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# Gerontological Intelligence Test

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# GERONTOLOGICAL INTELLIGENCE TEST

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## ABSTRACT

The current study was designed as a preliminary analysis to design an alternative intelligence scale for older adults ages 65 plus. This study was predominantly administered to White participants with a females being the prominent gender (30 females, 14males). 44 participants were administered the four subtests Analogies, Matrices, Geometric Shapes and Information. The Block Design and Vocabulary from the Wechsler Adult Intelligence Scale was administered to assess the validity of the current study. By creating a more tailored intelligence test for older adults, problems such as fatigue, administrator bias and physical limitations can be addressed. With the population of older adults increasing there is more of a demand for age specific intelligence tests. The results section of this study was able to identify items difficulty and eliminate items that did not provide adequate representation of that particular representation of that subtest.

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# CHAPTER I

## INTRODUCTION

The Gerontological Intelligence Test (GIT) is a preliminary study to identify proper testing subtests to better measure intelligence testing in older adults. The current tests being used to assess intelligence in older adults are the Wechsler Adult Intelligence Scale, Fourth Edition published in 2008 (WAIS-IV) and the Wechsler Abbreviated Scale of Intelligence, Second Edition published in 2009 (WASI-II). For this study however, due to limited resources, the Vocabulary and Block design subtests of the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III) was used to create an abbreviated version. According to the Centers for Disease Control and Prevention (CDC) one of the methods to label a person an older adult is by a numerical definition, which applies to anyone that is 65 years of age or older (CDC, 2015). This classification will be used throughout this paper. Furthermore, the cutoff age of 65 years old for classification is being utilized to maintain consistency with the WAIS-IV. However, unlike the WAIS-IV that has a ceiling of 90 years old, the current study does not have a ceiling age.

Prior to the advent of the WAIS, there have been many previous attempts to develop a method to assess intelligence, starting in 1905 with Alfred Binet in France with the Binet-Simon Scale. Developed to assess the abilities of school-age children to determine appropriate classroom assignments for each child, the Binet-Simon Scale was the first instrument attempting to assess intelligence. Among the first pioneers in American intelligence testing, were Henry

Goddard and Lewis Terman, who along with other pioneers, helped influence the current intelligence test, such as Yerkes' Army test and Raymond Cattell's fluid and crystallized intelligence study. The work of these pioneering psychologists ultimately developed the field of intelligence testing, leading the way for the current Wechsler's tests.

As seen in census records, older adults have been progressively living longer. Since the publication of the WAIS-IV in 2008, there has been an increase of approximately 0.2 percent in the population of adults 65 years of age and older, with a more recent increase of 0.7 percent between 2011 (12.8%) to 2012 (13.5%). According to Ortman, Velkoff and Hogan (2014), the American population is increasing, doubling the 43.1 million older adults (65 years and older) in 2012, to 83.7 million by the year 2050. Ortman et. al (2014) attributes this increase to the large baby boomer generation, whom will be over 85 by 2050. However, the WAIS-IV is currently normed and validated for individuals up to 90 years old, yielding results that must be used with caution for anyone older than the age of 90 years. Thus, warranting the need for a valid intelligence test that can assess older adults over 90 years of age.

As adults age, the human body experiences some natural deterioration. One such deterioration and common health concern is arthritis. Nearly half of the individuals that are being diagnosed with arthritis fall within the 65 years or older category. The most common form of arthritis is osteoarthritis, which is the breakdown of the cartilage on the end of bones within joints over time. The hands are one of the most common areas of the human body that experiences this gradual wearing down and subsequent development of osteoarthritis (CDC, 2014). This could present as a concern with multiple subtests in the WAIS-IV that require hand movements and time constraints, such as the Perceptual Reasoning and Processing Speed subtests. Block Design and Coding subtests. The Block Design subtest of the Perceptual Reasoning Index is used in current and previous versions of both the WAIS and WASI, relies

heavily on hand coordination. By not accounting for hand deterioration for this subtest, may lead to an unwarranted lower score for older adults. Another concern with older adults is macular degeneration, which increases as one ages and is the leading cause for vision loss or blindness in older adults (Congdon, O'Colmain, Klaver, Klein, Munoz, Friedman, Kempen, Taylor, Mitchell, , 2004). Macular degeneration, along with other common health risks that develop as individuals' age such as hearing loss, cataracts, tremors, and other physical or cognitive disabilities, can also have adverse effects on test performance for older adults. Thus, an intelligence test that is more tailored to account for these common health concerns of an older adult population would be potentially beneficial.

The current study is a preliminary analysis to assess potential subtests that could better assess intelligence in older adults. The Gerontological Intelligence Test (GIT) presented in the current study is designed to assess a large range of ages, and accounts for some of the unique concerns and considerations of testing the cognitive abilities of an older population. The GIT is compiled of 4 subtests. 2 subtest are design to assess verbal understanding and 2 subtest are designed to assess non-verbal. T this format was also used to attempt a comparison with the current intelligence too- the WAIS. To validate the current instrument, the Block Design and the Vocabulary subtests of the WAIS-III were also administered for the purpose of comparison.

The GIT has several advantages, primarily its potential to be administered to a group of participants. The WAIS also utilizes an administrator-examinee format, whereas the GIT can be administered as a paper-based instrument. Ideally, the format of the GIT can lead to the creation of a computerized format. The WAIS also uses an open-ended format, whereas the GIT employs a closed-ended, multiple choice formatted test. This format was chosen to eliminate administrator's influence in the decision and granting points for each item. By limiting the examiner influence of scoring, we hope to minimize human error.

Other benefits of utilizing the GIT is the simplicity of its administration. Since this test is multiple choice, the examinee can take the test on his or her own by circling the right answer. Furthermore, to minimize the potential fatigue associated to time constraints and the demands of the test, the GIT was designed to be completed at an older adult's own pace. Examinees' are allowed as much time as needed for each item, to better measure their cognitive abilities at their own cognitive pace. Due to the GIT consisting of only four subtests, the scoring and computation of the results of the GIT can be done quicker than the WAIS.

The following sections will be discussing the GIT in more detail. Furthermore, a history of intelligence testing will be provided and definitions will be clarified. More support for the GIT will be provided. Benefits of the GIT will be explained.

# CHAPTER II
# LITERATURE REVIEW

## 2.1 History of Intelligence Testing

Intelligence testing has been a topic of research for decades. Philosophers like Plato and Aristotle were among the first to explore intelligence and its significance. Aristotle stated "Knowledge is not given by the senses but acquired thought them as reason organizes and makes sense out of that which is perceived (Zusne, 1957)." Augustine greatly influenced Catholic and Protestant theology and had his first psychological ideas published in *Confessions*. He believed the mind was a unit consisting of reason, memory, will and imagination (Zusne, 1957). These philosophers among others sent the foundation for exploration into the human mind and intelligence testing. The following section will further explore in detail, the development of intelligence testing and the instruments that have influenced David Wechsler to create the WAIS and other assessments. Begining with Francis Galton who was greatly influenced by his half-cousin, Charles Darwin's *The Origin of the Species*.

The history continues with Cattell whom created the term "mental tests". Afred Binet is attributed with being the father of Intelligence testing and inspired many psychologist such as Spearman, Stern, Golddard, Terman and even David Wechsler. David Wechsler was also

influenced greatly by Robert Yerkes, as evident by many of Wechsler's subtests reflecting those of the Army Alpha test, which Wechsler helped develop under Yerkes' Committee on the Psychological Examination of Recruits. These psychologist have led the foundations for what psychology testing has become and their achievements will be discussed further in this section.

**Francis Galton**

Francis Galton (1822-1911) was the youngest of seven, and due to a caring mother's esteem, believed he was exceptional. When he enrolled school he soon realized there were other children just as exceptional as himself, or even more so. Although Galton believed he was average, he exceled academically and was accepted into Trinity College (Fancher, 1985). However, due to the expectations of honors exam, Galton suffered "a break down" which resulted in his graduation without honors recognition (Fancher, 1985).

Due to his perceived academic shortcomings, and inspired by his half cousin, Charles Darwin's book *The Origin of the Species* (1859), Galton postulated that intelligence was associated to individuals that had keener senses whom were favored by evolution (Davis & Rimm, 1989). According to this research, Galton was convinced that superior qualities were passed down by genes to offspring. Galton's *Hereditary Genius* (1869) outlined his findings, and in subsequent works, proposed that mental abilities and personality traits, were inherited (Seligman, 2002). These ideas led to Galton advocating for parental breeding practices that match strong candidates to produce more elite offspring. Among Galton's contributions in the field of heredity, he also demonstrated that normal distribution can be applied to psychological constructs, such as intelligence, with individuals' naturally regressing to the population norm

(Simonton, 2003). The pioneering work of Francis Galton ultimately influenced and paved the way for psychology scholars for decades, including one of his students James McKeen Cattell.

**James McKeen Cattell**

James McKeen Cattell (1860-1944) was the first American to publish a dissertation in Psychometric Investigation. Cattell studied under the tutelage Wilhelm Wundt, who is considered "father of experimental psychology" at the University of Leipzig. When he returned to the United States, he was associated with and work to develop many psychological organizations including *The Psychological Review, Journal of Science, Psychological Corporation*, and *Science Press*. He was also affiliated with organizations such as the American Psychological Association, American Association of University Professors, and the American Association for the Advancement of Science. Eventually becoming the president of the American Psychological Association (APA), where he addressed the community during his inaugural speech with aspirations of having psychology become a reputable science as much as the physical and life sciences.

In 1890 Cattell's article "Mental Tests and Measurement" was published in the British Journal *Mind,* coining the term "Mental Tests" in regarding the assessment of the general public (Zusne, 1975). Cattell and his graduate students developed a series of test that tested temporal function, sensory acuity and simple motor skills. Among the ten tests were subtests such as dynamometer pressure, the strength of one's hand squeeze; weight differentiation; reaction time for sound; time for naming colors; number of letters repeated in one learning among other subtests (Fancher, 1985). Although these tests commenced a fruitless movement towards mental testing, it sparked an interest among American psychologists for further exploration.

**Alfred Binet**

Alfred Binet (1857-1911) has often been called the father of intelligence testing. Being primarily self-taught in the discipline of psychology, he was mentored by Jean-Martin Charcot in Charcot's neurological laboratory in Paris. Initially studying and publishing research articles on hypnotism with Charcot, Binet had to make a formal, public withdrawal of four of his publications after Charcot's work on hypnotism was discredited (Bergin, & Cizek, 2001). Following the birth of his two daughters, Binet became interested in human development, which he ultimately published more than 200 articles, books and reviews on the topic. In 1891, Binet began working at the Sorbonne's Laboratory of Experimental Psychology, where he later was appointed as Director in 1894.

In 1899, France passed the Compulsory Schooling Law, which required all French children to attend school and be placed in appropriate classes based off of their abilities. During this time, Binet was appointed as a member of the Commission for the Retarded to further study child development. Under the new law, the French government commissioned Binet to develop a way identify children with developmental and intellectual disabilities, marking a new need for intelligence testing. Binet set out to create a test to distinguish between developmentally delayed and normal children, and in 1903 published his first book on the topic entitled *Experimental Studies of Intelligence.* Shortly thereafter, Binet and one of his top graduate students named Theodore Simon, released the first intelligence test, the Binet-Simon Intelligence Scale, based on his past experience and research on normal age-related developmental tasks in children.

The Binet-Simon Intelligence Scale compared a child's mental ability to that of their peers of a similar age (chronological age), to determine the child's Mental Age. The scale consisted of tasks that are assigned by age, such tasks would involve the child to identify body parts, digits, and drawings. If a child was able to accomplish all tasks within his or her respective

chronical age range, then that child's mental age is considered to be matched to their chronical age. If a subject could not perform a particular task that was associated with a particular age group, he or she was assigned a lower mental age.

The Binet-Simon scale received scrutiny by many clinicians who felt that the tasks were associated to incorrect age groups (Peterson, 1925). One proposed limitation of the test was it's reliance on the subject's chronological age to determine mental age. These critics noted that if a subject failed a simple task and passed a more difficult task, it was hard to determine their mental age.

Nonetheless, the Binet-Simon scale's utility sparked many future studies and improvements in intelligence testing. Most notably, the scale ultimately led to the most-widely accepted construct of intelligence (Carroll, 1982). In 1912, William Stern, a German Psychologist discovered that if the chronical age was divided by the mental age the ratio would become somewhat constant. This consistent and relatively stable ratio was coined the intelligence quotient (Carroll, 1982).

**Lewis Terman**

Similar to Galton, Lewis Terman (1877-1956) wanted to find differences between students' intellects. In his thesis "Genius and Stupidity: A Study of the Intellectual Processes of Seven "Bright" and Seven "Stupid" Boys" Goddard used complex functioning categories to identify each group. The 8 categories used were the following:

1. Tests of invention and creative imagination,
2. A typical test of logical processes,
3. Several tests of mathematical ability,
4. Anagrams, blanks in stories, and reading aloud to demonstrate language mastery,

5. Interpretation of fables,
6. Skill in learning the game of chess,
7. Memory tests, and
8. Tests of motor skill.

Terman revised the Binet scale, producing the Stanford Revision of the Binet-Simon Scale. The revised scale established specific criteria for placement in special need classrooms. This development allowed for improvement in school systems by reducing delinquency, augmenting grade systems and placement (White, 2000). He also investigated the early "ripe-early rot myth". The myth suggested that a child with a higher IQ should achieve more as an adult. Terman found that physical and personality features such as tallness, good health, social adoptability and better leadership skills correlated with children with higher IQs (Terman, 1916). Finally, Terman modified the Sterns Intelligence quotient, getting rid of the decimal. The new formula, "Classic IQ" was Mental Age divided by Chronological Age multiplied with 100.

**Henry Goddard**

Often referred to as the father of intelligence testing in the United States, Henry Goddard (1866-1957) translated the Binet-Simon Scale into English and distributing over 22,000 copies. Goddard was part of the development team for Yerke's Army Scales and influenced changes to the screening process of immigrants on Elis Island. (Zenderland1998). During the 19th century, there was a publically supported movement to eliminate feeble minded individuals. In The United States feeble-mindedness was considered to be predominately found among the immigrant population. Goddard developed a two-step process of identifying Feeble-mindedness. The first step was to visually examine the immigrant and the second step was to use a revised version of the Binet scale (Zenderland, L., 1998). These tests lead to massive immigrant

deportations within the United States. Goddard influenced intelligence testing and worked at various levels to advocate for increased testing.

**Robert Yerkes**

In 1916, Robert Yerkes (1876-1956) proposed a new method for scoring performance across psychological tests. This method consisted of a multiple item timed test, later comparing individual performance scores to the general population (mean and standard deviation). The new method was termed the point scale method. In 1917 Yerkes was asked by the United States army to develop a screening method for new recruits. The Army Alpha test was created as a verbal ability scale. The Army Beta test was developed as a nonverbal ability scale for soldiers that scored poorly on the Alpha test or were known to be unable to read (Yerkes, 1921). The test consisted of eight subsets and it took approximately 25 minutes to administer (Carroll, 1982). The Army test produced a mental age score much like the Binet scale. Following the preliminary study administration of 80,000 soldiers, the both Army tests were ultimately administered to more than 1,750,000 recruits throughout World War I (Fancher, 1985).

Three important differences between the Army Tests and the Binet scale can be observed. First, the Army Tests were administered in a closed-ended, multiple choice group format. Second, the test administration was different from that of the Binet scale that increased in difficulty as the participants progressed through the scale and utilizes time limits. The Army Scales gave the participants 25 minutes to respond to as many questions as possible. Third, the Army Test had participants use pencil and paper which are not present in the Binet scale (Carroll, 1982). These differences within the scales, as well as the distinction between the verbal abilities measured by the Alpha scale and the nonverbal abilities of the Beta scale, influenced the development of the Wechsler's intelligence scales used today.

**David Wechsler**

Wechsler's intelligence scale has been predominantly used since 1939. David Wechsler (1896-1981) worked under Yerkes to create the Alpha Army scales and volunteered to score the Alpha portion of the test. Later Wechsler began recruiting participants that performed poorly on the Alpha tests to be administered the Binet Scales. Deviating from Terman's Chronological-Mental age model, Wechsler also adapted his scales to utilize the distribution of normal curve to be applied to both age and abilities (Wechler, 1981). Wechsler viewed intelligence as a multidimensional construct and believed that age plateaus in the 20s. The early Wechler Adult Intelligence Scale (WAIS) was quite similar to the Army Tests, and consisted of 11 subtests. Six of the original subtests identified verbal skills and five identified performance material. The verbal portion consisted of: Information, comprehension, arithmetic, digit span, similarities, and vocabulary skills. The performance portion consisted of: picture arrangement, picture completion, block design, object assembly and digit symbol substitution. Since the inception of the WAIS, research has contributed to the revision and addition of the subtests, such as the Comprehension and Information subtests, forming the most recent editions of WAIS.

Overall, the history of intelligence testing has changed over the decades. Many psychologist in the field of intelligence testing had a mentor student relationship, influencing each other's tests. It is evident that the WAIS, with a few modifications is quite similar to the Army Alpha Scale. The GIT attempts to revisit The Army Scales and attempts to demonstrate that a method such as it can be used to test older adults. In the next sections justifications for this change will be explained.

# CHAPTER III

# DEFINING AND MEASURING INTELLIGENCE IN OLDER ADULTS

## 3.1 Defining Intelligence and Wording of the GIT

Defining intelligence has been a continuous problem. Definitions in 1921 range from "The ability to learn or having learned to adjust oneself to the environment" to "The ability to acquire capacity" (Wasserman & Tulsky, 2005). As seen in its history, the varying interpretation of intelligence will likely lead to the development of various scales to measure intelligence. The many interpretations of intelligence may also be influenced by the mentors, academic institutions, and peers of the researchers studying intelligence. Ultimately, this lack of a universal definition of intelligence, presents an obstacle when developing an intelligence assessment instrument. Binet focused on mental age and chronical age, whereas Wechsler focused on a more global level when defining intelligence. Although Wechsler and Yerkes worked together, these two psychology possess difference definitions for intelligence. Below are Wechsler and Yerkes's definitions.

Wechsler's theory of intelligence stated:

> "Intelligence is the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment. It is global because it characterizes the individual's behavior as a whole; it is an aggregate because it is composed

of elements or abilities which, though not entirely independent, are qualitatively differentiable" (Wechsler, 1975, as cited in Wasserman & Tulsky 2005).

Whereas Robert Yerkes stated:

"The term intelligence designates a complexly interrelated assemblage of functions, no one of which is completely or accurately known in man" (Yerkes, 1929).

Other notable psychologists' have also provided varying definition of intelligence, such as Joy Guilford and Charles Spearman:

"A systematic collection of abilities or functions for the processing of information of different kinds in various ways" (Guilford, 1985).

"As regards the delicate matter of estimating 'Intelligence,' the guiding principle has been not to make any a prior assumptions as to what kind of mental activity may be thus termed with greatest propriety. Provisionally, at any rate, the aim was empirically to examine all the various abilities having any prima facie claims to such title, ascertaining their relations to one another and to other functions" (Spearman, 1904).

Not only is defining intelligence a problem but, theories for creating scales are not unified and are usually data driven. With scales being based on different theories, there is no consensus on how to gather intelligence. In an attempt to unify definitions in a model, the Cattell-Horn-Carroll (CHC) model (Keith & Reynolds, 2010). The CHC model is a combination of two theories. The Gf-Gc model illustrates fluid reasoning and crystallized intelligence. Fluid Reasoning can be defined as "the ability to perceive relationships independent of previous specific practice or instruction concerning those relationships". Crystallized Intelligence is

knowledge that originates from prior learning and past experiences, such as previously learned reading material. The Carroll Three-Stratum Theory states that g (General Intelligence) is hierarchical and that Gf and Gc, along with other factors, load onto g (Keith & Reynolds, 2010).

Alternatively, the Wechsler Adult Intelligence Scale is based on general intelligence (g). The WAIS is composed of four factors: Verbal Comprehension, Perceptual Reasoning, Working Memory and Processing Speed. These factors act as the four indices used to determine an individual's Full Scale IQ (FSIQ). The GIT also in influenced by the three principles of Robert Sternberg's Theory of Intelligence, which states intelligence is: analytical, creative and practical (Clarke, 1986).

Lastly, a definition for older adults will be provided. For the current study, older adults are defined as anyone that is 65 of age or older. Initially, the age bracket of 65 and older was chose to maintain compatibility with the WAIS. Additionally, when viewing Census reports the older adult population bracket started at age 65. Another source used was the Centers for Disease Control and Prevention. The CDC has different criteria to define older adults, which includes health and dependency level, uses a numerical age bracket. For this study, the CDC age bracket criteria was selected. The age bracket considers anyone that is 65 or older as an older adult (CDC, 2015). These various sources above were considered in determining an appropriate start age for the term "older adults".

### 3.2 Justification for the Development of this New Intelligence Test

Presently there is no widely used, easily attained and administered test that is specifically tailored for the elderly population. When an older adult requires an intelligence test the Wechsler Adult Intelligence Scale (WAIS-IV) or Wechsler Abbreviated Scale of Intelligence (WASI-II) is administered.

The Wechsler Scales are designed for a wide age range of ages, starting at two years of age up to 90 years age. The scales for adults, the WAIS-IV and the WASI-II, which start at the ages of 16 and six, respectively, both cutoff age of 90. The Wechsler Intelligence Scale for Children (WISC) is given to children ages six through 16, and the Wechsler Preschool and Preliminary Scale for Intelligence (WIPPSI) assesses children two to seven years of age. As seen in the varying appropriate age ranges of the Wechsler scales, each age bracket has its own specific scale. However, these scales are not normed for older adults over 90 years of age. Furthermore, there is no tailored test for the adults 65 years or older.

The current study examines the need for a new intelligent test specifically designed for older adults. The Gerontological Intelligence Test is designed to be sensitive to complications of aging that impact neuropsychological testing. These aspects may include, but are not limited to, test fatigue and decline in motor skills. Limitations related to the WAIS-IV and WASI-II are discussed. Further limitations expressed in later sections are fine motor skill decline, effects of processing speed, scoring subjectivity and sampling subjectivity.

**The Effects of Fine Motor Abilities and Decline in Intelligence Test**

Older adults experience decline in physical abilities. Subtests such as the Block Design use hand coordination in a limited time frame becoming problematic for participants of a certain age group with declining physical abilities. For example an elderly participant may be penalized for preforming slowly even though they might be able to construct the design untimed. Block Design can be found in both the WAIS-IV and the WASI-II. Other subtests that may present a concern are Coding, Cancelation, Arithmetic and Symbol Search. These subtests not only present an issue with time but, with fine motor skill movement. Subtests such as Symbol Search require participants to draw small designs and turn pages. Another concern is having multiple subtests using hand movements to predict the same Index Scale. For example, receiving a low score on

both Coding and Symbol Search leads to an overall low score on the Processing Speed Index potentially skewing the results. With such a large portion of the WAIS requiring fine motor skills and timed answers certain health concerns can potentially impact the accuracy of the overall Full Scale IQ (FSIQ).

Arthritis is a health concern that may influence fine mother skills. Currently, arthritis is present in nearly half of the individuals falling within the 65 plus category. Furthermore, the most common form of arthritis is osteoarthritis which affects the cartilage on the end of the bones. One of the common areas affected are the hands (CDC, 2014). As seen above hands are used in multiple WAIS subtests and in one fourth of the WASI. With nearly half the older adult population having some form of arthritis administering a test with multiple hand movement subtests, places this age group in an unfair advantage.

**Effects of Processing Speed on Performance Intelligence Test**

Another issue with the WAIS-IV is the length of time that is required to complete the test. On average it takes an hour and a half to administer the WAIS which may lead to fatigue an older participant. Fatigue might cause a lower score and a higher error rate. Even if one considers the WASI-II instead of the WAIS-IV to account for test fatigue, the WASI as previously mentioned has motor skills concerns.

**Subjectivity of Scoring**

Both the WASI-II and WAIS-IV consist of material that requires a certain degree of subjectivity. Subtests such as Vocabulary and Similarities allow an examiner to determine an answer as correct or incorrect. Subjectivity is also based on the general knowledge the examiner possess. Potentially correct answers may be marked incorrect if they fall out of the typical response list in the manual. This type of testing creates opportunity for testing biases. An

examiner may be influenced by an elderly's appearance and slow response time rate. Age specific limitations are not accounted for properly within the subtests of the WAIS-IV.

**Sampling Subjectivity**

Another limitation of the WAIS-IV is the remarkably low normative sample for the 65 plus age brackets. The WAIS-IV, contains 13 age brackets, with five being in the 65+ age range. 200 subjects were used in the 65-69:11 (65 - 69 and 11 months) age bracket and 100 were used for each sequent age brackets totaling 600 subjects. Both the 65-90:11 and 16-24:11 age groups have a normative sample of 600 subjects. However, when comparing the age ranges within the age groups, there is only a 9-year difference in the 16-24:11 bracket, but a 25-year difference in the 65-90:11 bracket (Psychological Corporation, 2008). Thus, the latter age group is underrepresented. As seen by the number of subjects sampled, the 65 plus age brackets are disproportionately low. This is especially concerning, considering the Baby Boomer generation are currently reaching this age group. As seen in census records older adults are progressively living longer. According to Ortman, Velkoff and Hogan, the American population is expected to increase doubling the size of its older adult population from 43.1 million to 83.7 million by 2050 (2014). The WAIS-IV is normed for individuals up to the age of 90 and can be used with caution for anyone older. Therefore, an intelligence test that accurately tests past age 90 will be needed.

**Data of Visual and Auditory Problems in Older Adults**

Aside from Arthritis there are other health factors such as the following can affect testing. Macular degeneration, which increases as one ages and is the leading cause for vision loss or blindness in older adults (Congdon et al., 2004). Other visual concerns in older adults are as follows: cataracts (5.3 to 33.7%), diabetic retinopathy (1.6 to 5%), and glaucoma (6.8 to 12.3%) (Clarke, A. M., 1986). The CDC averages that 2/3rds of older adults have some form of visual

problems. Also, 1 older adult in every 3 has some form of auditory problem (CDC, 2011). These statistics illustrate the need to administer a multiple sensory test to older adults.

# CHAPTER IV

# THE GERIATRIC INTELLIGENCE TEST

## 4.1 General Test Design

The Gerontological Intelligence Test (GIT) is designed to effectively address the concerns previously mentioned. The test was designed to be easier to administer, trained, shorter in length, and less expensive to distribute. It was also intended to assess intelligence on a more social component level. The GIT was developed to limit fatigue, eliminate timed tasks, and decrease issues relating to confirmation bias and subjectivity. These changes should improve the testing experience for the examinees while providing a more accurate representation of their performance.

The GIT is designed in multiple choice form. This design was chosen to address the issues of confirmation bias and subjectivity. By having a close ended, self-administered test there is no administrator influences. Thus, deliberation between a two, one or zero point response is eliminated and human error is decreased.

An additional goal of the GIT is better representation of global knowledge. Some questions in the Wechsler test tend to be tailored to individuals that have completed a certain level of education. In the current generation of older adults, education may not have been readily available. The need to achieve higher education was not as predominant as it is presently. This can be observed in the current study's participants. Many participants indicated only achieving a

middle school grade level, with approximately 6 attaining some college. Also, as time passes language and information becomes more concise and difficult to recall. This does not necessarily mean the individual has a lower intellect but, that age is affecting certain functions. By basing the GIT everyday social elements and broader abstract reasoning the test may give a clearer indication of the examinees intellect.

Finally, the GIT addresses issues with timed testing. Timed test pose a problem with examinees that have declined fine motor skills. Ultimately, the GIT will eliminate timed testing however, for the present study timed testing was utilized. Originally administering both the two WAIS subtests (Vocabulary and Block Design) and the full GIT battery took approximately 2 hours. After some adjustments to the subtest items the administration time decrease to an hour and a half. Participants' retention rate decreased due to lengthy testing, thus a time component was added to the GIT's non-verbal scales (Matrices and Geometric Shapes). By adding a one minute time limit to the first 10 questions and a two minute time limit to the last 10 question the administration time decreased to approximately 45 minutes. A shorter test design can alleviate potential fatigue experienced. Lastly, since the GIT is self-administered it can be given to a group of examinees at once not to just an individual. This will maximize the examinee's time and allow for increased collection of test results per testing session.

### 4.2 Subtest Development

GIT is, based on Carroll's Three-Stratum Model. Where this test differs from the WASI and WAIS-IV is in the subtests. Each subtest was designed with special consideration to older adults needs. The four subtests are: Analogies Matrices, Geometric Shapes and Information. These subtests are separated into Verbal and Non-verbal sections. The Verbal portion of the test is composed of Analogies and Information. The Non-Verbal portion of the GIT consists of

Matrices and Geometric shape. Each subtest and their directions will be explained in the following sections.

## Verbal

The verbal portion of the GIT focuses on general information and abstract verbal reasoning. Analogies is designed to assess abstract thought process and verbal reasoning. Whereas Information is designed to assess for global information acquired and the participant's ability to recall this information.

### Analogies

Analogies is a set of two word patterns. Some Analogies deal with similarities, differences or any other word patterns. The first half of the question has a completed comparison and the second portion has a partially completed comparison. To receive points in this subtest the participant needs to correctly identify the comparison in the first portion of the question and ably this comparison to the second portion of the question. For example a question reads Dog is to Bark and Cat is to _____ (Visually a participant views the question as follows: dog – bark :: cat –). The first portion deals with an animal and the sound it makes. The second portion also has an animal, therefore to receive points the participant needs to identify sounds are being compared and choose the correct sound a cat makes. Therefore, the correct answer would be "Meow".

### Information

Information is a series of questions compiled of world facts. These world facts could have been acquired through newspapers, television, magazines, or any other method of publically sharing information. These are not facts that require any formal education or any information past 6 grade level. School is becoming important in recent years however, past older adult generations did not find a need for higher education. By having common knowledge type

questions will deceases the possibility of discriminating against less educated examinees. Making the questions less regionally specific, this subtest can be administered to American citizens and non-American citizen alike without having a bias towards American citizens.

## Non-Verbal

The non-verbal portion of the GIT focuses on abstract problem solving, inductive reasoning, spatial perception, abstract processing and problem solving. These subtests test how the participant is able to interpret a 2 dimensional object and apply changes as required. Problem solving tests the ability of recognizing a pattern, learn it and predict it.

### Matrices

Matrices is a series of patterns that can be created with shapes, sizes, colors, numbers, and directions of the shape. Each item displays a visual pattern of 3 or 8 squares with one square left blank. The sequences are displayed in either a line, a square or in a diamond shape form. Participants are required to analyze the pattern sequence, learn it and predict it by choosing the answer that best fits from multiple choice options. The first ten items have a time limit of one minute and the last ten items have a time limit of 2 minutes to complete the pattern.

### Geometric Shapes

Geometric Shapes are similar to Block Design, but do not have the physical component. This task is all computerized. In Geometric Shapes there is a completed design in the middle of the page. On each side of the computer screen there are a pair of columns with two to three answers on each side depending on the difficulty level of the question. The participant is asked to choose two or three shapes that go together to become the design in the middle of the page, much like complementing a puzzle.. The shapes can be rotated in any direction but, cannot be overlapped to complete the shape.

This task is similar to complementing a puzzle. Questions one through nine have a time limit of one minute and questions ten to twenty have a limit of two minutes.

# CHAPTER V

# METHOD

## 5.1 Participants

Participants were recruited in multiple locations. An independent living facility was used, along with a Senior Center, and different community activities groups. Initially the goal of the study was to recruit an even amount of participants per age bracket (65-69, 70-79, 80-89 and 90plus). Whoever, although there is a fairly even distribution between the age groups the 90 plus age bracket only has one participant. The distribution goes as follows: 14 participants in the 65-69 age group (32 percent), 13 participants in the 70-79 age group (30 percent), 16 participants in the 80-89 age group (36 percent), and 1 participant in the 90 plus age group (2 percent) totaling 44 participants. The mean in the sample collected is 76 with the minimum age being 65 and the maximum 90. The demographic in the sample collected is primarily White individuals with only one African American tested. The sample contains predominantly women, having 30 females and 14 males participate in the study. Individuals recruited functioned fairly average, with mild visual impairments, corrected with glasses or cataracts surgery. Two participants were blind in one eye. Furthermore, many participants reported some form of mental health medication, high blood pressure and most reported different forms of arthritis.

## 5.2 Materials

Due to limited resources the WAIS III was used. The abbreviated version of the WAIS-III was used. After both Vocabulary and Block Design were administered the full GIT was administered. The participants had the opportunity to take as many breaks as they needed. The test environment was fairly quiet and the participants had limited distractions. Overall, the full testing process took 40-45 minutes with the GIT taking 20 minutes.

## 5.3 Administration

The study was administered in a quiet room with the administrator and the participant. The first twenty participants were administered a lengthier version of the GIT with approximately 40 to 60 questions each subsection. This was used to identify the initial levels of difficulty of the questions developed for the GIT. Originally, taking 2 hours to administer, after some modifications the total testing time was 40 to 45 minutes with the GIT taking 20-25 minutes. Most participants took breaks in between materials administered. If a participant was not sure of a particular answer the participant was encouraged to "Take their best guess". If a participant was working on a timed item and the time elapsed the participant was prompted to answer the question or state "I do not know". If a participant answered three consecutive incorrect questions in a row the administrator would shift to the next section. Once a participant has reached their ceiling, answering more questions frustrated and discouraged the participant. These negative emotions were carried over throughout the test.

The GIT was designed to be self-administered. Each subtest has complete instructions prior to the actual testing and 2-3 trial questions. Trial questions are designed to assess if the participants understood the instructions and are ably them to the items. Also, trial questions were used as a learning tool to make the participant more comfortable with the material. Ideally, this

test would have been administered by a computer or a paper copy that can be scored at a later time. The current study was administered manually. The participant pressed one button on the computer to progress through the test. He or she read the instructions and then completed the trial questions. As the participant answers each question the administrator marks the correct or incorrect answers and once the ceiling was reached the administrator would manually switched to the next subtest.

Administrators had limited interaction with the participants. They are instructed to sit behind the participant and record the answers given. If the older adult feels uncomfortable using a computer, the administrator is allowed to press the "next" key button on the computer. Mostly, the older adults had no problems administering the test by themselves, some did need the administrator to assist with the technology.

## 5.4 Statistical Method

Initially, to identify the difficulty of each item 20 participants took the GIT in its entirety. The frequency of right answers versus wrong answers was analyzed to determine the final item list used for GIT. Cronbach's Alpha was used to determine the reliability of each scale in the current study. A factor analysis was conducted. Both an extraction method principal component analysis and rotation method-Varimax with a Kaiser Normalization Scale were run, to evaluate variability patterns among items, clusters, and effectiveness of each subsections in the GIT.

# CHAPTER VI

# RESULTS

To assess difficulty levels and redundancies among GIT items a frequency analysis was conducted for each subsection (Analogies, Information, Geometric Shapes, and Matrices). Furthermore, the Cronbach's alpha was analyzed to demonstrate the reliability of the each subscale. The following frequency and Cronbach's Alpha results are illustrated below:

## Analogies

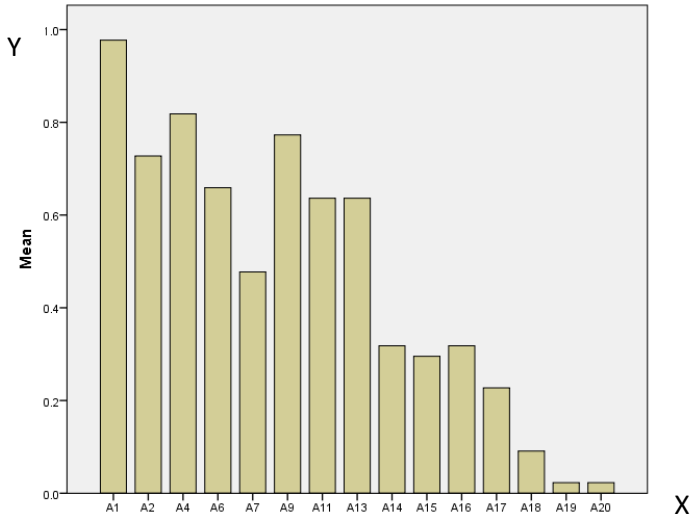
Frequency analysis showed the pass and fail rate for the items. Items with equal pass fail rate were dropped including A3. A5, A8, A10, A12

Scale Analogies (15 items) A1, A2, A4, A6, A7, A9, A11, A13, A14, A15, A16, A17, A18, A19, A20

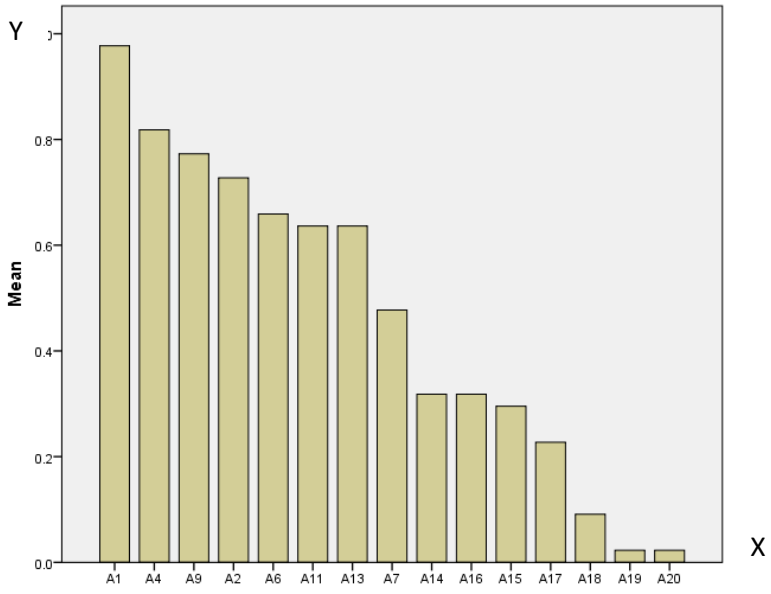
Cronbach's Alpha .824 Mean 7.00 Std. Deviation 3.278

Order of presentation by difficulty

(Before difficulty classification)




(After difficulty classification)



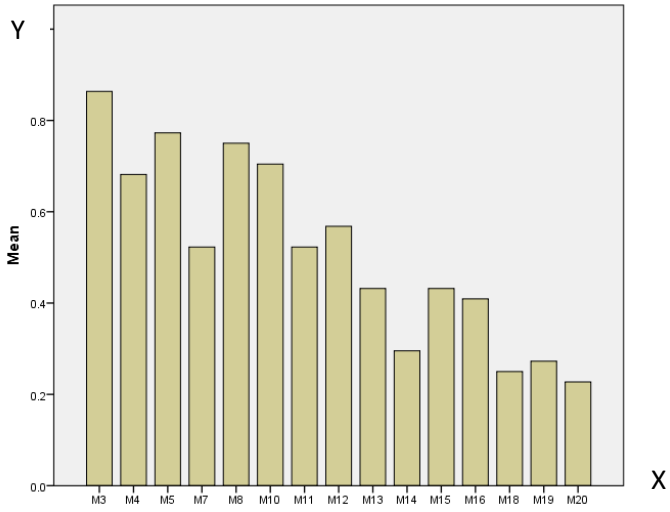

**Matrices**

Frequency analysis showed the pass and fail rate for the items. Items with equal pass fail rate were dropped including M1, M2, M6, M9, M17,

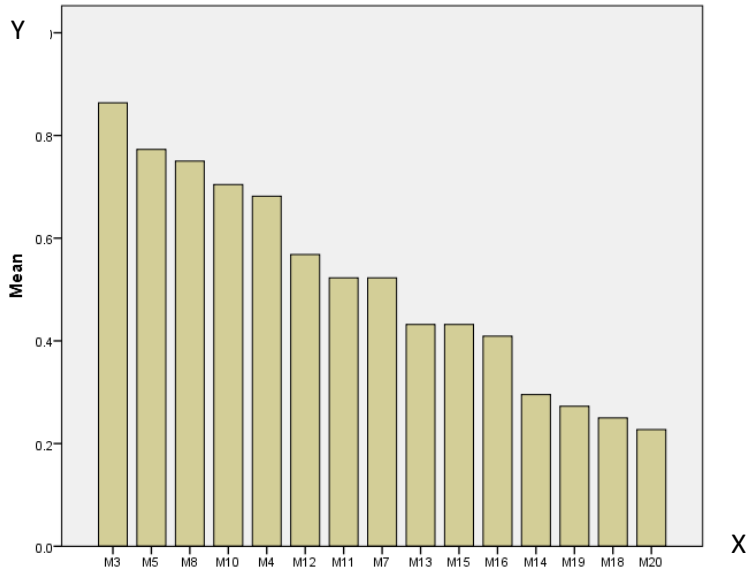
Scale Matrices (15 items) M3, M4, M5, M7, M10, M11, M12, M13, M14, M15, M16, M18, M19, M20

Cronbach's Alpha .848 Mean 6.95 Std. Deviation 3.78

(Before difficulty classification)




(After difficulty classification)



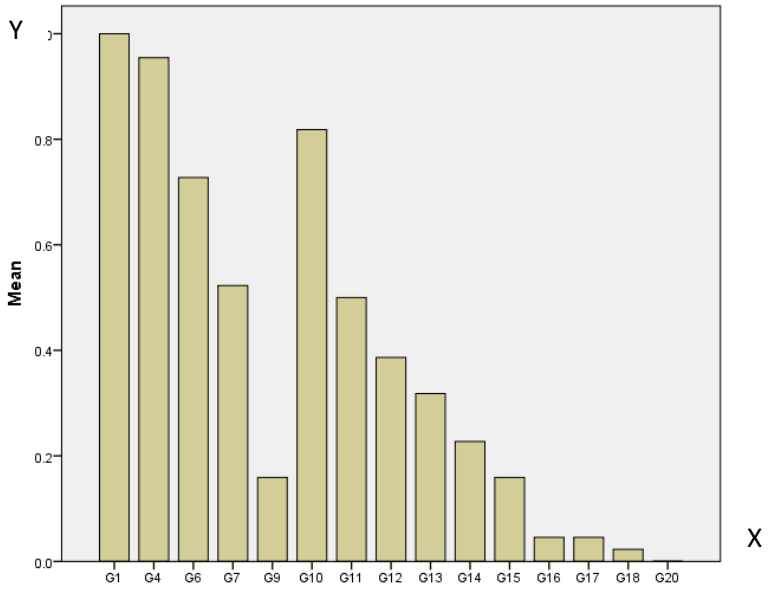

**Geometric Shapes**

Frequency analysis showed the pass and fail rate for the items. Items with equal pass fail rate were dropped including G2, G3, G5, G8, G19

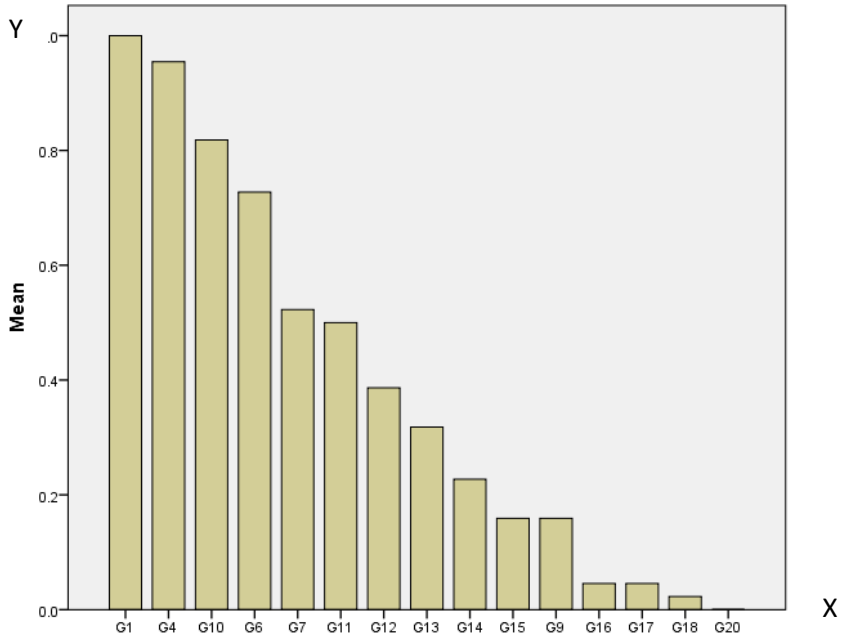
Scale GS (15 items) G1, G4, G6, G7, G9, G10, G11, G12, G13, G14, G15 G16 G17 G18 G20

Cronbach's Alpha .759 Mean 6.61 Std. Deviation 2.58

(Before difficulty classification)




(After difficulty classification)

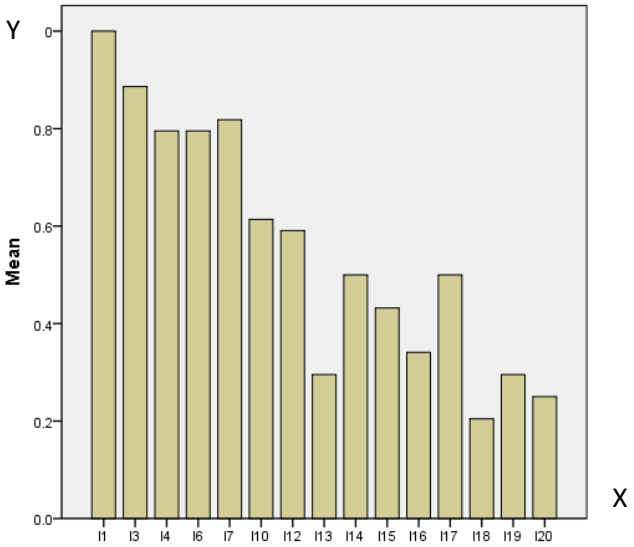



**Information**

Frequency analysis showed the pass and fail rate for the items. Items with equal pass-fail rate were dropped including I2, I5, I8, I9, I11.

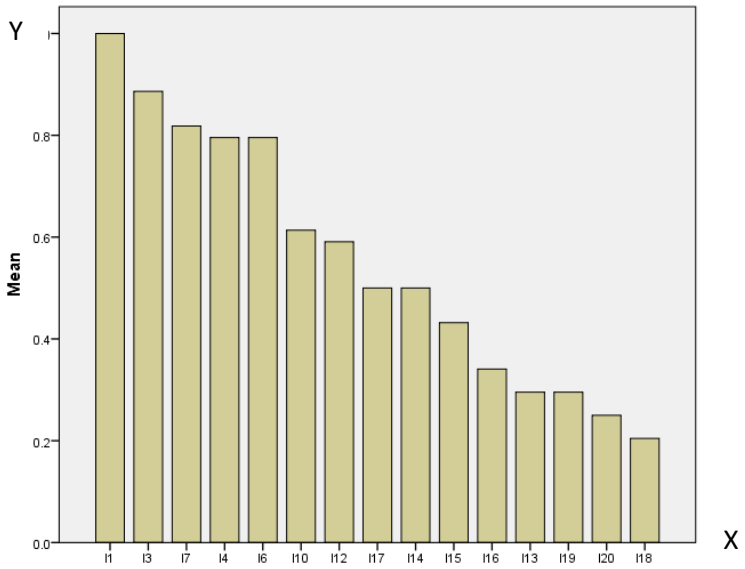
Scale Information (15 items) I1, I3, I6, I7, I10, I12, I13, I14, I15 I16 I17 I18 I19, I20

Cronbach's Alpha .759 Mean 6.61 Std. Deviation 2.58




(Before difficulty classification)

(After difficulty classification)



A correlation matrix was preformed results are portrayed below:

Correlation matrix

WAIS III Vocabulary and Block Design Subtests

| WAIS III Subscale | Geriatric Intelligence Scale | | | |
|---|---|---|---|---|
| | Verbal Subscale | | Nonverbal | |
| | Analogies | Information | Matrix | Geometric Shapes |
| Block Design | .599 | .539 | .465 | .529 |
| Vocabulary | .739 | .648 | .379 | .378 |

Correlation Matrix of the Geriatric Intelligence Scale

| Nonverbal Subscales | Verbal Subscale | | Nonverbal Subscales | |
|---|---|---|---|---|
| | Analogies | Information | Geometric Shapes | Matrix |
| Matrix | .335 | .551 | .512 | -- |
| Geometric Shapes | .335 | .233 | -- | |
| Information | .585 | -- | | |
| Analogies | -- | | | |

A factor analysis Extraction Method: Principal Component Analysis and Rotation Method: Varimax with Kaiser Normalization was performed to illustrate the patterns among the variables and to illustrate accuracy of subtests to define the Factors. Two subsections of special

interest are Matrices and Information. It is observed that Matrices is a better indicator for Verbal than for a Non-Verbal task. Information illustrates being a better Non-Verbal task indicator. Information was originally hypothesized to predict Verbal tasks. Full results are illustrated below:

Factor analysis

| | Factor | |
|---|---|---|
| | Verbal | Nonverbal |
| Matrix | .**818** | .230 |
| Geometric Shapes | **.608** | **.606** |
| Information | .107 | **.957** |
| Analogies | **.901** | .085 |

Total scale WASI and GIT is r=.749 Correlation is significant at the 0.01 level (1-tailed).

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Illustrated below is a Correlation Matrix for all variables

**Correlations**

| | | Analogies | Matrices | Geo_Shapes | Information | Age | VOC | BDScore |
|---|---|---|---|---|---|---|---|---|
| Analogies | Pearson Correlation | 1 | .549** | .370* | .642** | -.491** | .758** | .660** |
| | Sig. (2-tailed) | | .000 | .013 | .000 | .001 | .000 | .000 |
| | N | 44 | 44 | 44 | 44 | 44 | 44 | 44 |
| Matrices | Pearson Correlation | .549** | 1 | .557** | .569** | -.386** | .390** | .491** |
| | Sig. (2-tailed) | .000 | | .000 | .000 | .010 | .009 | .001 |
| | N | 44 | 44 | 44 | 44 | 44 | 44 | 44 |
| Geo_Shapes | Pearson Correlation | .370* | .557** | 1 | .231 | -.293 | .354* | .525** |
| | Sig. (2-tailed) | .013 | .000 | | .131 | .053 | .018 | .000 |
| | N | 44 | 44 | 44 | 44 | 44 | 44 | 44 |
| Information | Pearson Correlation | .642** | .569** | .231 | 1 | -.515** | .651** | .554** |
| | Sig. (2-tailed) | .000 | .000 | .131 | | .000 | .000 | .000 |
| | N | 44 | 44 | 44 | 44 | 44 | 44 | 44 |
| Age | Pearson Correlation | -.491** | -.386** | -.293 | -.515** | 1 | -.407** | -.411** |
| | Sig. (2-tailed) | .001 | .010 | .053 | .000 | | .006 | .006 |
| | N | 44 | 44 | 44 | 44 | 44 | 44 | 44 |
| VOC | Pearson Correlation | .758** | .390** | .354* | .651** | -.407** | 1 | .682** |
| | Sig. (2-tailed) | .000 | .009 | .018 | .000 | .006 | | .000 |
| | N | 44 | 44 | 44 | 44 | 44 | 44 | 44 |
| BDScore | Pearson Correlation | .660** | .491** | .525** | .554** | -.411** | .682** | 1 |
| | Sig. (2-tailed) | .000 | .001 | .000 | .000 | .006 | .000 | |
| | N | 44 | 44 | 44 | 44 | 44 | 44 | 44 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Lastly a descriptive analysis was conducted to identify the average and range scores for Vocabulary and Block design. It can be perceived that using the average age of all participants and their average Block Design and Vocabulary raw scores translated into scaled scores that participants tested average on the WAIS.

Mean scores for Block Design, Vocabulary and Age

| WAIS Subtest | N | Min | Max | Mean | Std. Deviation |
|---|---|---|---|---|---|
| BD Score | 44 | 16 | 57 | 32.273 | 9.585 |
| Vocabulary | 44 | 13 | 61 | 42.59 | 11.742 |
| Age | 44 | 65 | 90 | 76.16 | 7.912 |

# CHAPTER VII

# DISCUSSION

## 7.1 General Discussion

This is a preliminary study in the process of developing an intelligence test for older adults. The final product ideally would be a short, electronic, self-administered, accurate and cost effective predictor of cognitive performance. This test should minimize the influence of extraneous factors such as administrator bias or fatigue. Also, the GIT will take into account general aging concerns such as arthritis, visual impairments and hearing loss. The current format of the GIT sets the foundation into a fully self-administered electronic intelligence test. Having a product that displays larger words, shapes, easily legible and simple to administer. The current study explores different subsections and their ability to assess for verbal and non-verbal skills. All these results should be replicated. All correlations and factor analysis should be validated in subsequent studies. Internal consistency should be reexamined if any changes are made to the question or the subtests. These results should only be taken as the beginning to further research and trials towards a more tailored older adult scale.

## 7.2 Statistical Review and Outcomes

Overall, the current study has satisfactory Cronbach's alphas. All the subscales met satisfactory reliability scales. Frequency scales were analyzed for each subtest administered to obtain a more accurate representation of the item difficulty level and eliminating redundant

items. These are preliminary items that are subject to change if later research identifies better alternatives. Factor analysis was conducted to identify variability among the items and accuracy of subtests to indicate for Verbal and Non-Verbal skills. An interesting observation can be seen in the variables Matrices and Information. Matrices was hypothesized to be a better indicator for a Non-verbal task whoever, it loaded on Verbal skills. Information was hypothesized to be a better indicator for a Verbal task whoever, it loaded on Non-verbal skills. Furthermore, Geometric shapes seems to be a predictor for both Verbal and Non-verbal. Possibly altering the original items in the subscale can make Geometric Shapes become definitely sided. Overall, these results show a positive start to further exploration in scale making and question development in this area.

7.3 Limitations

- Demographics
    - Due to time constraints the study was limited to a particular region. This limitation lead to an unbalanced in gender and ethnic demographics. Future studies should have greater versatility in location, that may create a more diverse demographic. Furthermore, women were more likely to participate than men. Possibly, exploring incentives to increase male participates rates.
- Administration
    - Some older adults experienced fatigue taking both the abbreviated WAIS and the GIT. Leading to a reduction of initial GIT items and the addition of a timed component. Ideally, the GIT would be the only test administered and the participants would take the test at their own pace. A possible alternative to a time component is having participants take the abbreviated WAIS one day and the GIT the subsequent day. Another concern with administration of the GIT is that due to

monetary limitations the WAIS III was utilized. An updated study utilizing the WAIS-IV could be beneficial to evaluate the consistency and compatibility to the current study.

## 7.4 Future Directions

The current study is a preliminary analysis that will prompt future studies in the area of elderly intelligence testing. In the field of intelligence testing there is a deficit in the area of older adults. Future studies should consider alternative subsections or questions to compare with the GIT. This will assess the reliability of the chosen subsections of the GIT. Furthermore, a computerized version should be developed to assess the practicality of computer testing on older adults. Tailoring and adding greater details to the current items will facilitate in the transition to computerized testing. A greater demographic should be tested both ethnically and gender wise to illustrate a more versatile norming sample. Ultimately, the current study has commenced a long process and awareness towards intelligence testing in a growing population. This study has shown positive insight in this area and future studies should further this research.

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