparison of black South African University students and their White counterparts showed a twenty point difference in IQ in favour of the White students (average of 84 for the Blacks, and 104 for Whites based on 1993 US norms) (Rushton & Skuy, 2000). A repeat of this study among Engineering students four years later revealed about the same results (14 points difference between Blacks (IQ 103) and Whites (IQ 117)) (Rushton et al., 2004) appearing to indicate what the author called a "Jensen Effect"- the effect of a variable (in this case 'race') on the inherent intellectual capability (*g*) of a group (Rushton, 1998) or, in other words, a real genetically-based difference in Spearman's *g* of the two groups.

In other work done among Black South African Grade 1 pupils, RPM (as well as other 'culture fair' tests) was found to be associated with academic achievement (Venter & Bham, 2003). In Kenya, a real increase in IQ over time (a phenomenon known as "the Flynn Effect") was demonstrated in a rural population of a developing country for the first time using the RPM (Daley et al., 2003). The associations between diet and nutritional status and cognitive ability were reported on in studies done in rural Kenya (dietary supplementation in Primary 1 pupils), South Africa (Iron deficiency status among young mothers) (Beard et al., 2005; Gewa et al., 2009;

Whaley et al., 2003) as well in Ethiopia (Bogale et al., 2013; Stoecker et al., 2009) and in rural Gambia where a benefit of protein supplementation of maternal diet during lactation on cognitive ability of offspring over and above prenatal protein supplementation during early pregnancy was reported (Alderman et al., 2014). The remaining studies done in Africa using the RPM sought to show the link between other relevant factors and child cognitive development such as attachment (Mbiya Muadi et al., 2014) socio-demographic factors (Boyede, Lesi, Ezeaka, & Umeh, 2013) and Khat use (Colzato, Ruiz, van den Wildenberg, & Hommel, 2011).

2.2.7. NORMATIVE SAMPLES AND THEIR EVALUATION

Normative data are simply the average scores of a particular instrument in a given population which can be used as a standard of comparison for members of that population (Robert M. Kaplan & Saccuzzo, 2005a).. It basically consists of establishing mean values, and a standard deviation for that population. Normative data are useful for evaluating local populations against each other and are more accurate in determining what is "normal" for that population instead of using norms derived from other population samples. For example, in evaluating a Ghanaian child for Intellectual Disability using the Raven's Progressive Matrices, it would be more accurate and fair to measure him/her against other Ghanaian children with similar characteristics as them rather than comparing them to British children (i.e. using British normative data).

With regard to Ghana and normative data, a study was done using the Raven's Coloured Progressive Matrices among 6-11 year olds in Ghana (Anum, 2014). In that study the overall norms were found to be much lower than the British norms across all age spectrums. Also rural children scored much lower than urban children (predominantly urban sample was of children in private good quality schools), however when urban children were compared with British age-matched norms the gap in scores reduced significantly (Anum, 2014). Similar findings of lower scores when compared to British children, were reported in Libya (Al-Shahomee, 2012), Kenya (Costenbader & Ngari, 2001) and South Africa (Lynn & Owen, 1994). In a study done among rural Zulu primary school children the RPM was standardized as part of a battery of tests for assessment of rural children (Jinabhai et al., 2004). The limitations of the study from Ghana were the use of a narrow age range (6-11years) and the analysis of the various socio-demographic factors that might be predictive of the scores obtained with a view to teasing out the reasons for the internal variations between rural and urban scores was not done. These shortcomings were improved upon in the present study by correcting those methodological shortfalls.

With regard to the Slosson Intelligence Test, a diligent search of the literature revealed no standardization studies of the instrument in Africa. However, an adapted version of the SIT was used in a study in Southwest Nigeria in which neurological and cognitive deficits were reported among adolescents in custodial institutions compared to age-sex matched controls (Atilola, Omigbodun, Bella-Awusah, Lagunju, & Igbeneghu, 2014). Another study from Southwest Nigeria, found cognitive deficits among hearing impaired adolescents using the adapted SIT compared to controls (Adeniyi, 2013). That was all the literature that could be found on the SIT in Africa.

2.2.8. SELECTING AN INTELLIGENCE TEST

The choice of which intelligence test to use depends largely on what the specific purpose for testing is. Because different tests assess different mental abilities, it is important the purpose of the testing being done is reflected in the test that is finally chosen.

For example, because of its emphasis on eductive ability rather than reproductive ability, RPM is good for screening young people with a greater tendency to ask questions, make their own observations/schemas and think for themselves, rather than learn whatever is put in front of them.

It is good at recognising those who are good at forging new insights, and not necessarily good at expressing their ideas in words (John Raven et al., 1998). It is also useful in diagnosing dyslexia, since children who have been experiencing great difficulty with schoolwork may still obtain high scores on the RPM. Goodlad (Goodlad, 1984) and (JC Raven, 1977) contended that what passes for ‘’academic’’ knowledge in schools is generally out-dated when it comes to be taught, unhelpful in the solution of problems, and forgotten by the time it is needed. Matrices test therefore help to identify intelligence talent apart from these abilities.

The details of some selected intelligence instruments are given in the following section

2.3. REVIEW OF INTELLIGENCE TESTS

2.3.1. STANFORD-BINET TEST

The Stanford-Binet test has its roots in the pioneering work of Binet (Binet & Simon, 1905). He concentrated mainly on developing tasks which measured an individual’s abilities of judgement, attention and reasoning since he believed these to be the primary measures of intelligence. He however did not concentrate his efforts on devising tasks which measured these separately as distinct elements of intelligence, but instead aimed to measure only the total product of all these elements as the *General Mental Ability* of the individual. His two most important contributions to the fledgling science of intelligence testing were the concepts of Age Differentiation and Mental Age.

Age Differentiation refers to the idea that the older a child gets, the greater his/her mental ability, and as such any intelligence testing instrument would need to reflect that fact (Binet & Simon, 1905). He therefore sought to design tasks for every age group between two-thirds and three-quarters of children in that age bracket, as well as a smaller proportion of younger children and a larger proportion of older children could comfortably complete. This gave rise to the concept of

Mental Age, introduced in the second revision of the Binet scale in 1937, which referred to the idea of measuring the performance of an individual and comparing it with the average performance of individuals in a specific chronological age group. So, for example, a five-year old who could perform tasks normally performed by the average nine-year old, would be considered to have the Mental Age of a 9 year old according to Binet. With this scale, the *Intelligence Quotient* (IQ) was calculated by simply determining the Mental Age, dividing by the Chronological Age and multiplying by 100 to remove fractions (Robert M. Kaplan & Saccuzzo, 2005b).

The basic flaw in Binet's method though was the fact that the maximum mental age possible was 16 because of the assumption then that beyond 16 years mental age ceased to improve naturally since the brain did not develop any further. This therefore meant that a subject over age 16 years would invariably score below an IQ of 100. This made the Binet scale inappropriate for measuring adult intelligence. Also, the Binet Scale relied heavily upon items which tested only verbal or crystallized intelligence, which made it inherently biased in favour of the better educated and better exposed (Robert M. Kaplan & Saccuzzo, 2005b) . Additionally, because the items on the Binet test were grouped solely according to age, they had no relation whatsoever to each other. Subjects also did not receive a specific amount or credit for each task completed but rather credits for the block of items if he/she passed all. In spite of these problems though, the central ideas of Binet's scale- the attempt at objective assessment of intelligence, the concepts of Age Differentiation, Mental Age and General Mental Ability- have endured to the present day. Indeed, the latest revision of the Stanford-Binet Scale retains these features and has largely improved upon most of these criticisms.

2.3.2. WECHSLER ADULT INTELLIGENCE TEST (WAIS) AND THE WECHSLER INTELLIGENCE SCALE FOR CHILDREN (WISC)

The next major work on intelligence scales was done by David Wechsler around 1939 (Wechsler, 1939). Wechsler's scale sought to improve upon the weaknesses of the Binet scale. First of all it included items designed for adults. Secondly it used the point scale system where credit was received for each item passed (as opposed to passing a cluster of items before receiving a credit as pertained in the Binet scale). Also, items were grouped by content unlike the Binet scale. Finally it also introduced a "Performance Scale" where various items designed to measure Non-verbal or Fluid intelligence were introduced to give a better overview of the intelligence of subjects since it sought to remove the limitations of language and prior learning as pertained in other types of questions. In this novel type of task the subject was required not to answer a question verbally, but to perform a task. This enabled not just an overall score to be given, but also specific scores within specific domains to be given as well, to highlight specific areas of strengths and weaknesses. This signalled a vast improvement in intelligence testing up to that point as it gave much more information about a particular individual's mental abilities and areas of weakness. This practice has become standard practice now with the latest version of the Binet test also incorporating these improvements (Robert M. Kaplan & Saccuzzo, 2005b).

Since the earliest two Intelligence scales, a plethora of tests have been developed over the years to test specific domains and within different contexts. This has become necessary because whereas the Binet and Wechsler scales have been very good instruments for testing overall intelligence in normal Western populations, both scales have had their limitations for special populations such as those with sensory, physical or language handicaps (Robert M. Kaplan & Saccuzzo, 2005a). For example, people with language limitations (non-fluent grasp of English for example) or those from culturally deprived groups, or certain brain-damaged individuals cannot be fairly assessed using either the Binet or Wechsler scales. Also, the administration of these highly sophisticated tests have been limited to very highly trained specialist psychologists, amidst other prohibitive resource requirements which have made the use of such instruments impractical in most resource-low settings. As a result of these gaps, various other instruments were developed to remedy these and other challenges raised by the Binet and the Wechsler scales. To be fair though, these alternative instruments were not without their own set of problems when compared with the Wechsler and Binet Scales: weaker standardization samples, lower stability and documentation on validity, lack of interchange-ability with Binet or Wechsler scores among other psychometric limitations all hampered the effectiveness of these alternatives in assessing intelligence. Notwithstanding, the alternative scales had their clear advantages too: their appropriateness for specific populations, their relative ease of administration, the lack of reliance on verbal responses, the lesser bias due to scholastic achievement and lack of dependence on complex visual-motor integration all made these instruments better than the standard two in many ways (Robert M. Kaplan & Saccuzzo, 2005a).

2.3.3. SLOSSON INTELLIGENCE TESTS

The Slosson Intelligence Test (SIT) is another of the many tests that came after the standard two, which was designed to provide a quick assessment of "general verbal cognitive ability" (as stated by the developers) as a measure of crystallized intelligence, *gc*. First developed in 1964 by Richard Slosson and later improved by Nicholson and others (Slosson, Nicholson, & Hibpshman, 1991),it was designed to be a quick and easy-to-use screener of intellectual ability of subjects from ages four through sixty-five, that provides good correlation with the more standard instruments such as the Stanford-Binet and Wechsler scales. Like the Wechsler and Stanford-Binet, SIT measures various domains of verbal (crystallized) intelligence such as *Information*, *Comprehension, Quantitative, Similarities and Differences, Vocabulary,* and *Auditory Memory* which are important for having their own unique qualities that provide valuable information about a subject's intelligence. For example, Vocabulary is a relatively more stable measure of intelligence, which is not easily affected by emotional state or brain damage and does not require much concentration so can be used to evaluate premorbid or baseline intelligence.

All these are information about intelligence that the nonverbal measures of intelligence such as RPM could not have provided. SIT provides all these added advantages over the RPM thus giving a more global picture of the individual's intelligence than would otherwise have been the case. In addition to this, SIT also comes with the added benefit of being relatively easy to use, not requiring any highly specialized training to administer, and requiring much less time to administer compared to the Binet and Wechsler tests. This makes it particularly suitable for low-resource settings where the requisite trained specialized personnel and the time and money for administering the more established scales are often sorely lacking. Its weakness though is that it is designed primarily to be a screener that provides only an estimate of verbal intelligence and ideally should be followed up with a more thorough assessment using the standard two- Binet and Wechsler. The latest version (3rd edition) was published in 2002 and normed based on about 2000 individuals based in the USA with a low representation by ethnic minorities such as African Americans (hence the need for establishing local African norms). It consists of 187 items in question-and-answer format, designed to be administered strictly in the English language, and has been found to have a high correlation with the Wechsler Intelligence Scale for Children (WISC) and the Wechsler Adult Intelligence Scale (WAIS) as well as the Stanford-Binet Scales (Lowrance & Anderson, 1979; Slosson et al., 1991).

2.3.4. RAVEN'S PROGRESSIVE MATRICES

There have been several such alternative tests developed over the years, but two of the most popular (within their respective categories) and most widely used have been the Raven's Standard Progressive Matrices (designed to test Fluid Intelligence) and the Slosson's Intelligence Test (designed to quickly test Crystallized intelligence or Verbal intelligence). The Raven's Standard Progressive Matrices is one of the most widely referenced nonverbal tests that is used as an estimate of general intelligence with a range from age five all the way to age sixty-five. In his new instrument, Raven himself notes that his primary aim was to measure the two main components of Spearman's *g*, i.e. *eductive ability* (the ability to make meaning out of confusion and generate high-level schemata to handle complexity) and *reproductive ability* (the ability to recall and reproduce information that has been made explicit) (John Raven, 2000; John C. Raven, 1941). Indeed, since publishing his instrument, the evidence has been overwhelmingly in support of his claims of the RPM being a very accurate measure of general intelligence (Colom, Flores-Mendoza, & Rebollo, 2003; John C Raven & Court, 1998). Recent studies using functional Magnetic Resonance Imaging (fMRI) demonstrated that the differences in subjects' ability to complete the RPM tasks was reflected in differences in the firing of neurons in the brain (participants who scored highly on the RPM had increased brain activity in the anterior cingulate cortex and cerebellum) (Gray, Chabris, & Braver, 2003). This showed that RPM and such standard intelligence tests actually measured the workings of very specific brain activity . The RPM has also been demonstrated to cut in half the discrepancies between scores of ethnic minorities in the United States (such as African Americans and Latinos) compared to Caucasians from 15 points on the Wechsler and Binet to 7-

8 points, thus reducing the inherent biases of those established tests against such culturally-deprived groups.

The RSPM consists of a set of patterns set out in a logical progressive fashion in a matrix, with the subject required to predict what the next pattern should be, based on the previous series of patterns in the matrix. It is a simple but effective test designed to assess a subject's capacity for pattern recognition, making meaning out of seeming chaos, data organization and logical reasoning. It is designed to achieve this with minimal to no use of language thus removing the language and cultural biases. There are three variants of the Raven's Progressive Matrices of which the Standard Progressive Matrices (SPM) is the most widely used- the other two being the Coloured Progressive matrices (designed specifically for children aged 5-11 years) and the Advanced Progressive matrices (designed for the exceptionally gifted).

2.4 ASSESSING INTELLIGENCE IN CHILDREN AND ADOLESCENTS

2.4.1. COMPREHENSIVE ASSESSMENT PROCESS

In real life clinical practice, one seldom assesses the intelligence of a child in isolation. There are almost always other essential parameters that need to be assessed to give a more comprehensive view of the subject, including but not limited to the various biological, psychological, cognitive, family, environmental and cultural issues pertaining to that child. This would entail clinical assessment (involving a detailed individual and family history, mental state and physical examination), structured interviews (such as behavioural checklists) and standardised testing (such as the WISC or Slosson). The reasons for such are comprehensive assessment are many but prominently include the fact that for example in Intellectual Disability (one of the commonest reasons for intelligence testing) there is often a psychiatric co-morbidity or impairment in family or educational functioning lurking somewhere in the background.

Apart from that, the links between other domains of functioning and mental ability have been extensively documented. Work done by Aina and Morakinyo in Nigeria showed that the interplay between malnutrition for example and psychomotor development was quite complex and multifactorial, and not a simple direct correlation (F. Aina & Morakinyo, 2001). This underscores the need for a complete and total global assessment in real life clinical situations for greater utility of the intelligence testing.

2.4.2. INTERACTING WITH CHILDREN AND ADOLESCENTS DURING TEST

The approach to children and adolescents during testing needs to be a careful and considered affair. Children tend to be shy and reserved and comfortable only around the primary caregiver and as such all assessment needs to be done in concert with them. Adolescents on the other hand tend to prize confidentiality more and to be more sensitive to stigma. The approach therefore in dealing with them needs to show greater sensitivity to privacy and winning their confidence if any meaningful interaction is to take place.

2.4.3. THE EXTREMES OF INTELLIGENCE: GIFTEDNESS AND INTELLECTUAL DISABILITY

One of the most important uses of intelligence testing is to objectively document the extremes of intellectual capability: intellectual disability and intellectual giftedness. Giftedness is broadly defined as intellectual superiority, creativity and motivation (Fakolade & Archibong, 2014) above 2 standard deviations of the mean of the population. Intellectual disability is like-wise intellectual capacity less than 2 standard deviations of the mean. These two populations have vastly different needs from the majority of the population in terms of their social, educational and psychological optimal functioning hence the need for accurate assessment within the local context of their populations. For example, gifted children who are not identified and challenged according to their superior capacity can easily become bored and under-stimulated leading to a decline in their performance even on standard tasks. Similarly children with intellectual disability may find themselves needing extra care and supervision in getting them to grasp concepts and learn for them to function optimally. Both extremes would need an individualized educational plan once their needs are established.

2.5. THE RELEVANCE OF THIS STUDY TO CHILD AND ADOLESCENT MENTAL HEALTH IN GHANA

Assessing intelligence is a crucial aspect of the mental health assessment for children and adolescents (Martin, Volkmar, & Lewis, 2007; Turk, Graham, & Verhulst, 2007). Intellectual Disability (ID) is co-morbid with several mental disorders. The worldwide prevalence of ID stands at around 1% with developing countries generally carrying almost twice the prevalence rates in developed countries (Maulik et al., 2011). There is a need for reliable and valid tools for the testing of Ghanaian children in both clinical and educational settings. This will assist with educational placements for children at both extremes. Furthermore, the period of child and adolescence is best for mental health promotional activities and having norms will help to inform policy and planning for the health, education and general well-being of the future of Ghana.

It is apparent that a study on developing tools for intelligence assessment in Ghana is necessary and desirable. As a developing country, Ghana certainly has its fair share of challenges with respect to mental health problems among its children. If these challenges are to be met, it would depend on robust data being generated and establishing what is 'normal' so far as intelligence testing is concerned is certainly a significant step in that direction.

CHAPTER THREE- METHODOLOGY

3.1: STUDY LOCATION

3.1.1 The Republic of Ghana

The study was conducted in the Ashanti region of Ghana. The Republic of Ghana is centrally located on the West African coast. Bordered by three French-speaking countries, Togo on the east, Burkina Faso on the north and northwest, and Côte d'Ivoire on the west, Ghana has a total land area of 238,537 square kilometres. The Gulf of Guinea lies to the south and stretches across the 560-kilometre coastline. Figure 3.1 shows a map of Ghana with her ten administrative regions, with the Ashanti Region (the study site) coloured in purple**.**

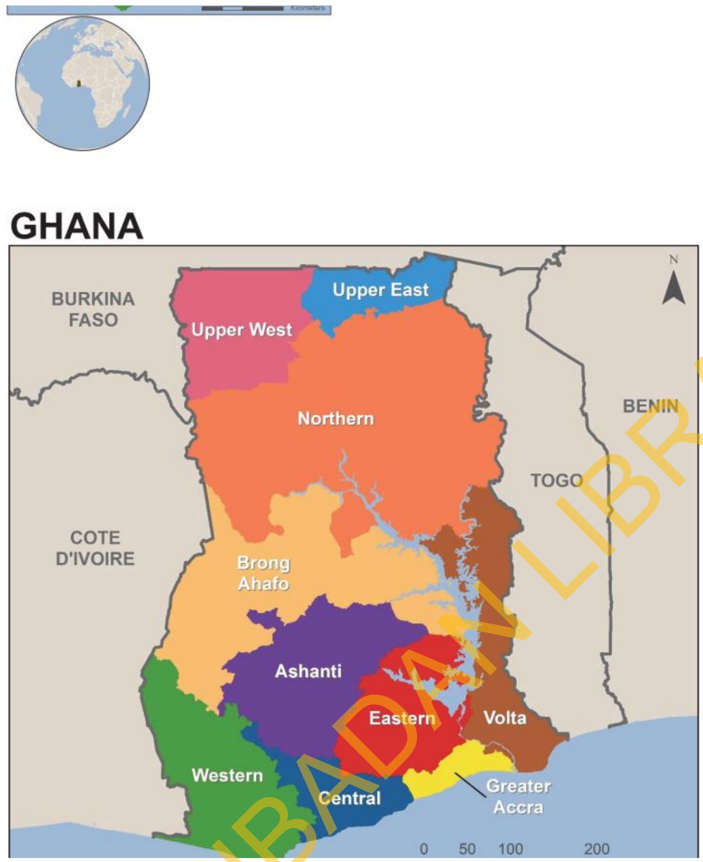

Fig 3.1: Map of Ghana. Source: Ghana Statistical Service (GSS, 2015)

Ghana gained independence from British colonial rule on 6 March 1957, and became a republic in the British Commonwealth of Nations on 1 July 1960 with Accra as its administrative and political capital. Ghana operates a multi-party democracy with an executive president who is elected for a term of four years with a maximum of two terms. There are 10 administrative regions in Ghana: Western, Central, Greater Accra, Volta, Eastern, Ashanti, Brong-Ahafo, Northern, Upper East, and Upper West. Ghana's population was estimated at 27 million in 2014 (GSS 2013). The Ashanti (study site), Eastern, and Greater Accra regions together constitute about 50% of the country's population. The regions are subdivided into 216 districts to ensure equitable resource allocation and efficient, effective administration at the local level (GSS 2013b). The Ghanaian population is made up of several ethnic groups, with the Akans constituting the largest group (48 percent), followed by the Mole-Dagbani (17 percent), Ewe (14 percent), Ga-Dangme (7 percent), and others (GSS 2013b).

The Ashanti Region where the study was conducted is the second most urbanized region in Ghana after Greater Accra Region, where the capital Accra is situated (Bentsi-Enchill, 2013). As the third largest region geographically, it occupies 24,389 square kilometres of Ghana's land surface. According to the 2010 census, it is the most populous Region with a population of 4,780,380 (GSS, 2015).

3.1.2 The Ashanti Region of Ghana

Figure 3.2 below shows the map of the Ashanti region of Ghana with Kumasi, its capital city in the centre of the map.

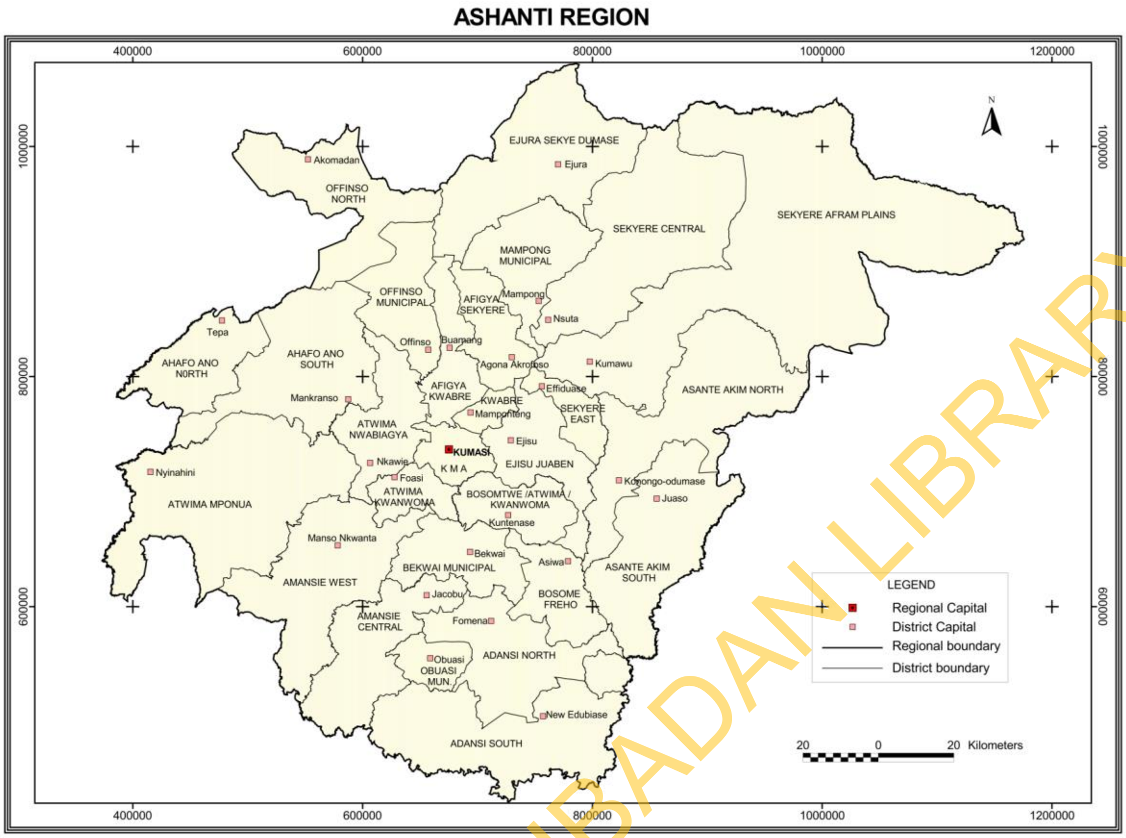

Fig 3.2: Map of Ashanti Region. Source: (Bentsi-Enchill, 2013)

Language and ethnicity (Bentsi-Enchill, 2013)

Like the other regions of the country, there are many ethnic groups in the Ashanti Region. The 2010 Population and Housing Census (PHC) shows the largest ethnic group as the Akan, specifically the tribal sub-grouping known as the Asante (74.3%), followed by the Mole-Dagbani ethnicity (11.3%), Ewe (3.8%) and Gurma (2.8%). About 30.5 percent of the Akan in the country are in the Ashanti Region. The people of Asante speak mainly a major branch of Akan called Asante Twi. This ethnic composition can therefore be taken to be largely representative of the country.

Religion

About 77.8% of the people in the region in 2010 were Christians of different denominations. The proportion of Muslims was 15.3%, the second largest, while those with no religious affiliation were 5.4% and 0.7% are traditionalists. This is also largely representative of the national religious composition of the country (Nyarko, 2014).

Economy and Living Conditions (Bentsi-Enchill, 2013)

In terms of the economically active population employed in the region, agriculture (including forestry) is their leading economic activity (30.5%). Other occupations include wholesale and retail trade (25.4 %), manufacturing (10.5%) and hospitality and food services 6.1%. The region has the largest mining site in the country at Obuasi.

Social infrastructure and amenities (Bentsi-Enchill, 2013)

The Ashanti Region has air, road and rail networks to many parts of the country. The air network links Kumasi to Tamale (Northern Region), Sunyani (Brong Ahafo Region), Accra (Greater Accra Region) and Takoradi (Western Region). The rail network links Kumasi to Accra and Takoradi on different routes. The road network links Kumasi to Tamale via Techiman and Yeji (Brong Ahafo Region). This makes Kumasi, the study site, easily accessible to all parts of the country hence fostering the national-character of its ethnic composition.

The region has the second largest teaching hospital, the Komfo Anokye Teaching Hospital in the country after the Korle Bu Teaching Hospital in Accra. It is a major referral hospital serving mostly the regions in the north. It has the full complement of hospital departments. Kumasi has the second largest public university in the country, the Kwame Nkrumah University of Science and Technology (KNUST) established in 1956. The initial purpose was for training students in science and technology but it has expanded to cover most disciplines, including agriculture, medicine, law and business administration.

3.1.3 Kumasi

The Kumasi Metropolitan Assembly (KMA), the most populated of the 30 districts in the Ashanti region was the site of the study. It is located between Latitude 6.35^{o} N and 6.40^{o} S and Longitude 1.30^{o} W and 1.35^{o} E and elevated 250 to 300 meters above sea level, approximately 270km north of Accra. Seven districts (rural areas) surround Kumasi. These are Kwabre East and Afigya Kwabre Districts to the north, Atwima Kwanwoma and Atwima Nwabiagya Districts to the west, Asokore Mampong and Ejisu-Juaben Municipality to the east and Bosomtwe District to the south. Bosomtwe District was randomly selected from this list for this study. With an estimated 2012 population of 2,146,440, Kumasi has an annual growth rate of 2.7%. It forms 42.6% of the region's population and is the second largest city by population in Ghana after Accra (Nyarko, 2014). Its strategic location has also endowed it with the status of the principal inland transport terminal, thus giving it a pivotal role in the vast and profitable business of the distribution of goods in Ghana and beyond to other West African countries. Figure 3.3 shows the map of Kumasi with its surrounding rural areas.

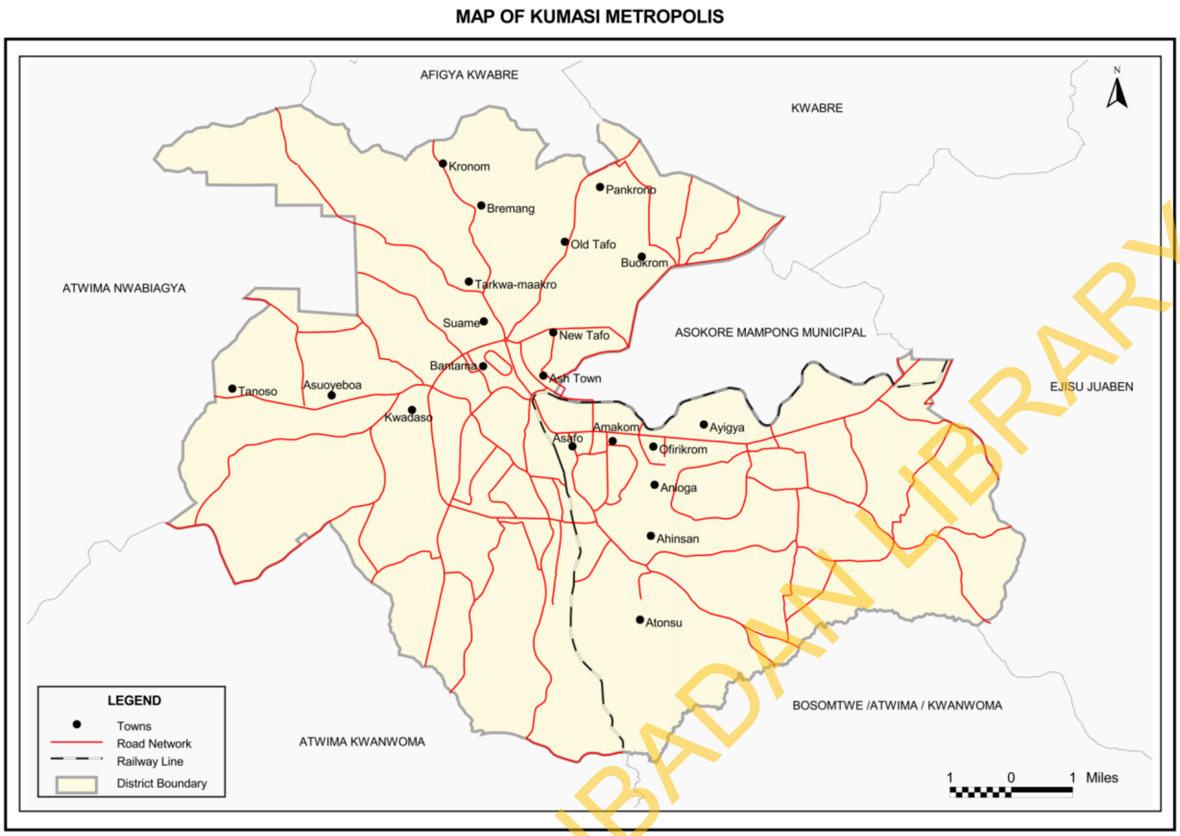

Fig 3.3. Map of Kumasi Source: Ghana Statistical Service, GIS

Education in Ghana and Kumasi (GSS, 2015)

The current system of formal education in Ghana was started in 1989 and it is based on a three-tier system. The first tier consists of six years of primary education followed by three years of junior high school (JHS), which constitutes the second tier. Together the first and second tier make nine years of basic education previously considered an acceptable exit point. The third tier consists of three years of senior high school (SHS), which was changed to four years in the 2007/2008 academic year but was reversed by the succeeding government to three years in 2009. The current government is implementing a policy to make SHS free and thus the new minimum exit point for formal education. Since the mid-nineties, pre-school education has been incorporated into basic education with all primary schools being required to have nurseries and kindergartens. The official language of instruction from Kindergarten to University is English, however it is common practice to find the local languages used as language of instruction particularly in the Lower primary level where most children are not familiar with English.

3.2 STUDY DESIGN

This is a cross-sectional survey designed to assess the intelligence of Ghanaian children aged 6-19 years in both rural and urban settings to establish norms for those specific populations using two of the most widely used instruments available: the Raven's Standard Progressive Matrices (RSPM) and the Slosson Intelligence Test (SIT).

3.3 STUDY POPULATION

Inclusion Criteria

For the RSPM, the inclusion criteria were any child of school-going age within the specified age range of 6-19 years in rural and urban Kumasi. For the SIT, because the instrument is an English-based test of Verbal Intelligence, inclusion criteria was urban children who were fluent in English.

Exclusion criteria

Children who had any known cognitive deficits were excluded from the study.

3.4 SAMPLE SIZE CALCULATION

This study purported to use two different instruments on two distinct populations: rural and urban children, to compare results.

Given that there were two instruments to be used and two distinct populations to be considered (urban and rural), two separate Samples were calculated:

Rural Sample Calculation:

*Estimation of single means***

(NB: *Formula chosen because single population was being considered with single instrument being administered)

The minimum sample size required to estimate CRP levels with a stated precision is given by the formula

$$n = \frac{Z_\alpha^{\ 2}\sigma^2}{d^2}$$

Where Zα = standard normal deviate corresponding to 5% level of significance = 1.96

σ = 5.3, standard deviation of the CRP from a previous study (Anum, 2014)

d = precision, assuming 10% of 5.3 = 0.53

n = minimum sample size, 203

Final adjusted Sample Size with 10% non-response rate = 220

This worked out to a sample of 15 participants per each cell using the individual ages as cells (from age 6-19 giving a total of 14 individual cells)

Urban Sample Calculation:

*Comparison of two means**

(*NB: formula was chosen because a single population was being considered with TWO different instruments being administered on them and compared)

The minimum sample size required to detect a difference in CRP levels between IQ scores on Raven's SPM and SIT was given by the formula

$$n = 2(Z_{\alpha} + Z_{1-\beta})^2\sigma^2$$

$$(\mu_1 - \mu_2)^2$$

Where Z_α = standard normal deviate corresponding to 5% level of significance = 1.96

$Z_{1-\beta}$ = standard normal deviate corresponding to a power of 80% = 0.84

σ = standard deviation of IQ scores

$\mu_1 - \mu_2$ = the difference in mean IQ scores on the Raven's SPM and the SIT. Since the two scales are in different units, the difference in mean IQ score is formulated as a fraction of the standard deviation of the standardized IQ scores.

Assuming $(\mu_1 - \mu_2)$ is 20% of the SD

$$n = \frac{2(1.96 + 0.84)^2\sigma^2}{(0.2)^2}$$

n = 392

Final adjusted sample size with 10% non-response rate = 420

This worked out to a sample of 30 participants per each cell using the individual ages as cells (from age 6-19 giving a total of 14 individual cells). (see Tables 8 and 9 in Appendix III).

3.5 SAMPLING TECHNIQUE

For both rural and urban sites, sampling was by multi-stage random sampling method.

Stage One

The first stage was concerned with selecting suitable districts from which to obtain schools for the study. A stratified sampling was done to obtain a randomly selected district out of the seven surrounding districts to obtain the rural sample. To do this a sampling frame of surrounding districts was prepared from a master list of all districts in the Ashanti region obtained from the Ministry of Local Government website (see: http://www.ghanadistricts.gov.gh/?plugin=81). This sampling frame numbered a total of 7 eligible districts from which one district was randomly selected using a computer-generated random number from an online website (at: www.random.org). The selected district was Bosomtwe District (number 7 on the list). For the urban sample, Kumasi was pre-selected as the study site and treated as one single district for the purposes of selecting eligible schools (i.e. all schools in the Kumasi Metropolis were considered and had an equal chance of being selected).

Stage Two

For the second stage of the multi-stage random sampling, selection of individual schools was the main goal. Four private schools and three public schools for the urban sample, and four public schools for the rural sample were to be selected. A sampling frame of all schools in the Kumasi Metropolis and surrounding districts was obtained from the Ashanti Regional Education Office of the Ghana Education Service and from the Kumasi Metropolitan Assembly to do this, of which 1565 schools were eligible. The seven urban schools were selected from this list by randomly generating 7 numbers from www.random.org as above. For the rural sample, a similar sampling frame of eligible schools was obtained from the Bosomtwe District office (n= 59) from which three basic schools (primary and JHS) were randomly selected as above. The rural Secondary school was randomly selected from a separate list of all rural secondary schools in the seven surrounding rural districts of Kumasi in order to make the rural sample much more widespread and generalizable rather than taking the entire sample from one locality. The Secondary school selected, Aduman SHS was located in the Afigya Kwabre District to the north of Kumasi. This was the second stage of the multi-stage random sampling.

Stage Three

Once the schools were selected a third sampling frame of eligible children from all eligible classes (given the age range) was obtained from the individual schools with the aid of their head-teachers and participants were randomly selected from randomly generated numbers online. This was done to avoid sampling bias and thus improve the generalizability of the data that was generated.

Figure 3.4 below graphically illustrates this sampling procedure.

Multi-Stage Sampling

RURAL SAMPLE **URBAN SAMPLE**

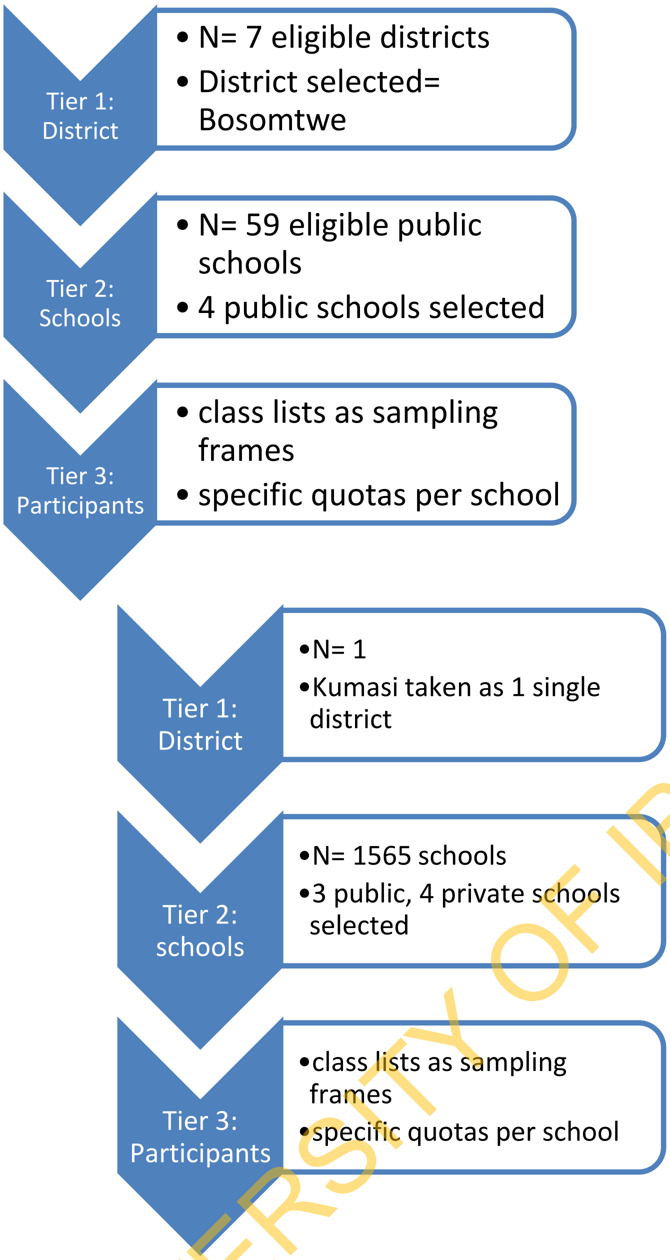

Figure 3.4: Multi-stage random sampling flow-chart

3.6 STUDY INSTRUMENTS (See Appendix II)

Instruments used were:

- **Raven's Standard Progressive Matrices (John Raven et al., 1998)-** to test Non-verbal intelligence (See Appendix II). This test is a self-administered test which is divided into five sub-sections each with 12 items (60 items total). Each item shows a progressive series of patterns ('matrices') with a final pattern missing. The participant is expected to select the missing pattern from a set of options given below each question. They are then to record their answer on a special answer sheet which was graded by the research assistants. The five sub-sections are labelled A, B, C, D and E and each can be scored separately, although they all generally test the same construct- 'eductive ability'.
- **Slosson Intelligence Test-** to test Verbal Intelligence (Slosson et al., 1991). (See Appendix II) This test consists of a series of 'age-appropriate' questions on various domains of Verbal IQ such as Verbal Comprehension, Working Memory and General Knowledge (which have been arranged progressively from easy to difficult- younger age to older ages), which are asked verbally by the research assistant with the participant giving their answer verbally. The starting point of the test depends on the chronological age of the participant. From this starting point, the research assistant goes progressively lower (easier questions down the line) until the participant obtains 10 consecutive correct answers. This establishes the 'Basal score' for the participant, which is considered their true level of baseline competence. Once the baseline is established, the research assistant then begins to ask questions from that point progressively forward with harder and harder questions until the participant gets 10 consecutive questions wrong. The last correct answer is taken as the participant's 'ceiling item'. To compute the final SIT score the baseline score is added to the number of correct items from that point to the ceiling item.

- **Patient Health Questionnaire-9 (Spitzer, Kroenke, Williams, & Group, 1999)** (Validated Akan and English Translations) to screen for Depressive and Anxiety symptoms. This questionnaire is a widely used well validated screen for Depression and Anxiety symptoms consisting of nine questions that are graded on a likert scale with specific cut-off points for clinically significant results. The validated Akan version (Guo et al., 2013; Weobong et al., 2009) was used where the participant was not proficient in the English language.
- Modified version of **Socio-demographic questionnaire (Olayinka Omigbodun, Dogra, Esan, & Adedokun, 2008):** This consists of questions relating to socio-demographic characteristics adapted from a questionnaire used in a previous study on adolescents in rural and urban Ibadan (Olayinka Omigbodun et al., 2008)
- **International Wealth Index (Smits & Steendijk, 2015)**, a measure of long-term household economic status using durable assets possession, access to basic services and housing material based on data from 2.1 million households in 97 developing country (including 3 demographic and health surveys from Ghana) developed by Smits and colleagues (Smits & Steendijk, 2015). Another reason the IWI instrument was used is because it provides an easy twelve-item set of simple questions that can be administered to even a 6 year old child about possession of such items as a television, bicycle, access to electricity, type of toilet etc. that provides a highly accurate and validated estimation of material well-being and Socioeconomic status. The questions from the IWI instrument were incorporated into the Socio-demographic questionnaire by Omigbodun et al.

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3.7 STUDY PROCEDURE

Preliminary work of obtaining school lists and contacts from the Ghana Education Service, the Kumasi Metropolitan Assembly and online databases was done. Contact was made with the selected schools and the requisite permission obtained to commence work. After this five research assistants were recruited and trained by the Researcher over a three-day period in the theoretical basis and practical administration of the various instruments. This training involved several practice rounds administering the instruments until there was agreement in procedures between all research assistants.

Pre-Test

A pre-test of all the study instruments was conducted on 20 children spread across four schools out of the 11 selected schools but in classes that were not used for the final study. This was done both to assess how conversant the research assistants were with the instruments, and also to assess the consistency of the research assistants. Lessons learned included the fine details of how to ask questions so as not to bias responses and to ensure uniformity in the way questions were asked. Also a better sense of the timing of tests was obtained, so as to better plan. It was also during this pre-test phase that it was confirmed that administering the SIT to rural children and to the selected urban public school children would be unfair and inaccurate as their grasp of the English language was rather poor. As such the decision was taken to only administer the SIT to urban private school children as they demonstrated a good-enough command of the English language to fairly answer the SIT. Also the local adaptation of the SIT (which involved modifying certain questions like "who was John F. Kennedy and why is he famous?" to "who was Kwame Nkrumah and why is he famous?", or changing Dollar calculations to Ghana Cedi calculations etc.) was tested during this period and was found to be adequate for the Ghanaian context.

Data Collection

The Researcher with five trained research assistants who were national service personnel attached to the Department of Psychiatry, Komfo Anokye Teaching Hospital, duly identified with Name tags/ID Cards supplied by the Researcher (see appendix IV) went out simultaneously according to a pre-published weekly timetable of scheduled schools to be visited per week (see Appendix V). During the long break-time of the schools (averagely 45 minutes long), and sometimes after school had closed, the selected participants were gathered in a quiet room either the school library or a classroom.

The socio-demographic questionnaire and PHQ-9 questionnaires were both administered in the local Twi language to the selected participants. All instruments were administered to all pupils except the SIT, which was interview-administered to only children in Urban Private Schools who had a good command of the English Language. All instruments were interview-administered except the RSPM. The RSPM was self-administered by the pupils after a detailed explanation of what to do was given. Instructions were given about how to answer the questions on the RSPM using the first item A1 as a demonstrative example. This was ***not*** a timed process as processing speed was not one of the domains being evaluated. The RSPM was administered in batches of 30 per sitting per day since it is designed to be mass-administered according to the Test makers. The data for the rural sample was collected within 2 weeks, so as to free up research assistants for administration of the SIT in the urban sample, which is a one-on-one administered test and so required more time and resources to administer.

For the urban sample, the procedure was the same as for the rural sample. The only difference was that the SIT was administered on a one-on-one basis, with a target of 12 participants per day. This resulted in an average of 60 successfully completed tests per week, resulting in the entire sample size of 420 being covered in less than 7 weeks.

3.8 DATA MANAGEMENT

All data was exclusively handled by the Investigators and supervisors with no access granted to any unauthorized person for any purposes without express permission. The data was entered personally by the Researcher into a laptop computer using Statistical Package of Social Sciences software (20th edition) and the data cleaned by running frequency distributions. The internal consistency of the Raven's Standard Progressive Matrices was determined by computing Cronbach's alpha value using the formula:

$$r = \frac{K\ COV/VAR}{1 + (K - 1)\ COV/VAR}$$

Where k is the number of items in the scale, COV is the average co-variance between items and VAR is the average variance of the items.

Also correlation between RSPM and SIT was assessed using **Pearson's correlation.**

Normative data was then described in terms of age-related means and standard deviations, and then compared to western norms (British and US norms) for significant differences using One-Sample Student t-test.

Effect of socio-demographic variables on raw scores of RSPM was then tested for significant differences as follows:

1. Comparison of mean raw scores of selected two-category demographics within the same population (e.g. rural Vs urban, private Vs public school etc.) **using Independent samples student t-test.**
2. Comparison of mean raw scores of selected multiple-category (>2) demographics within the sample population (e.g. level of education of parents, level of training of teachers etc) using **One-Way ANOVA**. Post-hoc tests (Least Significant Difference – LSD) were done for pairwise comparisons of the category means.

3. Comparison of means of variables with significant differences (as shown by points 1 and 2 above) to check for independent associations when other variables were controlled for, using **Multiple Linear Regression** .

4. Correlation between such interval variables as RSPM score, and Wealth Index with each other, using **Pearson Correlation**

3.9 ETHICAL CONSIDERATION

Ethical approval was sought and obtained (Ref. No.: CHRPE/AP/266/17) from the Committee for Human Research, Publications and Ethics (CHRPE) of the Kwame Nkrumah University of Science and Technology (KNUST) and the Komfo Anokye Teaching Hospital (KATH) (see Appendix V). Informed consent and assent was sought and documented for all participants selected for the study (Appendix V). Consent and approval was obtained from the head teachers of the schools. The content of the consent forms were translated into Twi for guardians who did not speak English in the presence of a witness who had read and understood the content.

Beneficence to Participants was ensured by way of offering expert mental health services to all participants who screened positive for either Depression or Anxiety symptoms during the screening process. Also the benefits of the study (the knowledge generated) would be quite useful to the sample population as well as the study population.

Non-maleficence to the participants was also maintained in that the study posed no more than minimal risk to study participants and did not involve any invasive procedure.

Voluntariness was fully respected in that the completely voluntary nature of the study procedure was fully explained to the study participants. They were also informed that participation would have no bearing on their grades or welfare in the school in any way. Teachers were not present during the consent process to ensure that there was no undue coercion from them. Token gifts such as pens and notebooks were given to all participants as appreciation *after* they had completed that assessment to prevent undue inducement. Teachers who helped in mobilizing volunteers were also given phone air time credit after their service as appreciation.

Confidentiality of data was ensured by making sure the forms used did not contain identifying details of participants, and only members of the research team had access to the data. Data from each participant was assigned an alpha-numeric code based on their school and this was used consistently in all forms pertaining to a particular participant to ensure accurate attribution of results to participants.

CHAPTER FOUR- RESULTS

4.0 INTRODUCTION

A total of 619 school children were recruited into this study consisting of 218 rural and 402 urban participants. Five participants (3 males and 2 females with ages ranging from 12-16 years) could not complete the intelligence tests, hence their data was excluded from the analysis. Final analysis was conducted on a total of 614 (99%) study participants.

This chapter is divided into four sections. The first Section provides a description of the socio-demographic characteristics and mental health profile of the participants. Section II gives results of the internal consistency of the Raven's Standard Progressive Matrices (RSPM) while, Section III presents the normative data obtained for the two instruments, Raven's Standard Progressive Matrices (RSPM) and the Slosson Intelligence Test (SIT). It also shows the results obtained from the comparison of normative data of the RSPM on children and adolescents in this study with British and United States Normative Data. Section IV then tackles the results of the analysis of the possible effects of the various sociodemographic variables on the raw scores of the RSPM.

SECTION I: SOCIO DEMOGRAPHIC CHARACTERISTICS AND MENTAL HEALTH PROFILE OF THE STUDY PARTICIPANTS

4.1 Personal Socio demographic Characteristics of the Study Population

Table 4.1 shows the personal characteristics of the study participants. Out of the total population of 614 participants, 336 (54.8%) were females. All age groups from 6 to 19 years were represented in the study with the highest age frequency present at age 13 with 55 (9%) participants. The mean age was 12.67 years (SD= 3.787). There were 396 (64.8%) participants from the Urban areas and 363

(59.1%) from public schools. Only 14 (2.3%) of the participants screened positive for depression and/or anxiety disorder during the period of assessment.

TABLE 4.1

Personal Socio demographic Characteristics & Mental Health Profile of Study Population

N=614

Variable	Frequency	Percentage %
Sex		
Male	278	45.3
Female	336	54.7
Total	**614**	**100**
Age in years		
6	28	4.6
7	38	6.2
8	43	7.0
9	47	7.7
10	40	6.5
11	51	8.3
12	45	7.3
13	55	9.0
14	48	7.8
15	47	7.7
16	43	7.0
17	50	8.1
18	53	8.6
19	26	4.2
Total	**614**	**100**
Type of school (N= 614)		
Private	251	40.9
Public	363	59.1
Total	**614**	100
Residence/sample (N= 614)		
Rural	218	35.5
Urban	396	64.5
Total	**614**	**100**
Depression &/or Anxiety Present		
None	600	97.7
Depression	4	0.7
Anxiety Disorder	9	1.5
Depression and Anxiety Disorder	1	0.2
Total	**614**	**100**

Table 4.2 displays the Home Characteristics of the study participants. For the majority of children (42.4%), their most educated caregiver had a primary level education. The majority of participants reported that they did not speak English at home (80.3%) and about half (49.3%) did not have a regular leisurely reading habit or regularly watch any educational programmes. About one-third of the participants (33.7%) were within the highest one-tenth in terms of the International Wealth Index (IWI) score.

TABLE 4.2 Home Characteristics of the Study Participants N=614

Variable	Frequency	Percentage %
The highest level of education of caregiver		
No Formal Education	45	7.3
Primary	259	42.2
Secondary	154	25.1
Tertiary	144	23.5
Postgraduate/Professional	9	1.5
Total	**611***	**99.5***
English spoken at home		
Yes	121	19.7
No	493	80.3
Total	614	614
Leisurely reading & watching educational programmes at home		
Yes	310	50.5
No	303	49.3
Total	**613***	**99.8***
Socioeconomic Status as estimated by IWI deciles		
2nd decile (10-19.99)	7	1.1
3rd decile (20-29.99)	13	2.1
4th decile (30-39.99)	11	1.8
5th decile (40-49.99)	43	7.0
6th decile (50-59.99)	64	10.4
7th decile (60-69.99)	85	13.8
8th decile (70-79.99)	64	10.4
9th decile (80-89.99)	113	18.4
10th decile (90-100)	207	33.7
Total	**607***	**98.9***

*data missing or unrecorded

Table 4.3 shows the School Characteristics of the study participants. Professional teachers with a four-year university (B.Ed) degree taught 252 (41.6%) of the participants. English was the language of instruction at school for 517 (84%) and 522 (52.4%) reported they had access to information by way of a functional well-stocked library or Information and Communication Technology (ICT) centre.

TABLE 4.3 School Characteristics of the Study Participants N=614

Variable/characteristic	Frequency	Percentage %
Level of teachers' training		
Pupil teacher/secondary level	70	11.5
Teacher training Diploma	163	26.5
Non-professional Graduate teacher	129	21.0
Professional Graduate Teacher	252	41.0
Total	**614**	**100**
English as language of instruction		
No	97	15.8
Yes	517	84.2
Total	**614**	**100**
Access to information		
No	292	47.6
Yes	322	52.4
Total	**614**	**100**

4.2 Association between the International Wealth Index (IWI) Score, Place of Abode (rural/urban) and Type of School (Public/Private)

This section displays the association between the International Wealth Index (IWI), the place of abode and the type of school attended by the study participants.

Table 4.4 displays the association between the mean IWI score and place of abode, type of school and whether English was spoken at home. Participants in rural areas had a significantly lower mean IWI score (61) than those from urban areas (84) (p<0.001). Participants in private schools (89) had statistically significantly higher IWI mean scores than those in public schools (67) (p<0.001).

Table 4.4 Association Between Mean International Wealth Index (IWI) Score and Place of Abode, Type of School Attended and Spoken Language at Home N=614

Variable	IWI Wealth index		Independent sample t- test	P value
	Mean Score	**Standard deviation**		
Residence/sample			-15.074	<0.001
Rural	61.3	18.8		
Urban	84.0	15.6		
Type of School			18.326	<0.001
Private	89.3	10.0		
Public	66.8	20.0		
English spoken at home			-15.901	<0.001
Yes	91.5	8.8		
No	72.2	20.1		

A comparison between individual schools with respect to their mean IWI score revealed a statistically significant difference in the mean wealth index of private schools in affluent neighbourhoods (IWI score= 92.92) when compared to rural public basic (primary) schools (IWI score= 60.24, p< 0.001), urban public primary school (IWI score= 63.57, p<0.001) and the urban private primary school in low income areas (IWI score= 83.23, p<0.001). This information can be seen in Appendix I.

4.3 Internal Consistency of the Raven's Standard Progressive Matrices (RSPM) and Correlation between RSPM and Slosson Intelligence Test (SIT)

The internal consistency for the 60-item RSPM was obtained. The Cronbach's alpha, a measure of how closely each item is related to all the other items and to the total for all scores was 0.954 (standardized item alpha= 0.950). The Cronbach's alpha of the RSPM for males and females was 0.962 and 0.948 respectively and 0.950 and 0.954 for rural and urban participants respectively.

Table 4.5 displays the Correlation of the RSPM and the SIT. The Pearson's Correlation Coefficient between the RSPM and the SIT was strongly positive at 0.722 (p<0.001). In addition, the Raven's and the Slosson's Pearson's Correlation Coefficient with the IWI were weakly positive at 0.323 and 0.323 respectively (p<0.001). There was a negative relatively weak correlation between and the Student-Teacher ratio the Raven's (-0.436) and the Slosson's (-0.264) (p<0.001).

TABLE 4.5 Correlation of RSPM and SIT raw scores of urban private schools with selected variables N= 614

Interval Variable	Interval Variable (2)	Pearson Correlation	P-value
Raven's SPM raw score	Slosson Intelligence Test raw score	0.722	<0.001
	IWI wealth index composite score	0.323	<0.001
	Student-teacher ratio	-0.436	<0.001
Slosson Intelligence Test raw score	IWI wealth index composite score	0.163	<0.005
	Student-teacher ratio	-0.264	<0.001
IWI wealth index composite score	Student-teacher ratio	-0.500	<0.001

4.4 Normative Data of the Raven's Standard Progressive Matrices (RSPM) and the Slosson Intelligence Tests (SIT)

The normative data of the Raven's Standard Progressive Matrices RSPM and the Slosson Intelligence Tests (SIT) by way of mean scores and standard deviations are presented below in Table 4.6.

Table 4.6 shows the mean scores and standard deviation for the RSPM for ages 6 years to 19 years. The lowest mean score of 13.46 (SD:6.2) was found in 6 year olds while the highest mean score of 40.42 (SD 8.796) was obtained among 19 year-olds. Figure 4.1 displays the average mean scores of the Ravens' in a graph. There was a dip in scores at age 13 and again at age 17 years but generally the trend was an increase in scores with advancing age.

TABLE 4.6

Mean Scores and Standard Deviations for the RSPM for

Ages 6 Years to 19 Years

N=614

Age in years	N	Mean	Std. Deviation
6	28	13.5	6.3
7	38	14.6	6.5
8	43	14.1	7.0
9	47	16.2	9.0
10	40	22.2	11.1
11	51	27.0	12.8
12	45	27.5	11.9
13	55	32.2	13.2
14	48	30.5	10.5
15	47	33.7	12.0
16	43	39.6	11.0
17	50	34.7	12.6
18	53	37.8	9.6
19	26	40.4	8.8
Total	614	27.9	13.8

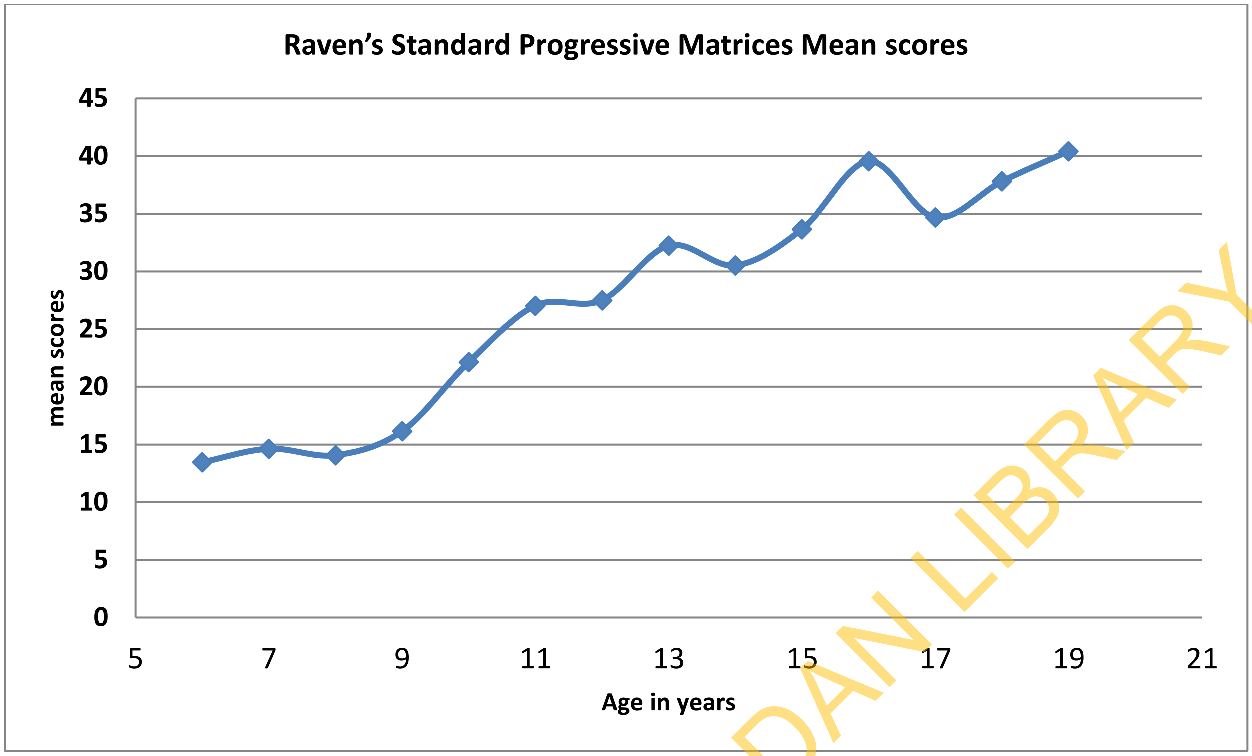


Figure 4.1: Mean Scores and Standard Deviations for the RSPM for Ages 6 Years To 19 Years

Table 4.7 shows mean scores and standard deviations of RSPM broken down by age and area of residence (rural/urban). Children in urban areas scored slightly lower than children in rural areas in the age 6 category (urban=13.44 SD 6.811; rural=13.50 SD 5.713). After age 6 however, urban children scored higher than rural children in every age category (mean difference at -5.177, $p<0.001$. Figure 4.2 displays the mean scores and standard deviations of RSPM by age and area of abode. At age 6, both urban and rural participants have similar mean scores but with increasing age the urban children have higher scores than rural children. From age 13 to 15 both rural and urban scores experience a slight dip and again from ages 16 to 17, with a rise again by age 19.

TABLE 4.7 RSPM Mean Scores and SDs by Age and Area of residence (N= 614)

Age in years	Frequency (N)	Area of residence	Mean	Standard Deviation
6	12	Rural	13.5	5.7
	16	Urban	13.4	6.8
	28	Total	13.5	6.3
7	12	Rural	12.8	2.7
	26	Urban	15.5	7.6
	38	Total	14.6	6.5
8	19	Rural	15.3	7.8
	24	Urban	13.1	6.2
	43	Total	14.1	7.0
9	18	Rural	12.8	2.9
	29	Urban	18.2	10.8
	47	Total	16.2	9.0
10	14	Rural	22.1	12.4
	26	Urban	22.2	10.6
	40	Total	22.2	11.1
11	18	Rural	23.4	12.1
	33	Urban	29.0	12.9
	51	Total	27.0	12.8
12	17	Rural	28.6	11.4
	28	Urban	26.9	12.4
	45	Total	27.5	11.9
13	17	Rural	24.7	10.8
	38	Urban	35.6	12.9
	55	Total	32.2	13.2
14	20	Rural	26.2	8.7
	28	Urban	33.6	10.7
	48	Total	30.5	10.5
15	16	Rural	25.6	9.1
	31	Urban	37.8	11.3
	47	Total	33.7	12.0
16	11	Rural	36.5	12.2
	32	Urban	40.6	10.6
	43	Total	39.6	11.0
17	19	Rural	31.6	13.0
	31	Urban	36.6	12.1
	50	Total	34.7	12.6
18	21	Rural	37.6	9.7
	32	Urban	38.0	9.7
	53	Total	37.8	9.6
19	4	Rural	37.5	17.2
	22	Urban	41.0	6.9
	26	Total	40.4	8.8
Total	**218**	Rural	24.5	12.6
	397	Urban	29.7	14.2
	614	Total	27.9	13.8

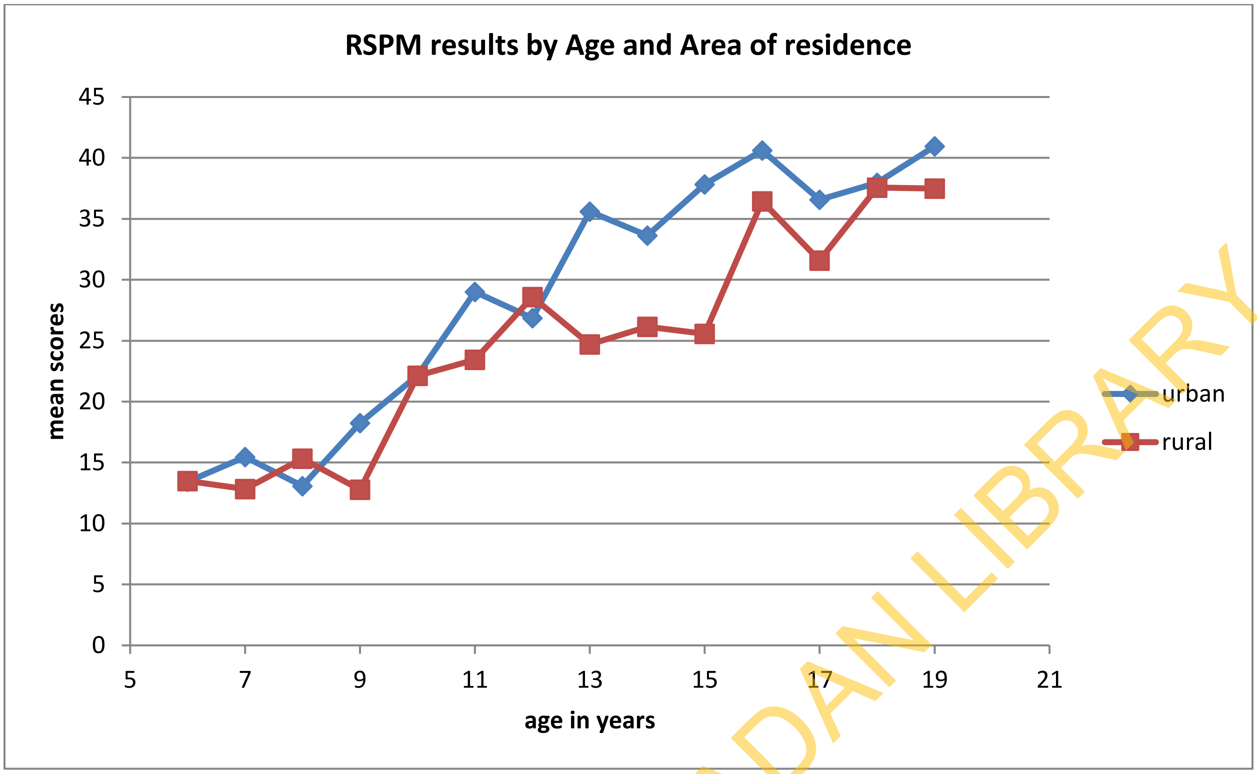


Figure 4.2: Mean Scores and Standard Deviations of RSPM by Age and Area of Abode.

Table 4.8 shows RSPM mean scores by age and type of school (public/private). Participants in Private schools consistently did better than those in public schools with the largest difference being seen at age 15 (private= 42.62, public= 26.42, difference of 16.2 points).

Figure 4.3 displays the RSPM mean scores by age and type of school. Participants in private schools persistently have higher scores than children in public schools although there is a closing of the gap by age 19 years.

TABLE 4.8 RSPM results by age and type of school N=614

Age in years	Type of school	Mean	Frequency (N)	Standard Deviation
6	Private	15.3	10	7.1
	Public	12.4	18	5.7
	Total	13.5	28	6.3
7	Private	16.6	19	8.4
	Public	12.7	19	3.0
	Total	14.6	38	6.5
8	Private	15.1	16	6.5
	Public	13.4	27	7.3
	Total	14.1	43	7.0
9	Private	21.3	21	11.1
	Public	12.0	26	3.1
	Total	16.2	47	9.0
10	Private	23.4	19	10.9
	Public	21.1	21	11.5
	Total	22.2	40	11.1
11	Private	33.4	26	11.0
	Public	20.5	25	11.3
	Total	27.0	51	12.8
12	Private	31.4	16	13.0
	Public	25.4	29	11.0
	Total	27.5	45	11.9
13	Private	39.2	26	10.8
	Public	26.0	29	12.1
	Total	32.2	55	13.2
14	Private	35.2	21	10.1
	Public	26.9	27	9.4
	Total	30.5	48	10.5
15	Private	42.6	21	6.4
	Public	26.4	26	10.6
	Total	33.7	47	12.0
16	Private	37.5	15	9.6
	Public	40.6	28	11.7
	Total	39.6	43	11.0
17	Private	36.9	13	10.9
	Public	33.9	37	13.2
	Total	34.7	50	12.6
18	Private	33.9	15	10.6
	Public	39.3	38	8.9
	Total	37.8	53	9.6
19	Private	40.5	13	5.3
	Public	40.3	13	11.5
	Total	40.4	26	8.8
total	Private	30.7	**251**	13.2
	Public	26.0	**363**	13.9
	Total	27.9	**614**	13.8

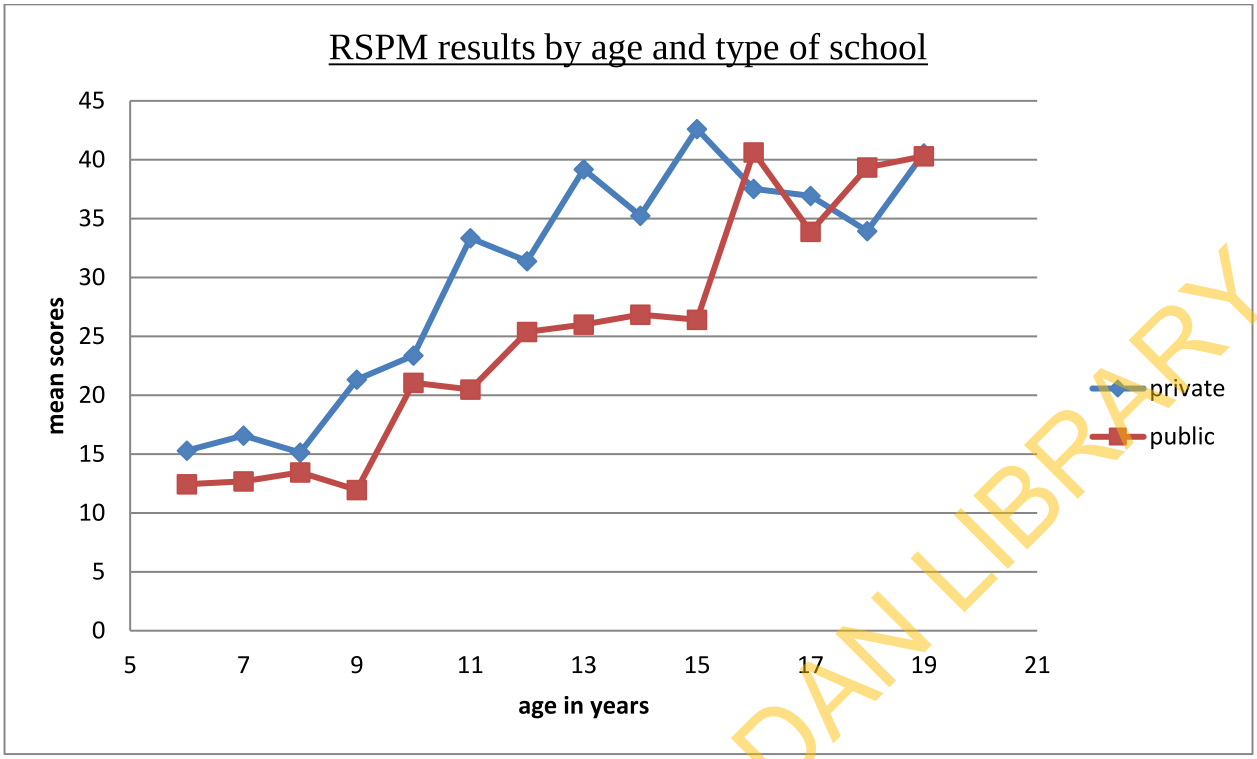


Figure 4.3 The RSPM mean scores by age and type of school.

Table 4.9 shows the mean scores and standard of the SIT by age, and type of school (all samples were taken from urban private schools on account of the test having to be delivered in English only). For ages 15-19 the test was administered to both public and private schools because at the secondary school level (level of most 15-19 year olds) participants are reasonably fluent in English to take the test. The test showed an upward trend with increasing age. From ages 15-18, public schools out-performed private schools with the highest difference being at ages 17 and 18 (difference of 13 points).

Figure 4.4 displays the Mean scores and Standard Deviation of the SIT by age and type of school. The result is from samples from private schools up until age 14 and from ages 15 to 19 years, the participants were from both public and private schools. The Slosson shows an increase in mean scores with rising age.

TABLE 4.9 Mean scores and SD of Slosson's Intelligence Test results by age and type of school (all urban private school participants) (N= 301)

age in years	Type of school	Mean	N	Std. Deviation
6	Public	-	-	-
	Private	38.2	10	8.0
	Total	38.2	10	8.0
7	Public	-	-	-
	Private	46.9	19	9.7
	Total	46.9	19	9.7
8	Public	-	-	-
	Private	53.0	16	6.1
	Total	53.0	16	6.1
9	Public	-	-	-
	Private	65.9	21	10.1
	Total	65.9	21	10.1
10	Public	-	-	-
	Private	69.2	19	11.2
	Total	69.2	19	11.2
11	Public	-	-	-
	Private	80.8	26	12.2
	Total	80.8	26	12.2
12	Public	-	-	-
	Private	96.4	16	16.2
	Total	96.4	16	16.2
13	Public	-	-	-
	Private	110.5	26	9.9
	Total	110.5	26	9.9
14	Public	-	-	-
	Private	109.1	21	18.8
	Total	109.1	21	18.8
15	Public	125.0	2	1.4
	Private	112.0	21	16.8
	Total	113.1	23	16.5
16	Public	123.5	15	18.9
	Private	121.3	15	12.3
	Total	122.4	30	15.7
17	Public	130.1	11	14.2
	Private	117.9	13	12.6
	Total	123.5	24	14.5
18	Public	123.1	14	18.9
	Private	110.1	15	13.3
	Total	116.4	29	17.3
19	Public	126.7	7	8.2
	Private	138.6	13	14.4
	Total	134.5	20	13.7
Total	Public	125.1	50	16.1
	Private	90.7	251	30.7
	Total	96.4	301	31.5

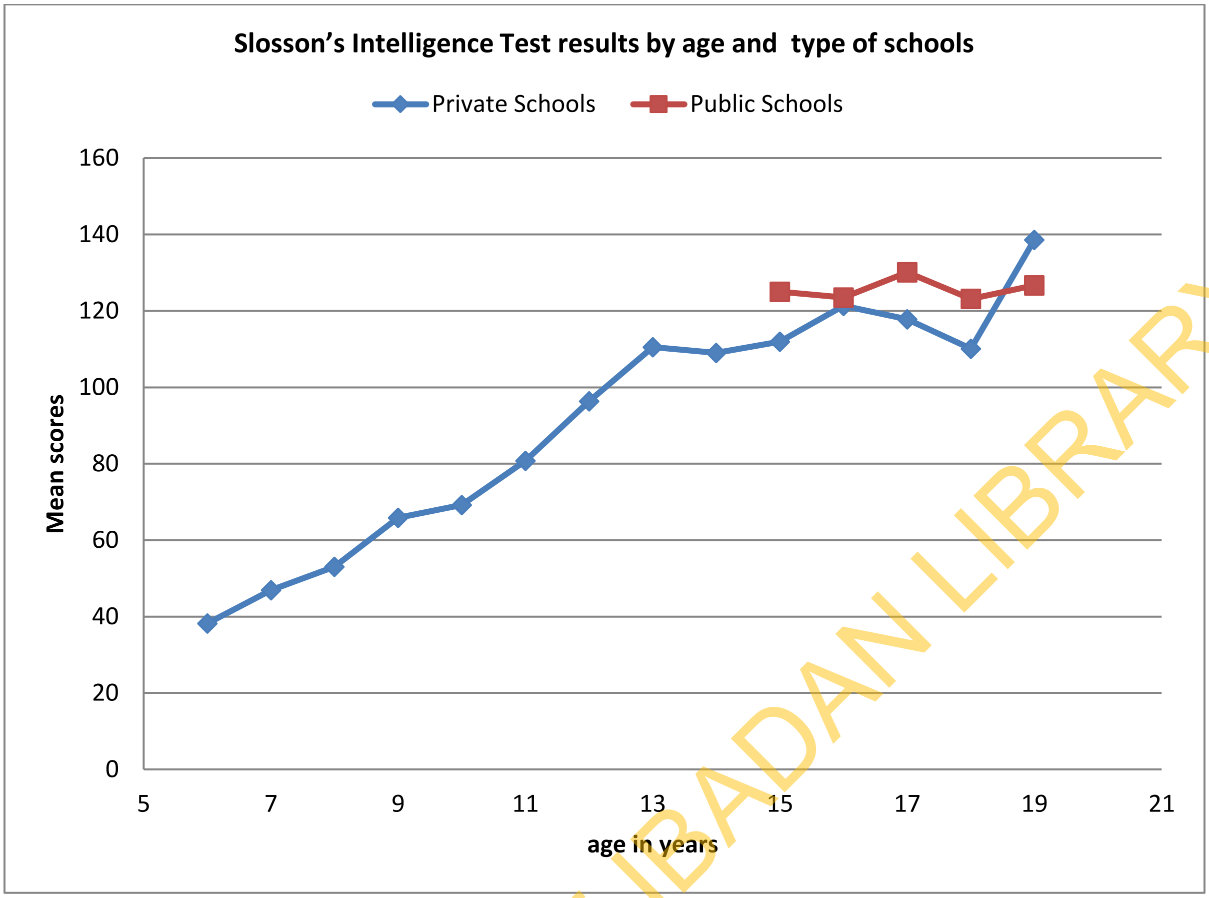


Figure 4.4 Mean scores and Standard Deviation of the SIT by Age and Type of School.

4.5 COMPARISON WITH BRITISH AND UNITED STATES NORMS

In this section, a comparison of the mean scores of various socio-demographic groups is made with the British Standard Norms of the RSPM using the 1979 data (for ages 6-15) and the 1992 data (for adults from ages 18 upwards). Unfortunately British normative data for ages 16 and 17 could not be obtained; hence comparison could not be made to British norms. However US norms (1993 standardisation data) for ages 16 and 17 were available, and have been shown to be very highly correlated with British norms according to the test makers (John Raven et al., 1998) hence of comparable values.

Table 4.10 shows the comparison between mean scores of RSPM of the participants with British norms. The difference between overall mean scores for each age-cell and British norms was statistically significant for every age. All local mean scores were lower than British Norms.

Figure 4.5 shows Mean Raw Scores of all participants compared to British Norms. Mean scores of participants at all ages were lower than the British norms.

TABLE 4.10 Mean Raw Scores of RSPM overall compared to British Norms (1979 & 1992 data) (N= 615)

Age in years	Ghana RSPM Mean Score (SD)	British RSPM Mean Score (SD)	One-sample t-test	P- value
6	13.5 (6.3)	16	-2.147	0.041
7	14.6 (6.5)	19	-4.143	<0.001
8	14.1 (67.0)	25	-10.313	<0.001
9	16.2 (9.0)	33	-12.822	<0.001
10	22.2 (11.1)	38	-9.025	<0.001
11	27.0 (12.8)	40	-7.228	<0.001
12	27.5 (11.9)	41	-7.589	<0.001
13	32.2 (13.2)	43	-6.049	<0.001
14	30.5 (10.5)	45	-9.544	<0.001
15	33.7 (12.0)	47	-7.593	<0.001
16	39.6 (11.0)	48*	-5.029	<0.001
17	34.7 (12.6)	50*	-8.617	<0.001
18	37.8 (9.6)	54	-12.282	<0.001
19	40.4 (8.8)	54	-7.870	<0.001

*US normative data from 1993 standardization

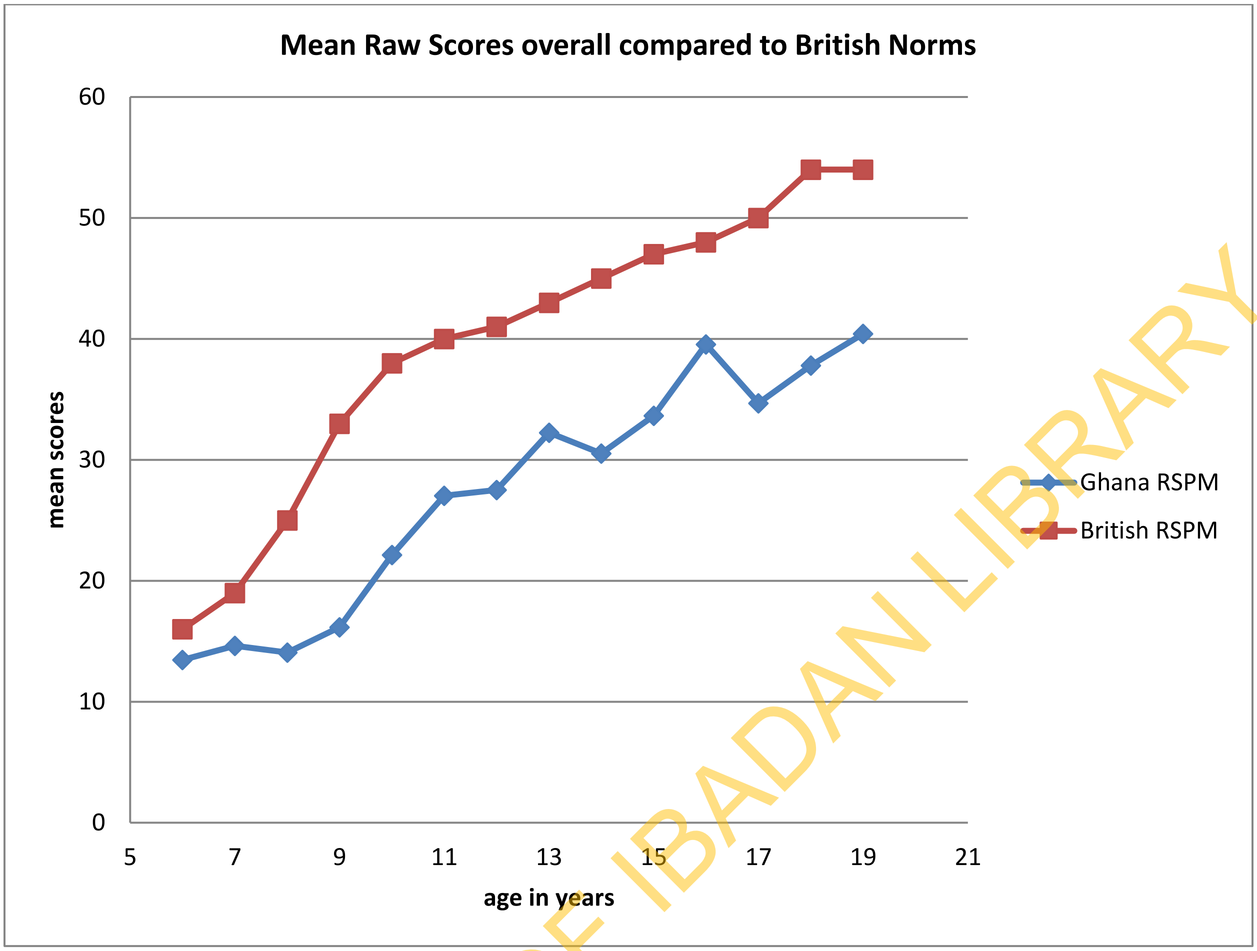


Figure 4.5: Mean Raw Scores of RSPM of all Participants compared to British Norms

Table 4.11 shows the comparison between mean urban RSPM scores and British norms. There was no statistically significant difference between the mean score of 6 year olds in urban schools, and British norms (t-test=-1.505, p= 0.153). All other differences in mean scores were statistically significant.

Figure 4.6 displays the Mean Scores for Urban School participants compared to British Norms. The mean scores are lower than British norms for all ages.

Table 4.11 Mean RSPM Scores for Urban Schools compared to British Norms (1979 & 1992 data) (N= 397)

Age in years	Ghana RSPM Mean Score (SD)	British RSPM Mean Score (SD)	One-sample t-test	P- value
6	13.4 (6.8)	16	-1.505	0.153
7	15.5 (7.6)	19	-2.389	0.025
8	13.1 (6.2)	25	-9.396	<0.001
9	18.2 (10.8)	33	-7.366	<0.001
10	22.2 (10.6)	38	-7.609	<0.001
11	29.0 (12.9)	40	-4.883	<0.001
12	26.9 (12.4)	41	-6.038	<0.001
13	35.6 (12.9)	43	-3.538	<0.001
14	33.6 (10.7)	45	-5.615	<0.001
15	37.8 (11.4)	47	-4.512	<0.001
16	40.6 (10.6)	48*	-3.950	<0.001
17	36.6 (12.2)	50*	-6.166	<0.001
18	38.0 (9.7)	54	-9.362	<0.001
19	41.0 (6.9)	54	-8.828	<0.001

*US normative data from 1993 standardization

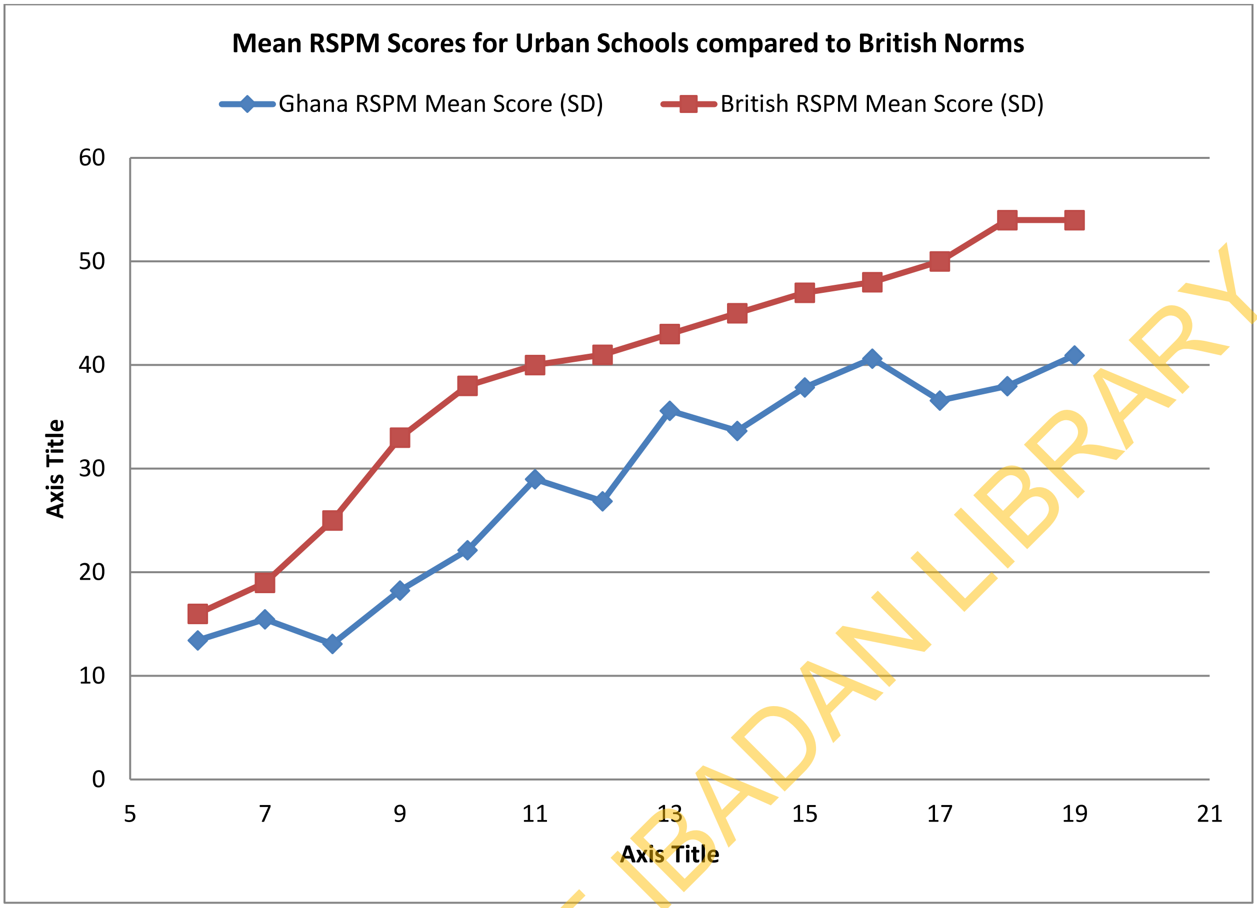


Figure 4.6: Mean Scores for Urban School Participants compared to British Norms.

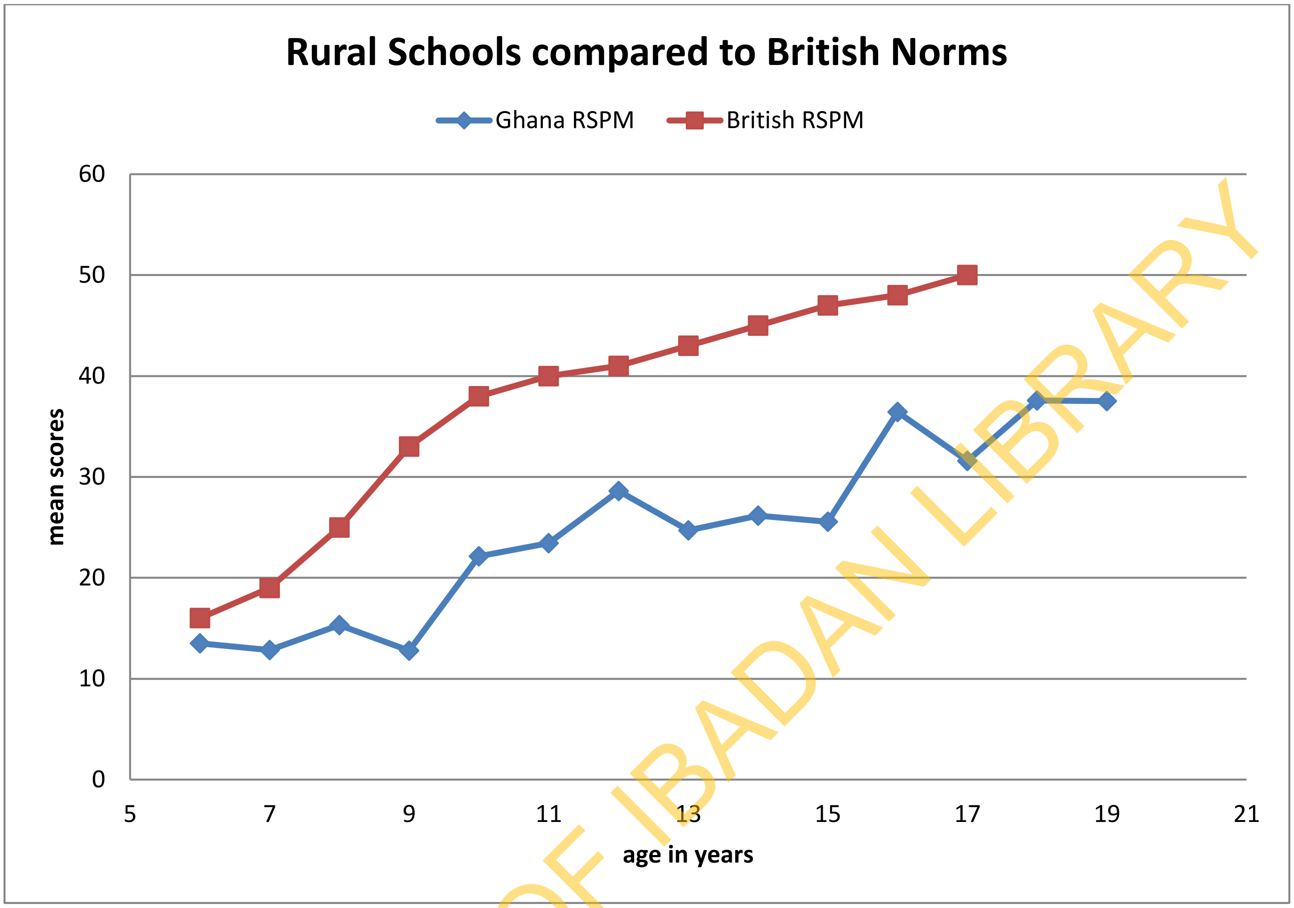
Table 4.12 shows comparison of rural scores with British norms. The differences between Rural mean scores for each age-cell and British norms were statistically significant for every age except for age 6 years (t-test= -1.921, p= 0.150). All local (rural) mean scores were lower than British Norms.

Figures 4.7 displays the Mean Scores for Rural School Participants compared to British Norms. Rural School participants score significantly lower at all age groups.

TABLE 4.12 Mean RSPM Scores for Rural Schools compared to British Norms (1979 & 1992 data) (N= 218)

Age in years	Ghana RSPM Mean Score (SD)	British RSPM Mean Score (SD)	One-sample t-test	P- value
6	13.5 (5.7)	16	-1.516	0.158
7	12.8 (2.7)	19	-7.938	<0.001
8	15.3 (7.8)	25	-5.429	<0.001
9	12.8 (2.9)	33	-29.570	<0.001
10	22.1 (12.4)	38	-4.793	<0.001
11	23.4 (12.1)	40	-5.813	<0.001
12	28.6 (11.4)	41	-4.493	<0.001
13	24.7 (10.8)	43	-6.985	<0.001
14	26.2 (8.7)	45	-9.668	<0.001
15	25.6 (9.1)	47	-9.394	<0.001
16	36.5 (12.2)	48*	-3.138	<0.011
17	31.6 (13.0)	50*	-6.174	<0.001
18	37.6 (9.7)	54	-7.771	<0.001
19	37.5 (17.2)	54	-1.921	0.150

*US normative data from 1993 standardization



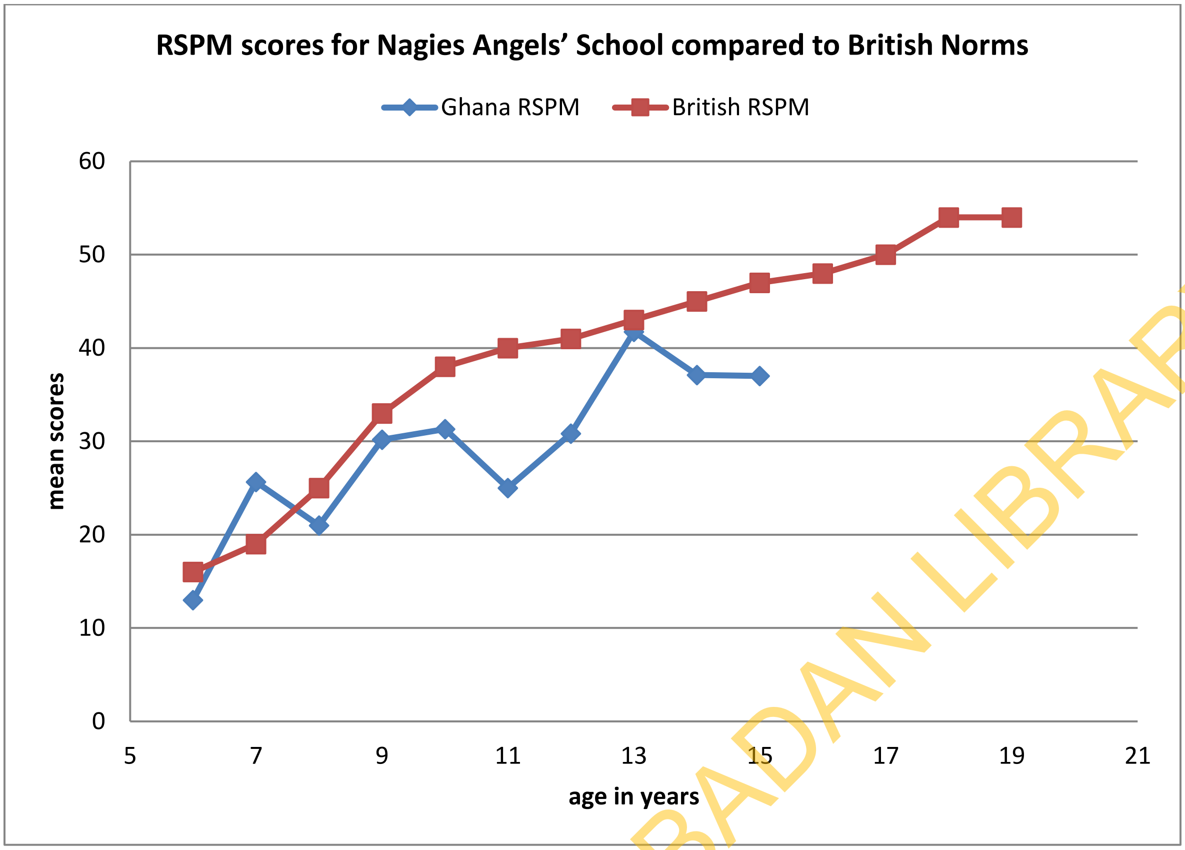
Figures 4.7: Mean Scores for Rural School Participants compared to British Norms.

Table 4.13 compares results from one of the private schools serving an affluent part of Kumasi with a relatively high standard of living, Nagies' Angels Educational complex with the British and US Norms. It showed no statistically significant difference between mean scores for ages 7 (t-test= 1.841, p= 0.125), 8 (t-test= -1.333, p= 0.410), 9 (t-test= -0.810, p= 0.455), 10 (t-test= -1.053, p= 0.403) and 13 (t-test= -0.654, p= 0.527), and British norms. Only differences between scores of 12 and 14 year olds and British norms were statistically significance. Results for ages 6, 11 and 15 could not be computed because only one participant was obtained each. Also since it was a Basic (Primary) school no samples for ages 16-19 could be obtained. Age 7 mean score was actually higher than British mean score for same age (mean Ghana score= 25.67, British norm= 19).

Figures 4.8 displays the Mean Scores for Nagies Angels' School Participants compared to British Norms. Even though the mean scores are generally lower than the British norms, at age 7, participants in Nagies' Angels scored higher than British counterparts at age 7 years.

TABLE 4.13 Mean RSPM Scores for Nagies Angels' School (basic school age 6 – 15 years) compared to British Norms (1979 & 1992 data) (N= 52)

Age in years	Ghana RSPM Mean Score (SD)	British RSPM Mean Score (SD)	One-sample t-test	P- value
6	13.0	16	_	_
7	25.7 (8.9)	19	1.841	0.125
8	21 (4.2)	25	-1.333	0.410
9	30.2 (8.6)	33	-0.810	0.455
10	31.3 (11.0)	38	-1.053	0.403
11	25 (-)	40	_	
12	30.8 (14.5)	41	-2.323	0.043
13	41.8 (6.6)	43	-.654	0.527
14	37.11 (9.5)	45	-2.500	0.037
15	37 (-)	47	_	_



Figures 4.8: Mean Scores for Nagies Angels' School Participants compared to British Norms.

Table 4.14 compares results from the second private school serving an affluent part of Kumasi with a relatively high standard of living, Angel Educational Complex Primary and JHS, with the British and US Norms. It showed no statistically significant difference between mean scores for ages 6 (t-test= -1.194, p= 0.277), 11 (t-test= -2.069, p= 0.065), 13 (t-test= -1.712, p= 0.138), 14 (t-test= -1.527, p= 0.202) and 16 (t-test= -4.142, p= 0.054), and British and US norms. Only differences between scores of 7, 8, 9, 10 and 15 year olds and British norms were statistically significance. Results for ages 12 could not be computed because only one participant was obtained. Also since it was a Basic school no samples for ages 17-19 could be obtained.

Figure 4.11 displays the mean scores of participants in Angel's Educational Complex compared to British norms. Mean scores are lower at all ages with closer scores at ages 6, 12 and 16 years.

Table 4.14 Mean RSPM Scores for Angel's educational complex (basic school age 6 – 16 years) compared to British Norms (1979 & 1992 data) (N= 74)

Age in years	Ghana RSPM Mean Score (SD)	British RSPM Mean Score (SD)	One-sample t-test	P- value
6	13.6 (5.4)	16	-1.194	0.277
7	12.8 (2.7)	19	-6.517	<0.001
8	16.3 (7.2)	25	-3.190	0.019
9	13.4 (5.4)	33	-9.568	<0.001
10	20.2 (12.2)	38	-3.589	0.016
11	33.6 (10.2)	40	-2.069	0.065
12	38.0	41	-	-
13	32.1 (16.8)	43	-1.712	0.138
14	37.8 (10.5)	45	-1.527	0.202
15	41.7 (6.4)	47	-2.893	0.015
16	38.3 (4.0)	48*	-4.142	0.054

*US normative data from 1993 standardization

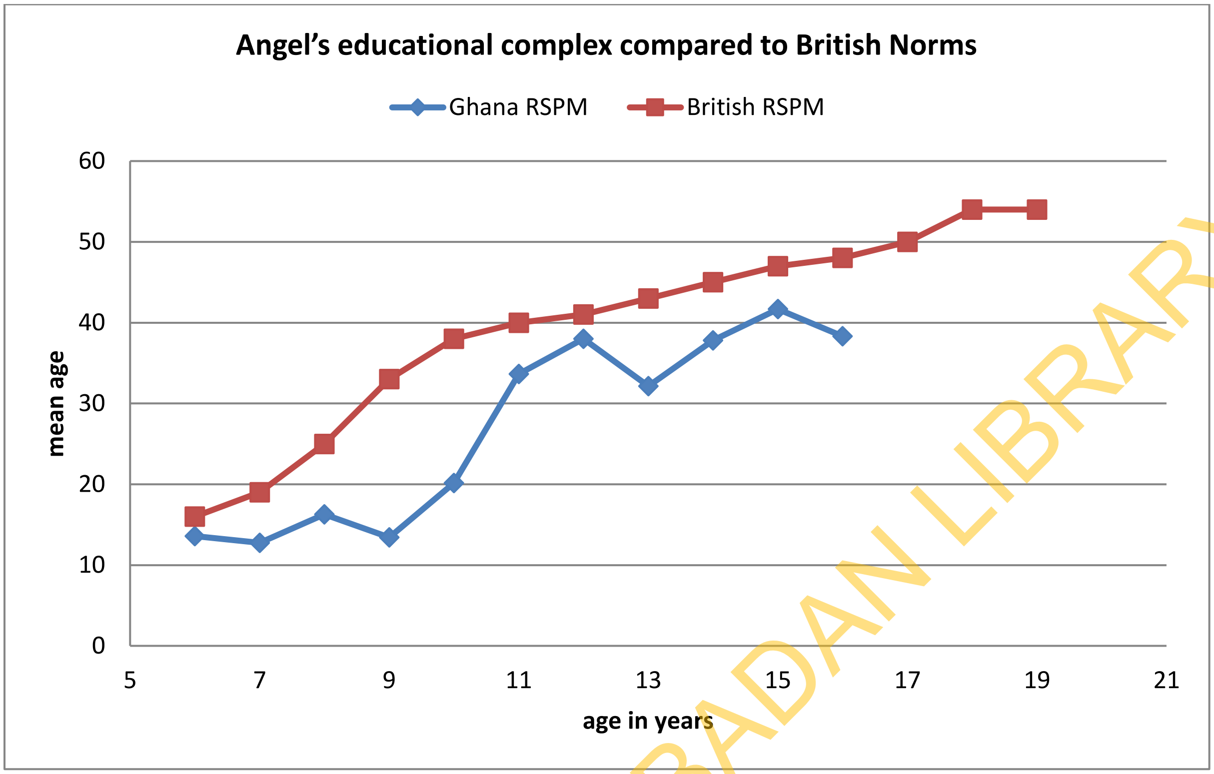


Figure 4.11: Mean RSPM Scores for Angel's School Participants compared to British Norms.

SECTION IV: ASSOCIATION AND CORRELATIONS BETWEEN THE MEAN OF THE RAW SCORES ON THE RSPM AND SOCIO-DEMOGRAPHIC VARIABLES

This section displays the association between the RSPM scores and socio demographic factors

4.6 Mean Score on the Raven's and it association with sex, place of abode, type of school, language spoken at home, language of instruction, Leisurely Reading and access to ICT.

Table 4.15 displays the association between area of residence (rural vs urban), type of school (public vs private), language spoken at home (English vs Mother tongue), leisurely reading habit, language of instruction at school and access to ICT. There was a significant difference in the mean score of all of the two-category variables compared ($p<0.05$ for each) except for sex ($p= 0.502$).

TABLE 4.15

Comparison of Mean of RSPM with sex, place of abode, type of school, language spoken at home, language of instruction, Leisurely Reading and access to ICT N= 614

Variable	Raw score RSPM		Independent sample t-test	p value
	Mean Score	**Standard deviation**		
Sex				0.502
Male	28.3	14.6	0.671	
female	27.5	13.3		
Residence/sample			-4.685	<0.001
Rural	24.5	12.6		
Urban	29.7	14.2		
Type of School			4.235	<0.001
Private	30.7	13.2		
Public	26.0	13.9		
English spoken at home			-5.576	<0.001
Yes	34.0	13.7		
No	26.4	13.5		
Leisurely reading/watching of educational programmes at home			-10.683	<0.001
Yes	33.3	12.8		
No	22.4	12.7		
English as language of instruction			15.203	<0.001
Yes	30.3	13.4		
No	15.2	7.9		
Access to Information (library/ICT centre at school)			-13.414	<0.001
Yes	34.3	12.5		
No	21.0	11.8		

TABLE 4.16: Mean Score on the Raven's and it association with level of education of most educated caregiver (Table 4.6.3), level of training of teachers (Table 4.6.5) and decile of International Wealth Index (IWI) (Table 4.6.4). There was significant differences in the RSPM scores of children in all multiple-category variables (p<0.001).

Table 4.16

Comparison of Mean of RSPM with Level of Education of Caregiver, International Wealth Index Score, and Level of Teachers' Training

N= 614

Variable	Mean	N	SD	F	p value
Level of education of caregiver				17.41	<0.001
None	23.5	45	12.0		
Primary/basic	24.4	260	12.9		
Secondary	28.0	154	13.6		
Tertiary	35.1	144	13.4		
Postgraduate/professional	34.8	9	13.6		
Wealth Index deciles				12.296	<0.001
2nd decile	22.7	7	13.8		
3rd decile	20.0	13	13.5		
4th decile	20.8	11	10.3		
5th decile	21.4	43	12.9		
6th decile	22.1	64	11.9		
7th decile	25.1	85	12.6		
8th decile	23.6	64	12.7		
9th decile	27.4	113	13.2		
10th decile	34.5	207	13.5		
Level of teacher's training				21.929	<0.001
Pupil teacher/secondary	27.8	70	13.6		
Teacher training diploma	20.9	163	10.6		
Non-professional graduate	31.3	129	13.6		
Professional graduate	30.7	253	14.3		

4.6.3 Comparing Educational Level of Caregiver and RSPM Scores

Table 4.17 shows the association between mean RSPM scores of children with different levels of caregiver education.

There was no significant difference in the mean scores of those whose caregivers' highest level of education was primary school versus those with no formal education at all (p= 0.674), as well as those with secondary education (p= 0.450). There was no difference between 'tertiary level' and 'postgraduate level' (p= 0.937) education of caregiver. There was a statistically significant difference between 'primary education' and 'secondary' (p= 0.007), 'tertiary' (p< 0.001) and 'postgraduate' (p= 0.020) levels of education of caregivers.

There was a statistically significant difference in the mean scores of those whose caregivers' highest level of education was tertiary (p<0.001) versus those with no formal education, as well as post-graduate level (p<0.001) versus those with no formal education.

There was however no statistically significant difference between secondary level of education of caregivers and postgraduate level (p= 0.132).

TABLE 4.17 Association between Mean RSPM scores of children with highest level of caregiver education (N= 614)

Level of education of caregiver	Level of education of caregiver (2)	Mean difference	P-value
None	Primary/basic	-.893	0.674
	Secondary	-4.476	0.45
	Tertiary	-11.621	**<0.001**
	Postgraduate/professional qualification	_11.267	**<0.001**
Primary/basic	secondary	-3.583	**0.007**
	Tertiary	-10.728	**<0.001**
	Postgraduate/professional qualification	-10.374	**0.020**
Secondary	Tertiary	-7.145	**<0.001**
	Postgraduate/professional qualification	-6.791	0.132
Tertiary	Postgraduate/professional qualification	0.354	0.937

4.6.4 Comparing the International Wealth Index Score and the Mean RSPM Raw Scores

Table 4.18 looks at associations between socioeconomic status as measured by the International Wealth Index and IQ as measured by RSPM scores.

The result shows comparisons of the 10th decile- the highest decile- with every other decile, as well as the lowest recorded decile- the 2nd decile- with every other decile. Participants in the 10th decile showed statistically significant differences in RSPM scores with children in every other Decile. For children in the lowest decile- the 2nd decile- there was no difference in their mean IQ scores compared to every other decile except the highest decile. The trend appears to be that high scores in RSPM, which are statistically significant, tend to cluster in the highest wealth index decile. All other deciles did not show much difference between themselves in terms of performance on RSPM.

TABLE 4.18 The Association of the mean RSPM scores of children with the International Wealth Index deciles using (N= 614)

Wealth Index deciles	Wealth index deciles (2)	Mean difference	P-value
10th decile (90-100)	2nd decile (10-19.99)	11.803	0.018
	3rd decile (20-29.99)	14.517	<0.001
	4th decile (30-39.99)	13.699	<0.001
	5th decile (40-49.99)	12.744	<0.001
	6th decile (50-59.99)	12.454	<0.001
	7th decile (60-69.99)	9.411	<0.001
	8th decile (70-79.99)	10.908	<0.001
	9th decile (80-89.99)	7.074	<0.001
2nd decile	3rd decile	2.714	0.655
	4th decile	1.896	0.762
	5th decile	0.942	0.858
	6th decile	0.652	0.900
	7th decile	-2.392	0.639
	8th decile	-0.895	0.862
	9th decile	-4.728	0.349

4.6.5 Association of the Level of Training of Teachers and the RSPM Scores

Table 4.19 shows the association between the average level of training of the participant's teachers and the mean RSPM score of participants.

There was significant difference in the mean score of children whose teachers' average level of training was that of a secondary school level of education/pupil teacher (lowest level of training) versus those whose teachers' average level of training was teacher training college diploma (three year tertiary diploma in education; mean difference= 6.870, p<0.001). This observation also held true comparing teacher training college diploma versus both non-professional graduate (i.e. those teachers with non-education-related four year university degrees; mean difference= -10.416, p=<0.001) and professional graduate (teachers with the education related B. Ed bachelor's degree from University; mean difference= -9.766, p=<0.001).

TABLE 4.19 comparing for significant difference in mean of RSPM of children according to level of teacher training using One-way ANOVA (N= 614)

Level of teacher's training	Level of teacher's training (2)	Mean difference	P-value
Pupil teacher/secondary level	Teacher training diploma	6.870	<0.001
	Non-professional graduate	-3.546	0.070
	Professional graduate	-2.897	0.104
Teacher training diploma	Non-professional graduate	-10.416	<0.001
	Professional graduate	-9.766	<0.001
Non-professional graduate	Professional graduate	0.650	0.649

4.6.6 Multiple Linear Regression of RSPM scores in child and caregiver characteristics

Table 4.20 shows the regression coefficients from multiple linear regression of RSPM scores in child and caregiver characteristics. School variables such as student teacher ratio, location of school and teacher's training were also included. The RSPM scores significantly increased by 1.97 units for each year increase in age (95% CI = 1.67 to 2.27). Males had significantly higher mean scores compared to females (95% CI = (0.20 to 3.47) while children from private schools had over 5 units of RSPM scores compared to those from public schools (95% CI = 1.58 to 9.36). Children who leisurely read or watched educational programmes also had significantly higher mean scores (3.39 points), and children whose teachers had higher education had significantly higher scores (4.44 points). There were no significant associations for overall wealth index, student teacher ratio or school type. English as language of instruction, or being spoken at home didn't appear to influence children's IQ. Similarly non-significant results were found for access to information and caregiver's educational level.

Table 4.20: Multiple linear regression of RSPM scores on child's and caregiver socio-demographic and school variables

Variable	Regression coefficient* (β)	95% CI for β	P value
Age	1.97	1.67 to 2.27	**<0.001**
Wealth index score	0.03	-0.03 to 0.09	0.355
Student teacher ratio	0.08	-0.02 to 0.17	0.107
Gender **Male vs Female**	1.83	0.20 to 3.47	**0.028**
Residence/sample Urban vs Rural	0.27	-2.75 to 2.21	0.831
Type of School Private vs Public	5.47	1.58 to 9.36	**0.006**
English spoken at home Yes vs No	2.17	-0.14 to 4.49	0.066
Leisurely reading/watching of educational programmes at home Yes vs No	3.39	1.55 to 5.24	**<0.001**
English as language of instruction Yes vs No	2.11	-1.38 to 5.61	0.236
Access to Information (library/ICT centre at school) No vs Yes	0.07	-2.39 to 2.54	0.954
Level of education of caregiver Tertiary vs Primary or Secondary	0.15	-1.83 to 2.13	0.883
Level of teacher's training Teacher training/professional graduate vs Pupil teacher/secondary	4.44	1.15 to 7.73	**0.008**

*For all categorical variables the regression coefficient is interpreted as difference in means between the two categories adjusting for the other variables.

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 DISCUSSION

This study was a cross-sectional survey done to derive normative values for the Raven's Standard Progressive Matrices (RSPM) and the Slosson Intelligence Test (SIT) among Ghanaian Children aged 6-19 years. The study also aimed to compare normative values derived from the participants to western standards (British and US norms) and the relationships that various sociodemographic factors had with performance on the two intelligence tests. There were 614 participants in the final analysis constituting 99% of the total number recruited. To the knowledge of the author, this is the first study of its kind carried out in Ghana in terms of scope and breadth.

This chapter considers the demographic characteristics of the sample population, normative data obtained and its comparisons to Western Standards, as well as possible effects of socio-demographic variables on the raw scores of the RSPM.

5.1.1 Socio-Demographic Characteristics and Mental Health Profile of the Study Participants

The mean age of 12.67 years was to be expected given the age range of 6-19 years for this study as this figure is virtually midpoint of the age range. However the greater proportion of females (54.8%) compared to males obtained in this study given consistent indicators revealing lower enrolments of girls in schools in most parts of sub Saharan Africa requires an explanation. This might be explained by the fact that in Ghana female enrolment in basic education, primary and Junior High School

(JHS) is consistently higher than males (Bentsi-Enchill, 2013; GSS, 2015) although this trend reverses at the Secondary level. Reports from Ghana reveal that in striving towards the attainment of MDG3, (Promote Gender Equality and Empower Women), there was active implementation of activities to promote girls' education, such that several regions of Ghana including the Ashanti region attained a Gender Parity Index of 1 (WHO, 2015), meaning there is no difference in the ratio of boys to girls enrolment at the basic level of education. There were more participants from urban areas (64.8%) compared to rural areas in keeping with the respective sample sizes calculated for both due to the fact that the urban population had two instruments administered (RSPM and SIT) unlike the rural sample, which had one. The sampling of this study deriving a two-third urban population is higher than the urban population in Ghana of 54% (GSS, 2015). However children in urban Ghana have an 80% primary school net attendance compared to rural Ghana (70%) (GSS, 2015). The low numbers of children who screened positive for Depression and/or Anxiety symptoms (2.8%) is also in keeping with figures obtained (2.31%) from a recent community study in Ghana which used similar instruments (Donnir et al., 2016). Depression and Anxiety known to affect processing speed and motivational disposition to solving complex cognitive problems (John Raven et al., 1998) are therefore unlikely to have affected the overall results obtained.

In terms of 'home characteristics' of the sample, majority of the participants in this study (42.4%) had their most educated caregiver with a primary level education. However, breaking this down further, children in rural areas were about twice as likely to have the most educated caregiver with primary level education (61%) compared to urban children (32.3%) (See tables in Appendix I). This trend for higher education of caregivers in urban participants, reflected in the other home factors as well, such as English spoken at home by at least one caregiver (rural= 3.7% versus urban= 28.1%) and an active leisurely reading habit or watching of educational programmes by the child (rural= 34.9% versus urban= 59.0%). Overall about one-third of the participants (33.7%) were above the 90th percentile of the International Wealth Index (IWI). The IWI is an asset based wealth index that runs from zero (no assets) to 100 (all assets) providing a uniform way of measuring wealth across place and time (Smits & Steendijk, 2015). This suggests that a third of participants were very 'wealthy', being above the 90th percentile of wealth index. This is not surprising given that urban participants had greater representation than rural participants. Furthermore, the Ashanti region in general (and Kumasi in particular) where this study was carried are known to be the main drivers of the Ghanaian economy outside of the capital Accra (Nyarko, 2014). Again the breakdown by area of abode (rural mean IWI score = 61.27, urban mean IWI score= 83.75) showed a vast disparity in between the rural and urban population Unsurprisingly greater average IWI wealth index was associated with participants in private schools and English being spoken at home as well. Anecdotal reports (and the author's own lived experience) indicate that well-to-do Ghanaian families primarily communicate in English at home with their children either exclusively or in addition to a local language making children from such households proficient bilingually. These trends demonstrate that on all recorded pertinent factors pertaining to the home factors of the child and adolescent participants in this study, rural and urban samples are different populations.

With respect to 'school characteristics', again there were significant differences observed. While English was the language of instruction of the vast majority of all schools (84%), a disproportionately large number of those in the lower primary classes (ages 6-8 years) reported having the local language as the language of instruction (local language = 44%, see appendix I), and this was almost exclusively in the rural primary schools. The language of instruction in schools especially in the foundational years remains a controversial subject especially as several studies reveal a benefit of instruction in mother tongue at primary level (Ball, 2014). A large proportion of participants (41.6%) had access to professionally trained graduate teachers (those with a four-year University degree in education- B.Ed). However an overwhelming majority of the B.Ed teachers (78.68%) were in the urban centres, and even the rest who were in rural areas, were all found in rural secondary schools. Rural schools were further disadvantaged so far as exposure to facilities that encourage cognitive stimulation were concerned with two-thirds reporting no access to information by way of a library or functional Information Communication Technology Centre with internet access, as opposed urban schools with two-thirds reporting easy access to these facilities.

Further, when the socio-demographic analysis was broken down to the individual schools level, interesting findings emerged. Unsurprisingly schools situated in rural areas had lower wealth index than urban schools. However, even among urban schools, there were great disparities between private and public school, and indeed even so among private schools. The average wealth of two private schools situated in relatively affluent suburbs of Kumasi (IWI= 92.92) was significantly higher ($p<0.001$) than the wealth of participants from the private school in low-income areas of Kumasi (IWI= 83.23). Anum made allusion to this gross disparity even among urban so-called "private" schools when he referenced the grading system for private schools by the Ghana Education Service ('*A*' for well resourced, through to '*D*' for poorly resourced) in his earlier study using a variant of the RSPM called the Coloured Progressive Matrices among young children aged 6-11 years in Ghana (Anum, 2014), although in his study there was no empirical evidence offered to quantify the disparity as has been done in this study. There was also no statistically significant difference in the wealth index of the affluent private schools and the top tier public secondary schools like Opoku Ware School (IWI= 91.95, $p= 0.574$, see appendix). This is presumably because in Ghana, the affluent tend to send their children to well-resourced private schools at the basic education level (primary and JHS) in order for them to qualify to enter the best secondary schools which are mostly public schools. Therefore it tends to be the same high IWI children who would be able to get into top public secondary schools like Opoku Ware School. This was further confirmed when a statistically significant difference was found between the wealth index of the affluent private primary & JHS schools and low-performing public SHS schools like Kumasi Girls' SHS ($p= 0.042$), where wealthy children are known to avoid, with lower income children accessing these schools. This trend was the same regardless of which affluent school was compared to all the others. Notably, so far as wealth index was concerned, the urban public school (IWI= 63.57) was practically identical to the rural public primary schools (combined mean IWI= 60.24, F-value= 59.594, individual p-values for the three rural schools versus the one urban public school were p= 0.55, p=0.451 and p=0.298). This was the same when the urban public school was also compared with the rural secondary school, Aduman SHS (IWI= 64.30, p= 0.690). This may suggest that children of the "urban poor" have roughly a similar standard of living as rural children in this study. These differences between private affluent schools and all other schools was not limited to just the wealth index. It was also observed in comparisons of student-teacher ratios that the two affluent schools, Nagies Educational and Angel School, with low student-teacher ratios were similar to each other (p=0.426, i.e. no significant difference in their respective student-teacher ratios) and different from all rural basic schools (p<0.001) and urban public schools (p<0.001) with higher ratios.

5.1.2 Internal Consistency of the Raven's Standard Progressive Matrices

The very high Cronbach's alpha (alpha 0.954) of the RSPM reveals excellent internal consistency of this intelligence test, strong correlations between the 60 items on this instrument and indication of its reliability (John Raven et al., 1998). The strongly positive Pearson's Correlation Coefficient (Pearson coefficient 0.722) between RSPM, a performance focused and non-verbal intelligence test and the SIT, a verbal intelligence test also lend strong external evidence to the two instruments' validity in measuring what it purports to measure among Ghanaian children (Slosson et al., 1991).

5.1.3 Normative Data for Raven's Standard Progressive Matrices and Slosson Intelligence Test and Comparison to British and US Normative Data

The normative data for the Raven's Standard Progressive Matrices and the Slosson Intelligence Test with their age-specific mean scores and standard deviations revealed an expected general trend upwards as age advanced. Rural children scored lower than urban children and public school children scored lower than private school children, except in the older adolescent category (ages 15-19) where the trend was rather the reverse with public school adolescents scoring higher than private school adolescents. This observed reversal of performance in the age 16-19 years age category was true for both RSPM and SIT. This is presumably due to the phenomenon of the better performing affluent private primary school children entering the various top-grade public secondary schools that had been alluded to in the previous section. Apart from this difference, the performance on the testing instruments generally tended to follow the trends observed regarding the various socio-demographic factors above according to area of abode, 'home characteristics' and 'school characteristics'. This will be further elaborated upon.

In comparing the normative data to Western standards though, some interesting observations were made. Overall, the Ghanaian norms were significantly lower than British norms at every age-cell ($p<0.001$ on average). This was also the result obtained in an earlier Ghanaian study using the Raven's Coloured Progressive Matrices (a variant of RSPM) among children aged 6-11 years (Anum, 2014). This has also been the general trend in most studies carried out in sub-Saharan Africa where children have scored significantly lower in the RSPM compared to their British counterparts (Al-Shahomee, 2012; CrawfordNutt, 1976; Owen, 1992; Rushton et al., 2004; Skuy et al., 2002; Venter & Bham, 2003; Wicherts et al., 2010).

However, when one begins to peel beneath the surface, an interesting picture begins to emerge. First, considering just urban scores, there appeared to be no statistically significant differences at age six (t-test= 1.505, $p=0.153$). This was also the case in the study by Anum (Anum, 2014) where urban six-and-half year olds had a mean score of 13 in the local study just as in the British norms. The pulling apart begins to happen however from age 7 onwards (see figure 5.1 below). Could this apparent baseline ability among six-year olds perhaps be the '*nature*' effect referred to in the literature (Bouchard Jr, 1997; Bouchard, 1983; Flynn, 2007; Hunt, 1995; Hunt & Carlson, 2007), with environmental factors exerting their influence later? Work done by Aina and colleague in Nigeria, assessing infants aged 8 weeks – 30 months for psychomotor development using the Bayley Scales of Infant Development and other instruments would seem to suggest this, as they found above-normal performance of the subjects in all five fields compared to western norms (O. Aina & Morakinyo, 2005). In other words, African children at a very young age appear to show no disadvantage to their western counterparts in terms of cognitive, physical and social development, until a little later in their childhood when significant differences start to set in. It would be instructive to see what future research on the cognitive, physical and social development of African children in the critical period of early childhood to adolescence will turn up to refute or support this observation.

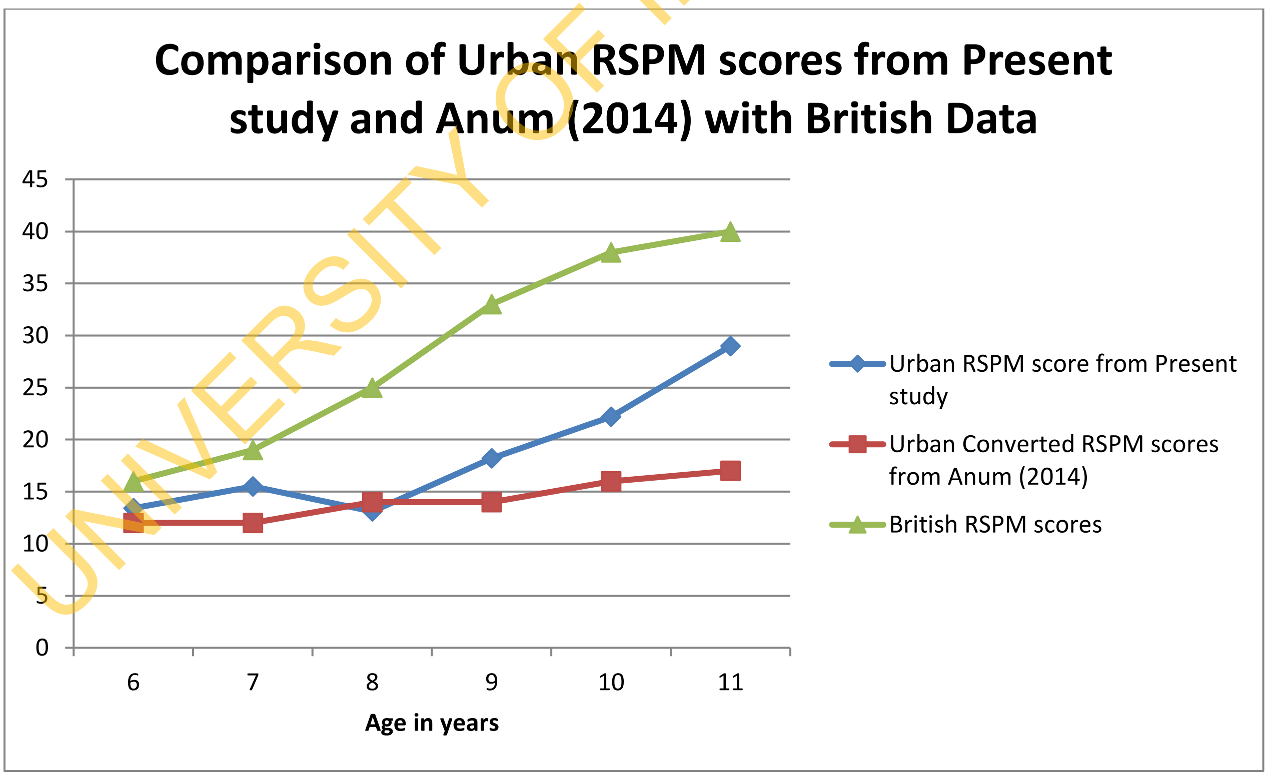
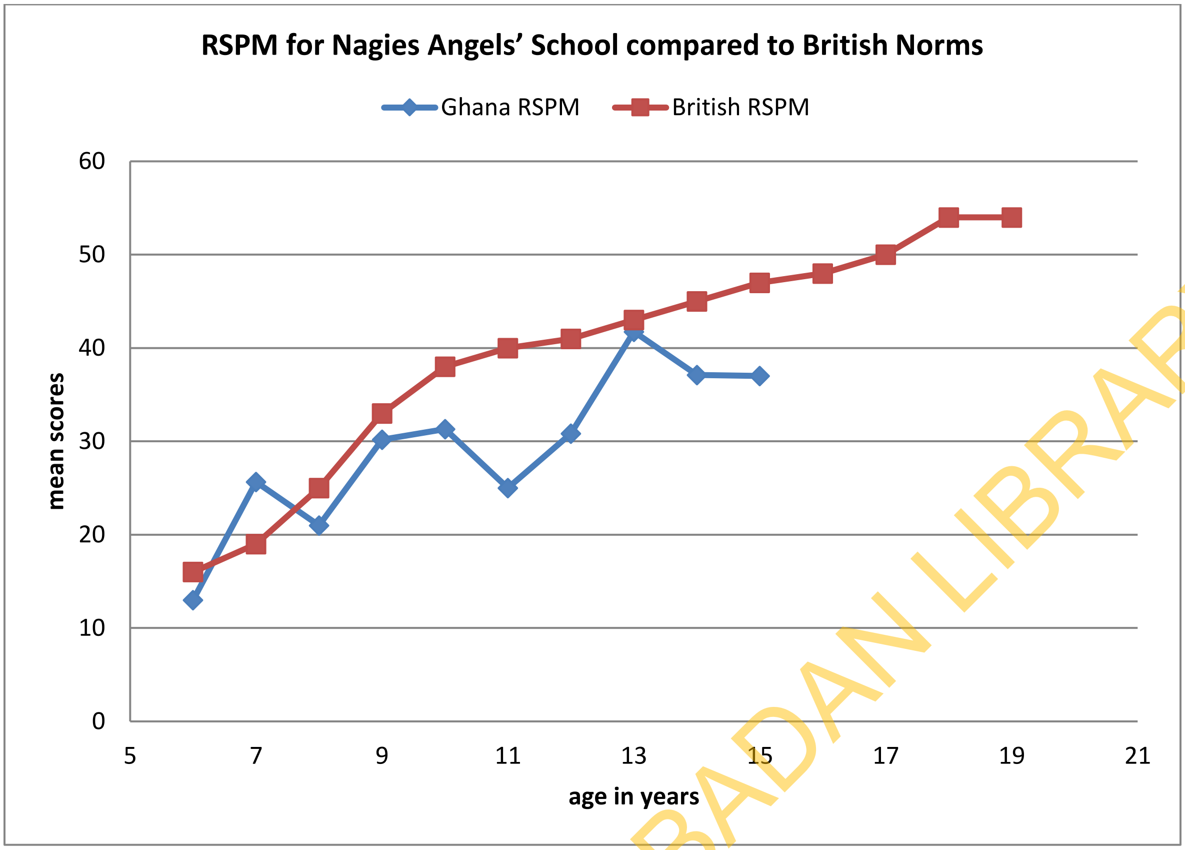


Figure 5.1 showing a comparison of Urban RSPM scores in the Present study, Anum (2014) and British Norms

It must be noted though that in Anum's study the scores tended to be on the low side (regardless of whether it was a rural or urban sample- see figure 5.1 above) compared to the data obtained from this present study (Anum, 2014). This was likely because, even though he had a large sample size (n= 743) his sampling technique was convenient 'purposive' sampling and clustered around roughly the same "urban poor" area of Accra (personal correspondence (Anum, 2016)).

In considering the rural sample however the gap is wide right from the beginning. Had it not been for the depressing effect of the rural scores (and indeed, the 'urban poor' scores as well) on the overall score, it is reasonable to think that the norms derived from Ghana would be quite comparable to western norms. The problem therefore would seem to be something environmental that appears to exert a stronger and stronger effect on cognitive abilities as the years go by. Whatever environmental factor it is, it may be less strong an influence the more urban/affluent the settings. This position would be supported by the work of others in South Africa, (Rushton et al., 2004; Shuttleworth-Edwards et al., 2004) Senegal and elsewhere in Africa (Bellamy & UNICEF, 2005; OLNESS, 2003) where strong environmental factors associated with poverty and rural living such as malnutrition, perinatal injuries, Malaria and other insults to the brain were associated with poor cognitive function.

Indeed to buttress the point about the relationship between poverty/wealth, standard of living and performance on intelligence testing, the results from one of the private affluent schools, Nagies Educational Complex, is here reproduced (see figure 4.9 below). There was no statistically significant difference in mean scores for children of ages 7, 8, 9, 10 and 13 when compared to British norms. In fact, for age 7 mean score was actually higher than the British mean score for same age (mean Ghana score = 25.67, British norm= 19).



Reproduction of Figures 4.9: Mean Scores for Nagies Angels' School Participants compared to British Norms

This trend was similar to the other private school serving an affluent neighbourhood. This trend is buttressed by data from elsewhere in Africa such as in Nigeria where well-to-do children from a Lagos suburb did significantly better than rural children and just as well comparative to western norms (Ashem & Janes, 1978). The difference in performance on IQ testing associated with different sub-population groups is quite well documented. The question now is: why?

5.1.4 Possible Effect of Socio-Demographic Variables on Raw Scores of Raven's Standard Progressive Matrices

Already, the picture emerging from this study appears to be one in which environmental factors play a very important role on cognitive ability. Given the relative genetic homogeneity within the Ghanaian population (the various ethnic groupings have peacefully co-existed and inter-married since the early 14th century (Miller, Vandome, & McBrewster, 2009) any differences observed among different sub-groups would therefore be more likely due to environmental differences rather than genetic differences. It is in this light that an in-depth analysis and discussion of the different socio-demographic factors characterising the different sub-populations becomes a useful exercise in trying to understand the possible reasons why these differences in cognitive ability exist.

After bivariate analysis, significant differences were found among almost all factors analysed, except for sex. This would be in keeping with the literature reviewed for this work which showed no significant differences in IQ by way of gender, but clear differences in all the other factors analysed. The differences in RSPM scores of children whose caregivers were relatively better educated compared to those who were less educated (e.g. mean difference in scores between tertiary level and no education (-11.621, $p<0.001$), primary level (-10.728, $p<0.001$) and secondary level (-7.145, $p<0.001$) was quite telling. Indeed this difference in mean RSPM score was also significantly different when primary level education of caregivers was compared with even secondary level of education of caregiver (mean difference = -3.583, p= 0.007). The role of caregivers in practicing positive child rearing practices that enhance cognitive development and mental well-being have been documented within the African context (OO Omigbodun & Olatawura, 2008). The better educated the caregiver is, the more likely they are to practice some of these child-rearing practices. Also, generally speaking, the better educated a caregiver is, the wealthier they are likely to be. Further discussion of this observation would be done shortly.

Speaking of wealth, again direct analysis of wealth index and IQ scores revealed a strong relationship between the two. Although Pearson correlation analysis revealed a weak positive direct correlation (0.323), and further multiple linear regression also showed no significant association when controlling for other variables, the relationship between the two would seem to be more complex than this simple analysis suggests. In the first place the IWI wealth index instrument used appeared to cluster most of the participants on the higher end of socioeconomic well-being (more than 50% of participants were above the 50^{th} percentile), perhaps because of the high levels of world poverty the instrument was originally designed for. As such, while giving a good broad overview of the socioeconomic well-being of the sample, it probably did not capture the nuances of standard of living that existed within the sample population. For example, one of the items asked about in the IWI instrument was the possession (or lack) of a car by the household, without any provision being made for the wide varieties of type, make and total numbers of vehicles (and thus the greater/lower value of vehicle) that might pertain in different households. This "bunching up" of the majority of participants in a relatively small section of the wealth index (an effect even warned about by the developers of the instrument (Smits & Steendijk, 2015)) may provide a possible explanation for why no strong correlation was found between IQ scores and standard of living.

Having noted the above, it is however noteworthy to observe that in spite of the shortcomings of the IWI wealth index instrument, it did pick up some significant differences in the IQ scores of participants as relates to their standard of living. For those from households in the 10th decile (above the 90th percentile or within the top 10% most wealthy) there was a statistically significant difference in the mean RSPM scores and every other decile. The opposite was true for those in the lowest decile (below the 20th percentile). For them, their average scores showed no statistical difference with that of every other decile going all the way up to even the 9th decile (those between the 80th to 90th percentiles); it was only the top 10% wealthy where a statistically significant difference was found in IQ scores. The trend therefore appeared to be that high scorers in RSPM which are statistically significant tended to cluster among the children of the wealthiest, but below the threshold of the 90th percentile of wealth, no significant difference was observed in IQ scores irrespective of whatever wealth decile one occupied. This observation was probably why an analysis of overall wealth index did not seem to show any association with IQ.

Perhaps this would suggest that indeed, as all the literature seems to suggest, wealth and the improved standard of living it affords does play a significant role in cognitive development, but not at all levels of wealth. Its effect would appear to be exerted significantly only beyond a certain threshold. This hypothesis may find support in the observation by Flynn that historically western IQ scores appeared to have been depressed (Flynn, 1987) and at levels comparable to current levels seen across Africa (Wicherts et al., 2010) until western standards of living improved a generation or so later resulting in an increase in average IQs of about 1 standard deviation across board (Wicherts et al., 2010), the so-called *Flynn Effect*. It would also be supported by the observed gradual rise in IQ scores in Kenya as the GDP of that East African economic powerhouse has increased (Daley et al., 2003).

If the effect of wealth and improved standard of living is to be accepted, it would explain a lot of other factors shown in the literature to have strong effects on cognitive function. Wealth brings improved nutrition particularly within the African context where the disparities are huge (O. O. Omigbodun et al., 2010). Indeed, rural children could differ by as much as two standard deviations below the western standard so far as height, being underweight and other measures of nutritional status was concerned (O. O. Omigbodun et al., 2010). The effect of nutritional factors such as iodine and iron on cognitive ability has been well documented (Brown & Pollitt, 1996).

Wealth also brings better education and school resources and positive child-rearing practices such as encouraging the natural curiosity and exploration of children rather than the traditional tendency to silence them as is the case in many (rural) African settings (OO Omigbodun & Olatawura, 2008). This thus tends to lead to greater cognitive stimulation from an early age typically by educated caregivers, who generally encourage such activities as active reading habits and watching of highly educative programmes, increased access to information through internet access or books, and other cognitively stimulating activities.

It is therefore no surprise that increasing levels of teacher training appeared to be associated with better IQ scores. Bivariate analysis showed a significant difference in the scores of children whose teachers' average level of training was relatively lower (e.g., 'pupil teacher' which is a teacher with only a secondary level of education and no formal training in the teaching profession) versus children with better trained teachers (say, a teacher with a three year teacher training diploma, or a graduate teacher with a four year professional training by way of a B.Ed degree from a University). Indeed further multiple linear regression analysis showed that even when we controlled for all other factors (including wealth index, age, type of school (private/public) and area of abode (rural/urban) among others), higher level of training of teachers was associated with significantly higher IQ scores than lower (4.44 score points). As to whether this was causative or not can only be speculated at present. However, the association is certainly present. This again goes back to the argument about early cognitive stimulation by one's environment to increase cognitive ability significantly. It also shows another way in which affluence will tend to foster improved IQ in such settings: the rich can afford good schools where even primary school children are taught by professional graduate teachers (as actually pertains in the two affluent schools in this study- Nagies Educational and Angel Educational Complex).

Of the remaining variables not yet discussed, multiple linear regression models showed an association between increasing age and RSPM scores independent of all other variables (increase of 1.97 units for each year of increase in age) as expected. Private school children also tended to do better than public school children by as much as 5 units of RSPM, even when all other variables were controlled for. Interestingly a leisurely reading habit was also associated with a 4.44 point increase in IQ scores over and above other variables (including increasing age, wealth index and type of school), lending further evidence to the notion that cognitive stimulation of any kind in and of itself leads to improved eductive ability in particular (John Raven et al., 1998) and cognitive ability in general. Also, surprisingly, English as the language of instruction at school was independently associated with a 3.12 point increase in RSPM score (95% CI = 0.247 to 6.180) controlling for the effect of other variables (such as level of teacher training, access to information type of school). Given that the RSPM and other such 'matrix reasoning' tests have been touted as "culture fair" tests which require no language to answer the questions (John Raven et al., 1998) it is quite a curious finding indeed and would warrant further investigation to ascertain the reasons behind this. Perhaps even the 'matrix reasoning' test is not as "culture fair" as previously thought? Another curious anomaly observed though was the fact that from bivariate analysis gender appeared to have no influence on RSPM scores (as also supported by the literature), however in the multiple logistic regression model there seemed to be a higher mean score for males compared to females (95% CI = 0.20 to 3.47).

The remaining 'home characteristics' such as education level of caregiver, language spoken at home, and such 'school factors' as student-teacher ratio, access to information and school type although showing significant difference of mean RSPM scores on bivariate analysis (as discussed above), lost their significance in multiple linear regression when other variables (including wealth index) were controlled for. For language spoken at home though, English as the 'home language' came quite close to statistical significance independent of all other variables in affecting RSPM scores ($p = 0.053$), and this would have been in keeping with both the literature as well as the finding of significance in the use of English at school as the language of instruction on RSPM scores. Perhaps these were also casualties of the wealth index instrument flaw whose (real) influence on RSPM scores (as suggested by the literature (see (Rushton & Skuy, 2000; Rushton et al., 2004; Skuy et al., 2000)) were filtered out secondary to the failure of the IWI instrument to adequately demonstrate the effect of standard of living on IQ.

Strengths of this study included the fact that the study design incorporated a lot more assessment of sociodemographic factors (such as quantifying wealth index as a measure of the socioeconomic status among other things) than other similar studies in order to begin the conversation in Ghana as to why certain sub-groups did better than others. Also it used two easy-to-administer instruments- one for Verbal IQ, the other for Performance IQ- that need minimal training to administer and can easily be used by non-specialists, and as such reduced the possibility of inaccurate assessment as a confounder of the data. It also allowed for the instruments to be compared with each other using Pearson's correlation. The selection process of participants was truly random and as such the results are fairly generalizable. Further, a wide age range from ages 6 to 19 were included in this study unlike the previous study which had a range of 6-11 years

Limitations of this study included the sample size which although sizeable, was rather on the low side for a normative study. As such not all age-cells could be adequately filled to enable robust analysis for each sub-group within the rural and urban populations. Also the single geographical region of the study site was a further limitation. Although broadly representative of the national character, better generalizability could have been aimed for if wider coverage was achieved through multiple sites across the country. Finally, the Language limitations preventing the administration of the Slosson to a wider more nationally representative sample instead of just a skewed sample of urban private school children who speak good English were also a limitation.

Research Questions answered include the mean score and standard deviations for the RSPM and SIT by age-cells, whether there is a correlation between RSPM and SIT, and associations between RSPM scores and various socio-demographic factors.

5.3 CONCLUSIONS

This study was the first attempt to standardize the Raven's Standard Progressive Matrices and the Slosson Intelligence Test in Ghana across the wide age range of ages 6-19 years. The significantly different results obtained from western norms underscore the need for local normative data on all psychometric instruments in order to be able to make meaningful conclusions from them. Also, the different results obtained within the Ghanaian samples according to specific sub-groups which largely connected to standard of living seems to suggest that for developing countries at least, the socioeconomic disparities are so wide as to cause a section of the population to take on the characteristics (including cognitive abilities) of more western populations, while another section of the population takes on characteristics usually associated with "African populations". This would seem to warrant the calls for different normative data for different socioeconomic sub-groups within the national population of developing countries like Ghana, for the very same reason local normative data are recommended rather than importing western normative data.

The findings of this study have therefore also supported the strong case for the effect of environmental factors on IQ scores over and above so-called genetic factors as argued by others. This is buttressed by the fact that the Ghanaian sample came from the same genetic pool and as such the significant differences can only be attributed to the environmental differences that exist for different children. Indeed, the finding that the private affluent schools did generally as well as British and American children with only minor lapses lends credence to the notion that with improved standards of living, African societies can also begin to improve their cognitive abilities and overall mental health as has been demonstrated already with the Flynn Effect in Kenya.

In light of these findings, one can therefore confidently make the following conclusion: development of eductive ability and by extension general intelligence is heavily influenced by the environment and is therefore not immutable. One is not "born smart" so much as one "*becomes* smart". Interventions therefore in improving the quality of education and the standard of living of African populations takes on an even greater urgency, as the quality of thinking of a country's future leaders (and therefore the quality of decisions made for the country) quite literally depends on it.

5.4 RECOMMENDATIONS

1. Additional studies with larger sample sizes are required to replicate and further solidify the findings here, particularly so for the Slosson Intelligence Test
2. Clinicians and researchers in Ghana begin to use these locally derived normative data in everyday clinical work and research, until such a time as better normative data are available, so as to have more accurate assessments of intelligence relevant to the local context.

3. Subsequent studies should explore further the relationships between standard of living and IQ using purposefully chosen samples from different socio-demographic schools, and also focus on the apparent transition 'window period' between ages 4 to about 10 years to ascertain whether or not environmental factors begin to exert their influence on cognitive ability at a certain period of time, and beyond a certain threshold of standard of living.

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APPENDIX 1: Additional tables

TABLE 1. Comparison of IWI score between 'affluent' private primary school VS 'low-income' urban private and urban public school

Specific type of school	**Specific type of school (2)**	**Mean difference**	**P-value**
Affluent urban private	Rural public basic	32.67	<0.001
	Low cost urban private	9.69	<0.001
	Urban public basic	29.60	**<0.001**
Urban public basic	Rural public basic	3.07	**0.140**
	Low cost urban private	-19.91	**<0.001**

TABLE 2 Home characteristics for Rural Sample

Variable	Frequency	Percentage %
Level of education of most educated caregiver		
No Formal Education	21	9.6
Primary	133	61.0
Secondary	45	20.6
Tertiary	17	7.8
Postgraduate/Professional	0	0
Total	216	100
English spoken at home		
Yes	8	3.7
No	210	96.3
Total		
Leisurely reading & watching educational programmes at home		
Yes	**76**	**34.9**
No	**142**	**65.1**
Total		
Socioeconomic Status as estimated by IWI deciles		
2nd decile (10-19.99)	**6**	**2.8**
3rd decile (20-29.99)	**10**	**4.7**
4th decile (30-39.99)	**10**	**4.7**
5th decile (40-49.99)	**33**	**15.5**
6th decile (50-59.99)	**41**	**19.2**
7th decile (60-69.99)	**44**	**20.7**
8th decile (70-79.99)	**30**	**14.1**
9th decile (80-89.99)	**29**	**13.6**
10th decile (90-100)	**10**	**4.7**
Total	**213**	**100**

TABLE 3 Home characteristics for Urban sample

Variable	Frequency	Percentage %
Level of education of most educated caregiver		
No Formal Education	**26**	6.5
Primary	130	32.3
Secondary	109	27.1
Tertiary	127	31.6
Postgraduate/Professional	9	2.2
Total	401	99.8
English spoken at home		
Yes	113	28.1
No	289	71.9
Total	402	100
Leisurely reading & watching educational programmes at home		
Yes	**237**	**59.0**
No	**164**	**40.8**
Total	**401**	**99.8**
Socioeconomic Status as estimated by IWI deciles		
2nd decile (10-19.99)	**1**	**0.2**
3rd decile (20-29.99)	**3**	**0.7**
4th decile (30-39.99)	**1**	**0.2**
5th decile (40-49.99)	**12**	**3.0**
6th decile (50-59.99)	**23**	**5.7**
7th decile (60-69.99)	**42**	**10.4**
8th decile (70-79.99)	**35**	**8.7**
9th decile (80-89.99)	**85**	**21.1**
10th decile (90-100)	**198**	**49.5**
Total	**400**	**100**

TABLE 4 School characteristics of Rural Sample

Variable	Frequency	Percentage %
Level of teachers' training		
Pupil teacher/secondary level	**0**	**0**
Teacher training Diploma	**163**	**74.8**
Non-professional Graduate teacher	**0**	**0**
Professional Graduate Teacher	**55**	**25.2**
Total	**218**	**100**
English as language of instruction		
No	**36**	**16.5**
Yes	**182**	**83.5**
Total	**218**	**100**
Access to information		
No	**139**	**63.8**
Yes	**79**	**36.2**
Total	**218**	**100**

TABLE 5 School Characteristics of Urban sample

Variable	Frequency	Percentage %
Level of teachers' training		
Pupil teacher/secondary level	**70**	**17.4**
Teacher training Diploma	**0**	**0**
Non-professional Graduate teacher	**129**	**32.1**
Professional Graduate Teacher	**203**	**50.5**
Total		
English as language of instruction		
No	**63**	**15.7**
Yes	**339**	**84.3**
Total	**402**	**100**
Access to information		
No	**155**	**38.6**
Yes	**247**	**61.4**
Total	**402**	**100**

TABLE 6 IWI Index calculation table

To compute the IWI wealth index, every answer of 'yes' to each consumer durable was noted. Then the consumer durable's corresponding IWI formula weight was added up together with the constant (IWI formula weight of 25.004470) to give a total IWI composite score.

Consumer durables	**IWI Formula weight**
Television	8.612657
Refrigerator	8.429076
Phone	7.127699
Car	4.651382
Bicycle	1.846860
Cheap utensils	4.118394
Expensive utensils	6.507283
Housing characteristics	
Floor material: *Low quality* *Medium quality* *High quality*	 -7.558471 1.227531 6.107428
Toilet facility: *Low quality* *Medium quality* *High quality*	 -7.439841 -1.090393 8.140637
Number of rooms: *Zero or one* *Two* *Three or more*	 -3.699681 0.384050 3.445009
Public utilities	
Access to electricity	8.056664
Water source: *Low quality* *Medium quality* *High quality*	 -6.306477 -2.302023 7.952443
Constant	**25.004470**
Minimum value	0
Maximum value	100

APPENDIX II: STUDY INSTRUMENTS

NORMATIVE DATA ON THE RAVEN'S STANDARD PROGRESSIVE MATRICES AND THE SLOSSON INTELLIGENCE TEST AMONG GHANAIAN CHILDREN

DATA SUMMARY SHEET

Serial Number:______ __
Today's Date: ____/____/__ __

MODIFIED SCHOOL HEALTH QUESTIONNAIRE IN ENGLISH

Please write the answers to the questions or draw a circle where it applies to you. This is not an examination it is only to find out about you and your health.

SECTION I
Personal Information

1. Name of School:
2. Type of School: Public_______ Private:______
3. Residence/Sample: Rural: _____ Urban:_______
4. What is your date of birth? Date of Birth: _____ ______ ________
   Day Month Year
5. How old are you?____
6. Are you a boy or a girl? (a) boy (b) girl

SECTION II
Family Information

7. Level of education of most highly educated caregiver/parent/guardian:
   i. None:___
   ii. Primary/JSS/Middle School:____
   iii. Secondary School/Standard 7:_____
   iv. Tertiary (Training College/Poly/University (1st degree):____
   v. Post-graduate/Professional qualification:____

8. Is English regularly spoken at home with respondent: Yes:____ No:____

9. Do you of your own accord read at least one book per term or watch at least one educational TV programme per week: Yes:____ No:____

10. Does your family own the following items:

    a. Television set: Yes___ No___

    b. Refrigerator: Yes___ No___

    c. Phone (mobile/landline): Yes___ No___

    d. Bicycle: Yes___ No___

    e. Car: Yes___ No___

    f. Cheap utensils (eg table, clock/watch, kettle, radio, standing fan, blender etc, any items under Gh₵200 worth): Yes___ No___

    g. Expensive utensils (e.g. washing machine, computer/tablet, motorbike, air conditioner, generator etc items worth over Gh₵1000): Yes___ No___

11. Does your family have access to electricity: Yes___ No___

12. What is your source of drinking water:

    a. Low quality (eg surface water body, borehole, unprotected well):___

    b. Medium quality (e.g. public tap, protected well, water tanker):___

    c. High quality (e.g. private tap water, bottled/sachet water):____

13. What type of toilet facility do you have at home:

    a. Low quality (e.g. no toilet/free range, pit latrine):___

    b. Medium quality (e.g. public toilet, KVIP):___

    c. High quality (e.g. private flush toilet):___

14. What material is your floor at home made of:

    a. Low quality (e.g. none, earth, dung etc):___

    b. Medium quality (e.g. cement, concrete, raw wood etc):___

    c. High quality (e.g. finished floor, carpet, terrazzo, tiles, ceramic etc):___

15. How many sleeping rooms are there in your house:

    a. 0 or 1 sleeping room:___

b. 2 sleeping rooms: ___

c. 3 or more sleeping rooms:____

16. IWI score:______

17. IWI quintile:_______

SECTION III
School Information (FOR OFFICIAL USE ONLY)

18. Average level of training of respondent's teachers:

    a. None___

    b. Pupil teacher/secondary___

    c. Teacher training college___

    d. Graduate teacher:___

19. Main language of instruction of child:

    a. English___

    b. Vernacular___

20. Access to information at school:

    a. Stocked Library___

    b. Functional ICT Centre___

    c. Other (specify)____

    d. None of the above:____

21. Student-teacher ratio of class of respondent:____

22. Co-morbidity:________

23. RSPM Score:______

24. SIT Score:______

PATIENT HEALTH QUESTIONNAIRE (PHQ)

This questionnaire is an important part of providing you with the best health care possible. Your answers will help in understanding problems that you may have. Please answer every question to the best of your ability unless you are requested to skip over a question.

Name________________________ **Age**_____ **Sex:** **Female** **Male** **Today's Date**________

1. During the <u>last 4 weeks</u>, how much have you been bothered by any of the following problems?	**Not bothered**	**Bothered a little**	**Bothered a lot**
a. Stomach pain			
b. Back pain			
c. Pain in your arms, legs, or joints (knees, hips, etc.)			
d. Menstrual cramps or other problems with your periods			
e. Pain or problems during sexual intercourse			
f. Headaches			
g. Chest pain			
h. Dizziness			
i. Fainting spells			
j. Feeling your heart pound or race			
k. Shortness of breath			
l. Constipation, loose bowels, or diarrhea			
m. Nausea, gas, or indigestion			

2. Over the <u>last 2 weeks</u>, how often have you been bothered by any of the following problems?	**Not at all**	**Several days**	**More than half the days**	**Nearly every day**
a. Little interest or pleasure in doing things				
b. Feeling down, depressed, or hopeless				
c. Trouble falling or staying asleep, or sleeping too much				
d. Feeling tired or having little energy				
e. Poor appetite or overeating				
f. Feeling bad about yourself — or that you are a failure or have let yourself or your family down				
g. Trouble concentrating on things, such as reading the newspaper or watching television				

h. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual

i. Thoughts that you would be better off dead or of hurting yourself in some way

FOR OFFICE CODING: Som Dis if at least 3 of #1a-m are "a lot" and lack an adequate biol explanation.
Maj Dep Syn if answers to #2a or b and five or more of #2a-i are at least "More than half the days" (count #2i if present at all).
Other Dep Syn if #2a or b and two, three, or four of #2a-i are at least "More than half the days" (count #2i if present at all).

PHQ 1/3

3. **Questions about anxiety.**		
a. In the last 4 weeks, have you had an anxiety attack — suddenly feeling fear or panic?	**NO**	**YES**
If you checked "NO", go to question #5.		
b. Has this ever happened before?		
c. Do some of these attacks come suddenly out of the blue — that is, in situations where you don't expect to be nervous or uncomfortable?		
d. Do these attacks bother you a lot or are you worried about having another attack?		

4. **Think about your last bad anxiety attack.**	**NO**	**YES**
a. Were you short of breath?		
b. Did your heart race, pound, or skip?		
c. Did you have chest pain or pressure?		
d. Did you sweat?		
e. Did you feel as if you were choking?		
f. Did you have hot flashes or chills?		
g. Did you have nausea or an upset stomach, or the feeling that you were going to have diarrhea?		
h. Did you feel dizzy, unsteady, or faint?		
i. Did you have tingling or numbness in parts of your body?...		
j. Did you tremble or shake?		
k. Were you afraid you were dying?		

5. **Over the last 4 weeks, how often have you been bothered by any of the following problems?**	**Not at all**	**Several days**	**More than half the days**
a. Feeling nervous, anxious, on edge, or worrying a lot about different things.			
If you checked "Not at all", go to question #6.			
b. Feeling restless so that it is hard to sit still.			
c. Getting tired very easily.			
d. Muscle tension, aches, or soreness.			
e. Trouble falling asleep or staying asleep.			
f. Trouble concentrating on things, such as reading a book or watching TV.			
g. Becoming easily annoyed or irritable.			

FOR OFFICE CODING: Pan Syn if all of #3a-d are 'YES' and four or more of #4a-k are 'YES'. Other Anx Syn if #5a and answers to three or more of #5b-g are "More than half the days".

6. Questions about eating. **a.** Do you often feel that you can't control what or how much you eat?	**NO**	**YES**
b. Do you often eat, within any 2-hour period, what most people would regard as an unusually large amount of food?		
If you checked "NO" to either #a or #b, go to question #9.		
c. Has this been as often, on average, as twice a week for the last 3 months?		
7. In the last 3 months have you often done any of the following in order to avoid gaining weight?	**NO**	**YES**
a. Made yourself vomit?		
b. Took more than twice the recommended dose of laxatives?		
c. Fasted — not eaten anything at all for at least 24 hours?		
d. Exercised for more than an hour specifically to avoid gaining weight after binge eating?		
8. If you checked "YES" to any of these ways of avoiding gaining weight, were any as often, on average, as twice a week?	**NO**	**YES**
9. Do you ever drink alcohol (including beer or wine)?	**NO**	**YES**
If you checked "NO" go to question #11.		
10. Have any of the following happened to you more than once in the last 6 months?	**NO**	**YES**
a. You drank alcohol even though a doctor suggested that you stop drinking because of a problem with your health.		
b. You drank alcohol, were high from alcohol, or hung over while you were working, going to school, or taking care of children or other responsibilities.		
c. You missed or were late for work, school, or other activities because you were drinking or hung over.		
d. You had a problem getting along with other people while you were drinking.		
e. You drove a car after having several drinks or after drinking too much.		

11. If you checked off any problems on this questionnaire, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult

FOR OFFICE CODING: Bul Ner if #6a,b, and-c and #8 are all 'YES'; Bin Eat Dis the same but #8 either 'NO' or left blank.
Alc Abu if any of #10a-e is 'YES'.

PATIENT HEALTH QUESTIONNAIRE - 9

(PHQ-9)

TWI VERSION

Instructions

Fa nkanko fa mmuay0 a 0fata ma ns0mfua a edidi so4 yi ho.

Naw4twe mmienu a etwaa mu yi, nne0ma a edidi so4 yi bi ha w'adwene anaa?

		Amma no saa koraa	Nna bebree b0y0 nnafua nson	Nna no boroo nnafua nson	Nna no nnyinaa
1	Anigye0 anaa ahomka amma w'adey4 mu	0	1	2	3
2	Awer0ho4 kaa wo a na anidaso4 asa	0	1	2	3
3	Nna ho b0y00 den, anaa nna no boroo so	0	1	2	3
4	$ber0 mmoroso4 baa y0, anaa w'aho4den so tee mmoroso4	0	1	2	3
5	Adidi mmoroso4 baa y0, anaa w'anum to y0	0	1	2	3
6	Yaw die bi baa y0, anaa 0y0 wo s0 w'adi wo ho anaa w'abusuafo4 hwamm4	0	1	2	3
7	)y00 den s0 wode w'adwene besi nno4ma worey0 bi so te s0, kowaa nkrataa akenkan anaa kasafonini (e. g. TV)	0	1	2	3
8	Obi b44 wo nkaye0 s0 wo kasa anaa wo nante0 ay0 nyaa	0	1	2	3
9	Adwene bi sii wo tiri mu s0, wo nte ase, anaa adwen bi besii wo tiri mu s0 di woho awu	0	1	2	3

S0 wogye to mu s0 nns0mfua yi bi haw w'adwene a, kyer0 s0ne0 0maa w'adwuma, wofie hw0 ne n'asiesie, ne sene0 wo ka woho k4 nnipa nky0n no y00 den maa wo?

Aanye den koraa	)y00 den kakra	)y0 den bebre	)y0den mmoroso4

APPENDIX III: ANCILLARY DOCUMENTS

TABLE 7: PROJECT TIMETABLE

WEEK	DAYS				
WEEK 1	MON 23 JAN **Opoku Ware SHS**	TUES 24 JAN **Opoku Ware SHS**	WED 25 JAN **Kumasi Girls' SHS**	THURS 26 JAN **Kumasi Girls' SHS/Aduman SHS**	FRI 27 JAN **Aduman SHS**
WEEK 2	MON 30 JAN **Atonsu M/A Basic school**	TUE 31 JAN **Atonsu M/A Basic school**	WED 1 FEB **Atonsu M/A Basic school**	THURS 2 FEB **Atonsu M/A Basic school**	FRI 3 FEB **Atonsu M/A Basic school**
WEEK 3	MON 6 FEB **Nagies' Educational Basic School**	TUE 7 FEB **Nagies' Educational Basic School**	WED 8 FEB **Nagies' Educational Basic School**	THURS 9 FEB **Nagies' Educational Basic School**	FRI 10 FEB **Nagies' Educational Basic School**
WEEK 4	MON 13 FEB **Global Educational Basic Sch.**	TUE 14 FEB **Global Educational Basic Sch.**	WED 15 FEB **Global Educational Basic Sch.**	THURS 16 FEB **Global Educational Basic Sch.**	FRI 17 FEB **Global Educational Basic Sch.**
WEEK 5	MON 20 FEB **Angel Educ. Basic School**	TUE 21 FEB **Angel Educ. Basic School**	WED 22 FEB **Angel Educ. Basic School**	THURS 23 FEB **Angel Educ. Basic School**	FRI 24 FEB **Angel Educ. Basic School**
WEEK 6	MON 27 FEB **Angel Educ. SHS**	TUE 28 FEB **Angel Educ. SHS**	WED 1 MARCH **Angel Educ. SHS**	THURS 2 MARCH **Angel Educ. SHS**	FRI 3 MARCH **Angel Educ. SHS**
WEEK 7	MON 6 MARCH **Esereso M/A Basic School**	TUE 7 MARCH **Esereso M/A Basic School**	WED 8 MARCH **Feyiase M/A Basic School**	THURS 9 MARCH **Feyiase M/A Basic School/Aputuogya M/A**	FRI 10 MARCH **Aputuogya M/A**

SAMPLE ALLOCATION TABLES

Table 8 RURAL SAMPLE N = 224

School	**AGE IN YEARS**																												**TOTAL**
	6		**7**		**8**		**9**		**10**		**11**		**12**		**13**		**14**		**15**		**16**		**17**		**18**		**19**		
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	
Aputuogya MA	2	3	3	2	2	3	3	2	2	3	3	2	2	3	3	2	2	3	3	2	-	-	-	-	-	-	-	-	50
Feyiase MA	3	2	2	3	3	2	2	3	3	2	2	3	3	2	2	3	3	2	2	3	-	-	-	-	-	-	-	-	50
Esereso MA	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-	-	-	-	-	-	60
Aduman SHS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	8	8	8	8	8	8	8	64
TOTAL	16		16		16		16		16		16		16		16		16		16		16		16		16		16		**224**

Table 9 URBAN SAMPLE N = 420

School	Type	AGE IN YEARS																												SCHOOL TOTAL
		6		7		8		9		10		11		12		13		14		15		16		17		18		19		
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Global Educ.	Private	3	4	4	3	3	4	4	3	3	4	4	3	3	4	4	3	3	4	4	3	-	-	-	-	-	-	-	-	70
Angel Basic		4	3	3	4	4	3	3	4	4	3	3	4	4	3	3	4	4	3	3	4	-	-	-	-	-	-	-	-	70
Nagies Basic		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	-	-	-	-	-	-	-	-	80
Angel SHS		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	7	7	8	8	7	7	8	60
Atonsu MA	Public	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	-	-	-	-	-	-	-	-	80
Kumasi Girls/ OWASS		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	8	8	7	7	8	8	7	60
TOTAL		30		30		30		30		30		30		30		30		30		30		30		30		30		30		**420**

RESEARCH TEAM IDENTIFICATION CARDS

RESEARCH ASSISTANT

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PRINCIPAL INVESTIGATOR

Dr. Kwabena Kusi-Mensah

Department of Psychiatry
Komfo Anokye Teaching Hospital

APPENDIX IV: CONSENT FORM

Participant Information Leaflet and Consent Form

<u>This leaflet must be given to all prospective participants to enable them know enough about the research before deciding to or not to participate</u>

Title of Research: Normative Data on the Raven's Standard Progressive Matrices and the Slosson Intelligence Test Among Ghanaian Children

Name(s) and affiliation(s) of researcher(s): Dr Kwabena Kusi-Mensah, Department of Psychiatry Komfo Anokye Teaching Hospital, Kumasi, and Centre for Child and Adolescent Mental Health, University of Ibadan, Nigeria

Background (Please explain simply and briefly what the study is about): Having an objective way of measuring 'intelligence' is a very critical need for mental health workers. At present there is no objective way of doing this among Ghanaian children and using existing tools and data from Western Countries gives biased results

Purpose(s) of research: This study is among the first studies in Ghana on intelligence testing that seeks to find out what can be considered "normal intelligence" among Ghanaian children using adapted versions of two of the most appropriate intelligence testing tools available

Procedure of the research, what shall be required of each participant and approximate total number of participants that would be involved in the research: If you consent to take part, you will have either one or both of the study instruments in use for this study administered to you by a member of the research team. This will consist of a series of problems or questions asked of you.

Risk(s): Administering of the study instruments may take up a bit of your time and energy. But this will be done strictly during break periods and will not affect academic work in any way

Benefit(s): The knowledge generated from this study will be crucial for health workers in evaluating Ghanaian children with cognitive and psychological challenges.Also participants with any problems picked up during the screening process will recieve expert attention

Confidentiality: All information collected in this study will be given code numbers. No name will be recorded. Data collected cannot be linked to you in anyway. No name or identifier will be used in any publication or reports from this study

Voluntariness: Taking part in this study should be out of your own free will. You are not under obligation to. Research is entirely voluntary

Alternatives to participation: If you choose not to participate, this will not affect your treatment in KATH in any way, as there will be no way of even identifying.

Withdrawal from the research: You may choose to withdraw from the research at anytime without having to explain yourself. You may also choose not to answer any question you find uncomfortable or private

Consequence of Withdrawal: There will be no consequence, loss of benefit or care to you if you choose to withdraw from the study. Please note however, that some of the information that may have been obtained from you without identifiers (name etc), before you chose to withdraw, may have been modified or used in analysis reports and publications. These cannot be removed anymore. We do promise to make good faith effort to comply with your wishes as much as practicable.

Costs/Compensation: For your time spent participating in this study, a token gift of school supplies will be given as a show of appreciation for your time and goodwill.

Contacts: If you have any concerns or clarifications, please contact Dr Kusi-Mensah on 024 44 44 268

Further, if you have any concern about the conduct of this study, your welfare or your rights as a research participant, you may contact:

The Office of the Chairman
Committee on Human Research and Publication Ethics
Kumasi
Tel: 03220 63248 or 020 5453785

CONSENT FORM

Statement of person obtaining informed consent:

I have fully explained this research to ____ and have given sufficient information about the study, including that on procedures, risks and benefits, to enable the prospective participant make an informed decision to or not to participate.

DATE: _______________________ NAME: ____________________________________

Statement of person giving consent:

I have read the information on this study/research or have had it translated into a language I understand. I have also talked it over with the interviewer to my satisfaction.

I understand that my participation is voluntary (not compulsory).

I know enough about the purpose, methods, risks and benefits of the research study to decide that I want to take part in it.

I understand that I may freely stop being part of this study at any time without having to explain myself.

I have received a copy of this information leaflet and consent form to keep for myself.

NAME:____

DATE: _____________ SIGNATURE/THUMB PRINT: _____________________

Statement of person witnessing consent (Process for Non-Literate Participants):

I ________________________________ (Name of Witness) certify that information given to _________________________________(Name of Participant), in the local language, is a true reflection of what l have read from the study Participant Information Leaflet, attached.

WITNESS' SIGNATURE (maintain if participant is non-literate): ______________________

MOTHER'S SIGNATURE (maintain if participant is under 18 years): _________________

MOTHER'S NAME: ____

FATHER'S SIGNATURE (maintain if participant is under 18 years): __________________

FATHER'S NAME: ____

APPENDIX V: ETHICAL APPROVAL LETTERS

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF MEDICAL SCIENCES / KOMFO ANOKYE TEACHING HOSPITAL
COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS

Ref: CHRPE/AP/266/17

3rd May, 2017.

Dr. Kwabena P. Kusi-Mensah
Principal Investigator
Department of Psychiatry
Komfo Anokye Teaching Hospital
Post Office Box 1934
KUMASI.

Dear Sir,

LETTER OF APPROVAL

Protocol Title: *"Normative Data on the Raven's Standard Progressive Matrices and the Slosson Intelligence Test Among Ghanaian Children."*

Proposed Sites: *Selected Basic and Secondary Schools in Kumasi Metropolis and Bosomtwi District.*

Sponsor: *Principal Investigator.*

Your submission to the Committee on Human Research, Publications and Ethics on the above named protocol refers.

The Committee reviewed the following documents:

- Three notification letters from the Study Sites (Aduman Secondary School, Global Educational Complex and Angel International School).
- A Completed CHRPE Application Form.
- Participant Information Leaflet and Consent Form.
- Research Protocol.
- Questionnaire.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for a fixed period of one year, beginning 3rd May, 2017 to 2nd May, 2018 renewable thereafter. The Committee may however, suspend or withdraw ethical approval at any time if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study, annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you Sir, for your application.

Yours faithfully,

Osomfo Prof. Sir J. W. Acheampong MD, FWACP
Chairman