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## A Study of Intelligence and Personality

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## **Abstract**

This project is an investigation into the potential correlation between intelligence and personality. A dataset of 60 individuals that have taken both the Woodcock-Johnson III intelligence test, and the MBTI personality preference test, has been compiled and analyzed. As flaws were found in the methodology of previous study teams, the current, larger, dataset has been used to retest the previous teams' hypotheses as well as our own. The additional cases were able to produce findings at a statistically significant level.

## **Opening Comments**

*"The way we think about children and learning has evolved from trying to rank them in order of general intelligence to thinking about the kinds of intelligence they exhibit on a range of cognitive abilities. The best I.Q. measures, like the Woodcock-Johnson III (WJ-3) and the best personality measures with implications for learning styles, like the Myers-Briggs (MBTI), have become more compatible as types of intelligence meet types of personality based on cognition preference patterns. The current literature is unclear about whether the best personality and intelligence indicators are measuring the same thing (or closely related things) in different ways or not. They should be different.*

*The notion commonly held by the public and most psychologists is that no important link exists between personality and intelligence. Personality is regarded as a bundle of preferences with no pattern superior to another. That is to say, one particular personality type from the sixteen possible Myers-Briggs Type Indicator (MBTI) profiles is no better than any other. This is not true of intelligence, however.*

*A higher intelligence quotient is considered superior, or better than a lower one, evidence of a higher ability to carry out logical processes and most mental functions in general. Many different instruments exist to identify personality and intelligence. It is the intent of this project to focus on two of them: the MBTI will be used to measure personality, and the Woodcock-Johnson® III Tests of Cognitive Abilities will be used to describe one's pattern of intelligence. We intend to compare the results of these measures in the hopes that we will find correlations between some of the four dimensions of personality type and certain broad cognitive abilities associated with intelligence.*

*The I.Q. literature still refers to abilities. The personality literature tends to talk about inclinations and preferences. However, the learning styles "preferences" measured by the MBTI have proven to be correlated with performance on academic aptitude and performance measures. The SAT and MCAS are supposedly measures of college aptitude (the former) and student achievement (the latter) in high school, yet they correlate with the MBTI, especially the Sensing and Intuition dimension. Professionals familiar with the WJ-3 and MBTI suspect there may be more similarities than differences, between these measures of Cognitive Ability and "Cognitive Style." (Creed, 2005 private communication)*

*WPI has experimented with mass administration of the MBTI to incoming classes of students and has learned which students are most likely to struggle as freshmen. However what then? How does one get to the level of the specific problems in processing and acquiring information that are hampering student progress? These MBTI data would be more valuable if the relationship between the*

*MBTI and the WJ-3 were already known. The psychological counselors trying to diagnose problems in learning would benefit if the results showed that there was a pattern of relationships between the two tests that is strong and stable. By administering the MBTI to a group of students that have already had the WJ-3 administered on them, one could find out if there is a typical pattern of relationships between the indicators that is strong enough to immediately interpret MBTI differences in WJ-3 terms or not.*

*Many different individuals and organizations have a potential interest in the results of this study. Our advisor, Professor John Wilkes is extremely interested in the study as he is qualified in the use of the MBTI as a learning styles indicator and wonders if preferences are based on cognitive abilities. Hence, WPI may also benefit from any results we uncover that deal with that measure as WPI already has an MBTI archive tied to student course outcomes data. Jim Creed, an expert in the use of the Woodcock-Johnson, has been fascinated by this question for years, ever since he became qualified to use the MBTI. He is very eager to see some research on the subject and convinced the Woodcock-Muñoz Foundation to support the study. Many of Creed's colleagues in the field of educational diagnostics are also very interested in answering this question of whether a "quick look" at a student population using the MBTI should precede a detailed look at the individual students who are struggling, using the more expansive (and expensive) WJ-3.*

*Considerable value can be gained by a faculty trying to think about students in a new way, (as types of learners), through the use of the MBTI alone. However, there will be times when one needs to dig deeper to help individual students. The*

*WJ-3 could be used in cases of students with learning difficulties in order to distinguish when the problems are more serious than a disinclination of a student to learn how to do what doesn't come naturally to them. Extreme versions of this type of learner problem could be understood better, by knowing how the MBTI and Woodcock-Johnson III relate to one another. Some of the MBTI preferences are probably grounded in differential ability patterns measured by the WJ-3. Other student performance problems may be better explained not by an inability to do something, but rather by an unwillingness to do so because it not a well-developed cognitive preference. These kinds of problems, the MBTI picks up on better than the WJ-3.*

*The harsh reality is that school systems are unable to accommodate to the needs of all the different types of learners equally well. They are often inadvertently set up to meet the needs of some types of learners at the expense of the other types of learners. When perusing extreme cases to help a struggling student, it is best to know if this is the kind of student that normally thrives in the system or not, if a given type of learner tends to struggle anyway it would be worth knowing the coping strategies of successful learners of this type, so they could be taught to those who can't come up with them on their own. Conversely, when a type of student normally thrives, but this one is not, it is time to look deep than at preferences and enter the level of measure abilities looking for specific lapses.*

*It is not only theoretical interest that leads us to propose a study of the relationship between the WJ-3 and the MBTI, but a concern with helping students at risk of failure. We also want to encourage the movement towards a multiple*

*intelligences perspective on student learning that is grounded in reliable psychological measures. The two measures that we proposed to use together are interesting since they promise to help one understand student learning styles and tie them to the kinds of learning tasks, (and especially MCAS and SAT assessments) on which given types of learners are most likely to under or over perform. In combination, these two can be used with "normal" students, sub-groups could be considered to be "at risk" or individuals in noticeable difficulty. Our advisors are "qualified" to use them.*

*This is a good project opportunity for us, for several reasons. First, as mentioned previously our sponsor Jim Creed knows of no formal research on their relationship. So, to the knowledge of the students, faculty, and other professionals involved in this project, this is original research. We thought that the only research that has been done that links the MBTI to I.Q. involved performance on the Scholastic Aptitude Test, as you will see later in the paper. We assumed that Isabel Myers had PSAT scores for her high school students since she worked for the College Board and ETS while during her study of I.Q. and the MBTI, but actually in her book "Gift Differing", she refers to an I.Q. test that the schools all seemed to be using in the 1960's. She got some "real" I.Q. data from the school archives. She reports these results for nearly 9,000 high school students in the Philadelphia, and reports a modest correlation. Thus, the I.Q. measure in use must have been brief and mass administered, not a diagnostic tool with multiple dimensions. Hence, we are in a very good position to do some groundbreaking research in the field of psychology, despite Isabel's pioneering research when she was attempting to*



*validate the MBTI by predicting the relative average I.Q. scores of her 16 personality types. This will be the first look at the MBTI and I.Q. relationship with a modern multi-dimensional cognitive ability oriented I.Q. test. Therefore, we go into this knowing that there were hints from the past that the S-N scale might correlate to I.Q. in the past. We even have Isabel's rank ordering of how the 16 types should correlate to an I.Q. measure's overall composite score. It is no longer pure conjecture that personality preferences may be grounded in patterns of cognitive ability.*

*Personality and cognitive ability are two of the major aspects of psychology used to distinguish human beings in a society. Finally, we are continuing the research of six WPI students (Quinn et al., 2005) (Chery and Brock, 2005) who were approached by an educational diagnostician experienced in the use of the Woodcock-Johnson test battery, Jim Creed. He was willing to help them acquire the materials to administer the Woodcock-Johnson if they would assist him in doing research to answer this question. In our case (and that of Blanchette and Wood, 2006), the plan was to acquire the necessary data from school systems where he was training the staff to use the WJ-3.*

*If personality preference and cognitive ability are proven to be related, there is really no telling how big an impact those results would have on theorizing in psychology. If it is found that personality tests with multiple factors and I.Q. tests of multiple intelligences are related at the level of the individual subscales, new theorizing will be called for. The MBTI is used to think about learning styles, leadership, job performance, standardized test performance, and interpersonal*

*relationships. Intelligence differences have not been an important part of that theorizing thus far. Indeed, efforts to relate I.Q. tests to performance measures outside of the school setting have not been very successful. (M.A. Wallach, (1971) "The I.Q./Creativity Distinction") The I.Q. tests of the past have not been related to success in life, only to academic performance.*

*In summary, our group is in a very good position to break new ground in the field of psychology, by correlating two prominent pieces of cognitive measurement technology rarely used together in the field of psychology. Since a professional in the field to help solve this problem, it is clear, approached us that there not only exists an interest in the scientific community to have this problem solved, but practical practitioner issues as well. Hence, we will be given the resources and support necessary to collect data. Some prior WPI students were trained in the use of the WJ-3, and administered to about 25-30 of their classmates. However, we hope to get cases where that data has already been collected through Creed's network of people trained in the use of the WJ-3 who are using it regularly with public school students. We feel that this project will serve as good research experience, as well as a compelling investigation into how these tools intersect with society. As we understand it, exploring the society-technology connection is the very essence of an Interactive Qualifying Project, and measurement devices, whether in Psychology or Mechanical Engineering, are technologies." (O'Brien, and Provencher)*

## **MBTI Psychological Preferences**

The MBTI places a participant into four dichotomies which, according to Jungian theory describe the major cognitive preferences and attitudes of the participant that shape their personality. These dichotomies describe how a person orients and receives their energy (E-I), how a person prefers to perceive\* and process data (S-N), how people make rational decision on judgments based on their perceived data (T-F), and lastly the attitudes (J-P) that people have in place regarding their cognitive functions. The latter indicate what the dominant factor in one's personality is. Each participant is placed into one of each of these dichotomies and labeled with one of 16 possible 4-letter acronyms describing their pattern of preferences.

### ***Extraversion / Introversion (E-I)***

The Extraversion / Introversion pair of psychological preferences considers where a participant places their energy and attention. One's attention and energy flow is typically outward or inward. This preference also determines the method in which one's dominant function is shown.

### ***Extraversion (E)***

Extraverts focus their energy and attention outward. Their presence often has an energizing effect on a crowd. As large groups of people are a preferred environment, Extraverts often have many friends and acquaintances. Often Extraverts are considered outgoing and work well in group environments. Projects are often started quickly and sometimes carelessly by extraverted people. A preference for extraversion also indicates that a person's dominant cognitive

function will be presented in an extraverted way and the secondary cognitive function will be presented in an introverted way.

### ***Introversion (I)***

Introverts focus attention and put their energy towards themselves and the thoughts they have in their inner "world." These are people that are stimulated by and thrive on processing their own ideas, pictures, memories, and reactions rather than by what is going on around them. Working alone or with one or two well known people is the preferred environment for introverts. Projects often move along slowly such that ample time exists for reflecting and deciding whether or not to act. Introverts are described as reflective and reserved. They may have fewer friends but often know their friends very well. A preference for introversion indicates that a person's dominant cognitive function will be presented in an introverted way, and the secondary cognitive function will be presented in an extraverted way.

### ***Sensing / Intuition (S-N)***

The Sensing / Intuition pair of psychological preferences considers the preferred method by which a person receives information from their environment. Similar to right on left and handedness, these functions are not rational in that a person does not have control over which method they prefer to use to receive information. However, they can and do learn what is situationally appropriate and do not always act in line with their preference. For Extraverted people with a "Perceiving (P)" attitude of their cognitive functions will have this preference as their visible to the outside dominant function. An Introverted dominant function is not

visible to the outside world so if the S-N is dominant they will appear to an outsider as T or F, as the auxiliary function is “Extraverted” by an Introvert.

### ***Sensing (S)***

Sensing individuals pay close attention to the physical reality around them and have the tendency to perceive information using their five senses. They will often focus primarily on things that are factual, objective, tangible, and currently present. A keen attention to detail is also common with sensing individuals. Sensors are practical and are more comfortable learning via a hands-on method. Problems are solved by processing all the details until the problem is understood. “Big-picture” conceptual mastery is formed at the end from a series of facts by using a “bottom-up” process. It is also possible for sensing individuals to miss the big picture on new opportunities by continually analyzing details and facts. Seeing the trees, but not the forest, is something they have to learn to guard against.

### ***Intuition (N)***

Intuitives pay attention to their impressions and patterns of information that may be uncovered. Thinking a problem through is considered a more effective path to a solution than using hands-on experience or gathering lots of factual data. They tend to think the necessary information is present if only they can pick on the subtleties and nuances. These people often consider the future and what can be possible or what will be possible, rather than considering the pragmatic considerations and the record, present and past. Symbols and abstract theories excite intuitives even if they are unsure of how to use all the information. Events are summarized to an impression and judgment rather than retained as a group of facts

or details to be referred to later in raw form. Reading “between the lines” and looking outside the box is the preferred way for an intuitive to gather and process information. The big picture is the first thing considered when working on a problem or mastering a concept. The details needed to apply the concept to solve the problem are accrued later, after they become “relevant” and can be attached to the general abstract concept. Intuitives use a “top-down” approach to learning and solving problems.

### ***Thinking / Feeling (T-F)***

The Thinking / Feeling pair of psychological preferences refers to how one prefers to make decisions using the data they acquired with their preferred and less preferred perceiving functions (S-N). Everyone can use both of these methods to make a decision but all people have a preference which is consciously learned and applied. Using a preferred mode of decision making and checking it with the other method often reveals different information about the dynamics of the decision itself. Extraverted individuals with a Judging (J) attitude of their preferences will have this preference act as their dominant cognitive function and that will be visible to outsiders. Introverts with a T or F dominant will appear to be S or N to the outsider or they Extravert their auxiliary function. When the Judging preference (T-F) is dominant, coming to a decision is the goal and the perceiving function is subordinate means to this end.

### ***Thinking (T)***

Thinking individuals have a tendency to use true-false and if-then Boolean logic to make decisions. Their sense of Integrity leads them to want to find

the most basic truth or principle and apply it to a situation regardless of the human interpersonal or team moral effect their decision may have. Justice, and fair play, not harmony, is the overriding consideration. Systematically analyzing pros and cons of a situation is considered a necessity to arrive at a logical and objective (unbiased) decision. Being truthful is often regarded as more important than being tactful. Sometimes these people are seen by others as too task-oriented or simply uncaring or lacking in empathy.

### ***Feeling (F)***

Feeling individuals make their decisions by weighing value consideration and the long term needs of the involved in teamwork or affected by the outcome together with the objective details of the situation. Finding what is best for the people involved is of primary importance when solving a problem and that requires being able to see them from their point of view. These people are very communication oriented and considered warm and caring but sometimes too idealistic and indirect. Harmony between people is of paramount importance. Decisions are made with the "heart" rather than the "head," which means an F will subjectively empathize with those affected by the decision in order to make the best possible decision. This often leads to more tactful and evasive case by case solutions rather than standing on principle and insisting on the coldly presented (and potentially cruel) truth.

### ***Judging / Perceiving (J-P)***

The Judging / Perceiving pair of psychological preferences considers how one lives their "outer-life" and the behaviors that others will notice. This preference

decides which cognitive function (S-N, T-F) is dominant in ones personality. One's interaction with the outside world is shaped either by how one prefers to take in data (S-N) or how one prefers to process data and make decisions (T-F). The J/P preference indicates which cognitive function one extraverts, not which one is actually dominant. However, using both J-P and E-I information one can tell which is, in fact, the dominant.

### ***Judging (J)***

Judging individuals use their decision making preference (T-F) in their outer life and their perception preference (S-N) as an internal supporting function. It appears to others that judging individuals are organized and planned, and have a burning desire to have all decisions made such that life is under control. Common activities of judging individuals are making to-do lists, avoiding procrastination, being disciplined and task oriented, and rushing toward the immediate goal or finish line. The emphasis is on being done, getting closure, and moving on to accomplish other things.

### ***Perceiving (P)***

Perceiving individuals display their perceiving function (S-N) externally and their decision making function (T-F) is the hidden support function. It appears to others that perceiving individuals try to understand the world around them and adapt to it rather than organize it or impose their will in it by controlling things. It also appears that perceptives are spontaneous and flexible in responding to events changing around them. They change their minds and let their plans be reshaped by circumstances as they unfold. Sometimes decisions are not made, in the hopes that



a conflict will resolve itself before the time arrives. Perceptives often use the pressure of an approaching deadline as motivation to get work done. They do not like to make a decision before they have to do so due to external pressures.

## **Cattell-Horn-Carroll (CHC) Theory**

CHC Theory is comprised of a framework of 3 strata; general intelligence, broad cognitive abilities, and narrow cognitive abilities. There are nine broad abilities (Gf, Gc, Gv, Ga, Gsm, Glr, Gs, Gq, Grw) which comprise over 70 narrow abilities. This is the underlying theory used to create the WJ-3. Seven of these nine are tested by the WJ-3 which allows enough empirical data to make reasonable conclusions on the cognitive abilities of the subject. Descriptions of the seven tests are as follows.

### ***Fluid Intelligence / Reasoning (Gf)***

*"[Fluid Intelligence / Reasoning is] the use of deliberate and controlled mental operations to solve novel 'on the spot' problems (i.e., tasks that cannot be performed automatically). Mental operations often include drawing inferences, concept formation, classification, generating and testing hypotheses, identifying relations, comprehending implications, problem solving, extrapolating and transforming information. Inductive (inference of a generalized conclusion from particular instances) and deductive reasoning (the deriving of a conclusion by reasoning; specifically: inference in which the conclusion about particulars follows necessarily from general or universal premises) are generally considered the hallmark indicators of Gf. Gf has been linked to cognitive complexity which can be defined as a greater*

*use of a wide and diverse array of elementary cognitive process during performance.” (Blanchette and Wood)*

### **Comprehension-Knowledge (Gc)**

*“[Comprehension-Knowledge] can be thought of as the intelligence of the culture that is incorporated by individuals through a process of acculturation. Gc is typically described as a person’s wealth (breadth and depth) of acquired knowledge of the language, information and concepts of a specific culture, and/or the application of this knowledge. Gc is primarily a store of verbal or language-based declarative (knowing ‘what’) and procedural (knowing ‘how’) knowledge acquired through the ‘investment’ of other abilities during formal and informal educational and general life experiences.”(Blanchette and Wood)*

### **Visual-Spatial Abilities (Gv)**

*“[This is] the ability to generate, retain, retrieve and transform well-structured visual images.” The Gv domain represents a collection of different abilities reach that emphasize a different process involved in the generation, storage, retrieval and transformation (e.g., mentally reverse or rotate shapes in space) of visual images. Gv abilities are measured by tasks (figural or geometric stimuli) that require the perception and transformation of visual shapes, forms, or images and/or tasks that require maintaining spatial orientation with regard to objects that may change or move through space.”(Blanchette and Wood)*

### **Auditory Processing (Ga)**

*“[Auditory processing refers to] abilities that ‘depend on sound as input and on the functioning of our hearing apparatus.’ A key characteristic of Ga abilities is*

*the extent an individual can cognitively 'control' (i.e., handle the competition between 'signal' and 'noise') the perception of auditory information, the Ga domain circumscribes a wide range of abilities involved in discriminating patterns in sounds and musical structure (often under background noise and/or distorting conditions and the ability to analyze, manipulate, comprehend and synthesize sound elements, groups of sounds, or sound patterns. Although Ga abilities play an important role in the development language abilities (Gc), Ga abilities do not require the comprehension of language (Gc)."*(Blanchette and Wood)

### **Short-term Memory (Gsm)**

*"[Short-term memory is] the ability to apprehend and maintain awareness of elements of information in the immediate situation (events that occurred in the last minute or so). [This is] a limited-capacity system that loses information quickly through the decay of memory traces, unless an individual activates other cognitive resources to maintain the information in immediate awareness. "*(Blanchette and Wood)

### **Long-term Storage and Retrieval (Glr)**

*"[This is] the ability to store and consolidate new information in long-term memory and later fluently retrieve the stored information (e.g., concepts, ideas, items, names) through association. Memory consolidation and retrieval can be measured in terms of information stored for minutes, hours, weeks, or longer. Horn differentiates two major types of Glr—fluency of retrieval of information over minutes or a few hours (intermediate memory) and fluency of association in retrieval from storage over days, months, or years. Exstrom distinguished two additional*

characteristic processes of Glr. '(1) reproductive processes, which are concerned with retrieving stored facts, and (2) reconstructive processes, which involve the generation of material based on stored rules.' Glr abilities have been prominent in creativity research where they have been referred to as idea production, ideational fluency, or associative fluency. "(Blanchette and Wood)

### **Cognitive Processing Speed (Gs)**

"[This is] the ability to automatically and fluently perform relatively easy or over-learned cognitive tasks, especially when high mental efficiency (i.e., attention and focused concentration) is required. The speed of executing relatively over-learned elementary cognitive processes. "(Blanchette and Wood)

## **The Woodcock-Johnson III Tests of Cognitive Abilities**

The Woodcock-Johnson III offers many tests of cognitive abilities. The 14 detailed below test the seven CHC factors listed above. There are exactly two tests for each CHC factor and no tests have a median reliability below .72, which means that once a substantial quantity of data is acquired, it will be safe to assume the data will accurately reflect cognitive abilities.

### **Test 1: Verbal Comprehension**

"This test has four subtests namely, Picture, Vocabulary, Synonyms [and] Antonyms, and Verbal Analogies. Each tests a different aspect of English language development. Picture Vocabulary measures lexical knowledge. The test requires the person to identify pictures of objects. The beginning items require the subject to point to pictures of common objects. The remaining items require the subject to

*name pictures orally. The difficulty of test items increases gradually as the selected pictures are not necessarily commonplace, nor do they necessarily represent familiar concepts. The synonyms test measures vocabulary knowledge. The test involves the subject hearing a word and providing a synonym. The antonyms test measures a counterpart aspect of vocabulary knowledge. In this test, the subject hears a word and then must provide an antonym for that word. Finally, Verbal Analogies is a measure of the subject's ability to reason using lexical knowledge. In this test, the subject listens to three words of an analogy and must then complete the analogy with an appropriate fourth word. Verbal Comprehension has a median reliability of .9 in the age 2 to 19, and .95 in the adult range. The test corresponds to the Gc factor of CHC theory.”(Blanchette and Wood)*

### **Test 2: Visual-Auditory Learning**

*“This test is a long-term storage and retrieval exercise (Glr). The test requires the subject to learn, store, and retrieve a series of visual-auditory associations. On this test of the associative and meaningful memory, the subject must learn and recall rebuses (pictographic representations of words). Visual-Auditory Learning has a median reliability of .86 in the age 5 to 19 range and .91 in the adult range.”(Blanchette and Wood)*

### **Test 3: Spatial Relations**

*“This test measures ability in visual-spatial thinking (Gv). The task requires the subject to identify the two or three pieces that form a complete target shape. The difficulty of each test item increases gradually as pieces are flipped, rotated, and*

become more similar in appearance. *Spatial Relations* has a median reliability of .81 in the age 5 to 19 range and .85 in the adult range.”(Blanchette and Wood)

#### **Test 4: Sound Blending**

“This is [a measure of] auditory processing (Ga). The test measures skill in synthesizing language sounds (phonemes). The subject must listen to a series of syllables or phonemes and then blend the sounds into a complete word. The difficulty of test items increases gradually as words comprising an increasing number of phonemes are spoken to the subject. *Sound Blending* has a median reliability of .86 in the age of 5 to 19 range and .93 in the adult range.”(Blanchette and Wood)

#### **Test 5: Concept Formation**

“This is a test of fluid reasoning (Gf), and is a controlled-learning task. The task involves categorical reasoning based on principles of inductive logic. The test also measures an aspect of executive processing—flexibility in thinking, when required to shift mental sets frequently. This test does not include a memory component, which sets it apart from most other concept formation tasks. The subject is presented with a stimulus set from which he or she must derive the rule for each item. For all but the last few test items the subject is given immediate feedback regarding the correctness of each given answer before the next item is presented. *Concept formation* has a median reliability of .94 in the age 5 to 19 range and .96 in the adult range. “(Blanchette and Wood)

### **Test 6: Visual Matching**

*"This is a test of processing speed (Gs). Specifically, the test is a measure of perceptual speed. It measures the speed at which the subject can make visual symbol distinctions. There are two versions of the test. Visual Matching 1 is designed to be administered among preschool children and individuals who have developmental delays or reduced functioning. This version requires the subject to point to the two matching shapes in a row of four to five shapes. There is a two minute time limit and the subject is not required to write. Visual Matching 2 is for individuals above the developmental age of an average 5-year-old. The subject is required to look along a row of six numbers and circle the two numbers that are the same. The test items increase in difficulty, beginning with single-digit numbers and ending with triple-digit numbers. There is a three minute time limit. Visual Matching has a median reliability of .89 in the age 5 to 19 range and .93 in the adult range. Please note that only Visual Matching 2 was applied to the subjects in this project, and Visual Matching 1 was not administered at all."*(Blanchette and Wood)

### **Test 7: Numbers Reversed**

*"This is a test of short-term memory (Gsm). It is primarily a measure of short-term memory span, but it can also be used to measure working memory or attentional capacity. In this test, the subject must hold a sequence of numbers in memory while performing a mental operation on it, in this case, reversing the order of the numbers. Numbers Reversed has a median reliability of .86 in the 5 to 19 age range and .90 in the adult range."*(Blanchette and Wood)



### **Test 11: General Information**

*“This test measures comprehension-knowledge (Gc), namely the depth of the subject’s general verbal knowledge. General Information has two subtests. In the first subtest, subjects are asked “Where would you find...(an object)?” In the second subtest, subjects are asked “What would you do with...(an object)?” The test progresses in difficulty, beginning with objects that are commonplace and ending with objects that are more unusual. General Information has a median reliability of .88 in the age 5 to 19 range, and .94 in the adult range. “(Blanchette and Wood)*

### **Test 12: Retrieval Fluency**

*“This test measures an aspect of long-term retrieval (Glr), namely fluency of retrieval from stored knowledge. The subject is asked to name as many examples from a given category as possible in one minute. There are three different categories: things you eat or drink, first names of people, and animals. Retrieval Fluency has a median reliability of .83 in the age 5 to 19 range and .91 in the adult range. “(Blanchette and Wood)*

### **Test 13: Picture Recognition**

*“This test measures an aspect of visual-spatial thinking (Gv), namely, visual memory of objects or pictures. The subject is presented a set of pictures for five seconds, and is asked to identify a subset of those pictures among a field of distracting pictures. Verbal mediation is eliminated as a memory strategy; varieties of the same type of object are used as the stimuli and distraction images. The difficulty of the test increases as the number of stimulus pictures increases. Picture Recognition has a median reliability of .72 in the age 5 to 19 range and .79 in the adult range. “(Blanchette and Wood)*



**Test 15: Analysis-Synthesis**

*"This is a test of fluid reasoning (Gf), namely, general deductive reasoning, a thinking ability. It is a controlled-learning task in which the subject is given instructions on how to perform an increasingly complex procedure. In all but the last few test items, the subject is given immediate corrective feedback for each response before the next item is presented. The test actually involves learning a miniature system of mathematics, although this information is not told to the subject. The rest also contains some of the features involved in using symbolic formulations in other fields, like logic and chemistry. Analysis-Synthesis has a median reliability of .89 in the age 5 to 19 range and .94 in the adult range. "(Blanchette and Wood)*

**Test 16: Decision Speed**

*"This measures an aspect of processing speed (Gs), namely, the ability to make correct conceptual decisions quickly. The subject is shown rows of pictures. For each row he or she must locate as quickly as possible the two pictures that are most similar conceptually. There is a three minute time limit. Decision speed has a median reliability of .87 in the age 5 to 19 range and .90 in the adult range. "(Blanchette and Wood)*

**Test 17: Memory for Words**

*"This test measures short term memory span (Gsm). The subject is asked to repeat lists of unrelated words in the order they are given. As the test progresses, the number of words in each list increase. Memory for Words has a median reliability of .8 in the age 5 to 19 range and .85 in the adult range. "(Blanchette and Wood)*

## **Project History – The Approach**

The first two teams of Mary Brock and Joel Chery; Andrew Martin, Brad Gilmartin, Matthew Morneault, and Matthew Quinn began this study with a thorough and rigorous seven-week training seminar in administration of the Woodcock Johnson III by Jim Creed, a certified educational diagnostician who was one of the first people to wonder about the possibility of a correlation between the categories of the MBTI and the factors of the WJ-3. The four students on the theory and funding team and the two on the analysis team, worked together on data collection. They met twice a week for three to four hours with Creed and learned, to Creed's satisfaction, how to administer the WJ-3. With one-on-one attention from a professional trainer for several weeks, the students felt confident they could gather valid data points and thus a reliable dataset. Due to the rigorous training process, however, the team was left with only a few weeks to acquire the actual data set, and setting up the WJ-3 administration sessions was more difficult than expected. Only one of the six met their quota of 10 completed cases; and on average each collected 5 WJ-3 cases. Not all of these cases came with a completed MBTI however.

The original plan was to gather data only from WPI students who had already taken the MBTI, but some team members decided that the "hard" part was getting people to take the WJ-3. They sought friends and family to take the long one on one test and never got around to administering the second (MBTI) measure when they were available at home on break. Sometimes students were off campus when the administrators returned weeks later to ask for the MBTI data. The result is about 6 incomplete cases that (so far) cannot be used, and at one point there were 10-12 such cases.

The first team began by exploring the WPI class of 2006 database of MBTI scores looking for names of people who would still be on campus and available to administer the WJ-3 to. The team contacted these people while being trained to administer the WJ-3. Enough initially agreed, but as training dragged on over a month passed, and they heard nothing. When the time came, very few of these WPI students were still willing to offer their time for the study. There was no time to wait until their schedules were lighter. These cases were lost and a scramble was necessary to replace them. Thus, the data collection team decided to expand the scope of the data collection effort beyond the students and faculty at WPI who had already taken the MBTI. By the end of the last seven week period the team had collected nearly forty cases of WJ-3 and/or MBTI data and 31 of these cases were complete (both elements present) for a first round of analysis, by Joel Chery.

The second team to participate decided (with Jim Creed's advice) to foster a relationship with the local public school systems which were using the WJ-3. They hoped that this would lead to gaining access to large datasets, since only the 20 minute MBTI would have to be added to each existing case of the WJ-3. Half of the team (Caitlin Wood and Jessica Blanchette) presented their alma mater Fitchburg High School with a proposal to combine research efforts for mutual benefit. This proposal went to a guidance counselor. The team suggested that the high school could gain information about types of students who thrive and struggle in the school system and in return, Creed's WPI project team could gain a significant increase to the growing data set.

The Fitchburg H.S. representative knew Jim Creed and agreed to the proposal on the contingency that parental permission slips were to be signed by the parents of the students whose data would be used in such a study. After several weeks of waiting there was still no word from Fitchburg High School about the number of study participants. Guidance Counselors soon stopped returning letters, phone calls, and emails. By the time it became clear that this wing of the study had fallen through, the students were still not trained to administer the WJ-3 themselves, and had only increased the data set by adding their own WJ-3 and MBTI scores to the data set. All they could do was reanalyze the existing 33 cases in a slightly different but interesting way.

The other half of the team (Amanda Provencher and Brendan O'Brien) tried a similar strategy. They sent a similar proposal to the West Boylston Public School System in the hope of administering the MBTI to students who had already taken the WJ-3. Again, permission slips were required. (Jim Creed was training staff in that system just before the request was made.) Once again the school system agreed after many meetings that took weeks to arrange. This time it was a higher level decision maker, Director of SPED, who could commit to the system as a whole, that was involved, but it seemed worth the waiting for formal meetings.

When the school came through with about 15 cases of WJ-3 data, however, the team realized that many sections were missing and some of the data points were very old, even cases dating back to the 5<sup>th</sup> grade for current 10<sup>th</sup> and 11<sup>th</sup> graders. This meant data sets comprised of WJ-3 scores and MBTI scores with over five years between results. West Boylston claimed that it was prepared to update its files

and would retest the students. However, it was estimated that it would take a year to get twenty cases. Further, some parents were uncomfortable with their children taking “extra” tests (the MBTI) to be used for a study. The parents feared this would single their children out as needing special attention. Without a year to wait, the two team members begin to patch small holes in the existing data set by gathering MBTI data for existing WJ-3 cases without it and reanalyzed existing data (now with the addition of their own WJ-3 and MBTI scores) under a new set of hypotheses. They followed a logic similar to that of Mary Brock's hypotheses, and actually tested both hers and their own, departing substantially from Jessy and Caitland's approach.

The third and current team was left to pick up the pieces and devise a new strategy to get the data set up to at least 60 (and hopefully 75 or more) cases which would be statistically more likely to produce significant findings. The team started by once again contacting Jim Creed to begin training sessions as had been done with the first team. This time, however, meeting with Jim was not nearly as easy as it had been for the first project team, as Jim had a new consulting and training job that required him to travel much more often. While the team waited for Jim, they began to explore other possibilities.

As it had been nearly a year, the team decided to contact the West Boylston Public School System to determine the status of the twenty cases promised to Brendan and Amanda the year before. It was determined that the twenty cases had never had the WJ-3 re-administered to them by the school psychologist and the project had faded from their consciousness. The data collection team had not followed up and warned them three months in advance that they were coming, so

they thought the project was over and had not carried through. They had no idea that another team would form to finish the project. Lack of continuity in the members of the data collection team, and thus not keeping in contact with people who agreed to participate, again cost us cases that were, in principle, willing to cooperate.

Without another direction to turn, the students continued to contact Creed to get as much training as possible, and thus ended up experimenting with a WJ-3 preparation CD and observing the administration of the WJ-3 by Mary Brock (a veteran of the first group trained by Creed) to students they recruited for her to do the administration. Hence, it was not clear how long training would last before the new administrators would pass the certification test given by Creed.

In fact, it took six of the eight weeks the project was scheduled for the first two (Neel and Joyceline) to pass and thus be certified. However, they agreed to take on Mary Brock's role of administering the WJ-3 and MBTI even after their project was officially over. In the meantime, Mary Brock continued the actual administration to subjects that the other members of the team recruited for her. In this way, the current team was able to gather five additional cases. One of the three members of the reanalysis team, Nathan, was recently certified, which brought the total to three trained persons available to administer during the next school term. Hence, there was a month left to gather data. During this time twenty-five cases were added (including the five team members' own test scores). Approximately nine WJ-3's still lack MBTI's which means that they were unable to be incorporated into this round of the analysis. It is likely that at least half of these MBTI's can still be obtained, but the minimum goal of 60 cases was still reached in time for this analysis.

The analysis team also made a significant finding while adding cases to the data set that had been collected over the past few years. Joel Chery's dataset was created using raw Woodcock Johnson scores, as opposed to the normalized Z scores. This mistake compromised the validity of the findings from the previous teams' analyses, since they had all followed his lead in adding cases. Thus, a decision was made not to include their findings in the literature review but rather to reanalyze the whole data set and retest all the hypotheses.

The new analysis team obtained all of the original WJ-3 test scores from Jim Creed, and created a new data set from scratch, entering normalized Z scores into the working data set. These are far more suitable for comparative correlation analysis. It was decided that it was easier to retest the Brock, O'Brien and Provencher hypotheses all at once than to go through their reports hypothesis by hypothesis see if the prior (unpublished) results still replicate. Blanchette and Wood's procedures were different and the data could not be set up to test their hypotheses so rapidly. Hence, that remains undone. It should also be noted that the previous team used all 14 Woodcock Johnson test scores rather than the Z scores from the 7 basic functional units. The hypotheses will have to be adjusted to meet this new requirement, since there are typically two scales dealing with each dimension, and they should have been combined to increase measurement reliability.

### **Test Administration and Training**

Before the first team could start administering the Woodcock-Johnson battery of tests, they underwent training by one of the nation's foremost trainers, Jim Creed.



They spent about 10-12 hours with Creed (a few hours a week for four weeks), and then they spent time training each other (about 8-10 hours), before a final test was administered by Jim. He spent a great deal of time not only going over the test but also demonstrating what to do in situations where a test subject was difficult or not giving the expected or desired responses.

Before any training, the WJ-3 had been administered to each of the team members by Jim, partly to generate additional cases for the dataset but also so that each of the students would understand the point of view of the subject being tested. After each section, Jim discussed the meaning of the section, such as highlighting the skills that section was addressing. For example, the "Numbers Reversed" section not only tested one's ability to memorize sequences of numbers, but also how well one could manipulate the input and output it in the desired way. The students learned how each section of the WJ-3 tested different areas of cognitive ability. Afterwards, he stressed the importance of not telling the subjects what to expect on the test before they took it in order to test their true cognitive abilities.

For the rest of the training, the teams met with Jim over a four week period and spent two to three hours going over a few sections of the WJ-3 at a time. The lessons required two groups of three, each member with a specific role: a test subject, an examiner, and an observer. Roles were rotated until everyone had a chance to administer the test. The person role playing the test subject was instructed to be difficult, by giving incomplete or wrong answers, failing simple examples or not meeting the "floor" requirement of a specific test, going over the time limit, or asking many questions of clarification.



Jim explained that it was important to be patient and to speak with confidence when addressing our test subjects, so as not to make them uneasy. Also, he said it was important to not just read the test to the person (in a dry fashion) but rather to be personable with them (such as making eye contact, smiling, answering questions without violating the rules of the test). In order for a subject to be adequately assessed, he/she must be at ease. Jim observed both groups, and offered his own suggestions for administration, such as potential answers to certain questions, or ways to direct a subject to give an answer in a certain way.

When Jim was not present, the team members tested one another to gain experience. Each student had to give and receive at least two full tests to members of the group, each lasting about 2 hours. Jim offered suggestions on how to be a difficult test taker, based on his own experience as a seasoned administrator. Administering the test many times also familiarized the teams with the layout of the test and the answers, so that they were more confident in whether or not to query an answer, and became more knowledgeable about general administration, like how to set the book up so that one can see both the answers and the test subject's side, and how to write down the answers in the booklets. This was surprisingly difficult, because each test requires a different method for administration. For one test, the administrator must be able to point out many different parts of a page (as indicated by the test) in order to explain a concept to the subject. For another test, the administrator is required to write answers quickly while also keeping an eye on a timer. Usually there was a bit of juggling involved, so that the test would adequately assess someone's cognitive abilities. In the end, a half dozen engineering and

science undergraduates were meeting the standards Jim was used to in dealing with people who had graduate degrees in psychology.

## **Hypothesis Revision**

After finding the flawed data set left from previous project groups it became apparent that developing new hypotheses would not be necessary. Given the nature of the coding flaws in the previous data set, the previous hypotheses were never properly tested, and all previous findings had no validity. The strategy to use dimension by dimension rather than scale by scale analysis also made the prior findings less useful. As noted, the previous teams had developed hypotheses on each WJ-3 test administered to study participants, rather than the seven categories of tests. Each categorical result is in the form of standard deviation Z scores, derived from the results of two different batteries testing the same category. Resolving this issue of what the new hypotheses would be led us to examine the intersection of hypotheses for both tests in one category and look at their overall logic. The resulting hypotheses can be seen in Figure 1 of Appendix A.

These hypotheses were developed by the first project group, and modified to fit the current data set layout. A full explanation of the logic used for the development of these hypotheses can be found in the report [Intelligence and Personality \(2005\)](#) by Brock and Chery.

## **Data Analysis and Findings**

This project was an examination of the difference between the actual and predicted scores for each of the seven intra-cognitive scores in the WJ-3. All of the z scores for each MBTI personality type were entered into an SPSS file. Then the

Pearson Chi-Square and Pearson's R Correlation were calculated to determine if there was a relationship between certain MBTI personality variables and the different intra-cognitive scores of the WJ-3. We used Pearson correlation coefficients because our data was based on Z-scores, which are interval level data. Z-scores measure the distance, in standard deviations, that a data point is from the mean value of a data set.

After all of the calculations were complete, the Pearson's R correlation coefficients and their significance values were examined first. The Pearson's R correlation significance values assess the probability that any correlation reported is not really going to be present in the population under study, based on the size of the sample gathered from that population and the size of the relationship found in the sample data. Operating with a modest sample and not as much variation in the WJ-3 scores as would be found in the general population, the odds are against finding small relationships that will be considered reliable findings based on a consistent data pattern. Hence, we decided to set a liberal significance level for a first scan to see if anything was there. At the .10 level, there was a 1 in 10 chance of being wrong if we believed the sample data is representative of the population at large. On examining the data, we decided to use the more traditional .05 level of significance, representing a 1 in 20 chance of error, since our data were rarely in the fuzzy .1 to .06 range. Thus, if the Pearson's R Sig. was less than .1 the correlation was considered significant and that data was looked at more closely to see how strong the relationship was, as that would be a finding to report as a relationship present. Any data with a Pearson's R Correlation Significance value over .1 was considered

to be evidence of no relationship. The Pearson's R Correlation value was reported in all cases but a relationship was claimed only for .1 or less. The Pearson's R Correlation value indicates the direction and string of the relationship. Below is a table of all of the findings:

MBTI Preference vs. Woodcock Johnson Test Raw Analysis

MBTI	WJ-3 Test	% of Variance	Corr. Value	Corr. Sig.
E-I	Comprehension-Knowledge (Gc)	2.16%	0.15	0.26
E-I	Long-term Storage and Retrieval (Glr)	3.10%	-0.18	0.18
E-I	Visual-Spatial Abilities (Gv)	0.01%	-0.01	0.94
E-I	Auditory Processing (Ga)	0.61%	-0.08	0.55
E-I	Fluid Intelligence/Reasoning (Gf)	1.35%	0.12	0.38
E-I	Cognitive Processing Speed (Gs)	0.00%	0.01	0.96
E-I	Short-term Memory (Gsm)	0.55%	0.07	0.57
E-I	GIA extended	3.92%	0.20	0.13
S-N	Comprehension-Knowledge (Gc)	11.16%	0.33	0.01
S-N	Long-term Storage and Retrieval (Glr)	6.20%	-0.25	0.06
S-N	Visual-Spatial Abilities (Gv)	0.28%	0.05	0.69
S-N	Auditory Processing (Ga)	6.40%	-0.25	0.05
S-N	Fluid Intelligence/Reasoning (Gf)	10.30%	0.32	0.01
S-N	Cognitive Processing Speed (Gs)	1.14%	0.11	0.42
S-N	Short-term Memory (Gsm)	9.49%	-0.31	0.02
S-N	GIA extended	0.00%	0.01	0.97
T-F	Comprehension-Knowledge (Gc)	0.00%	0.00	0.98
T-F	Long-term Storage and Retrieval (Glr)	0.00%	0.01	0.96
T-F	Visual-Spatial Abilities (Gv)	0.04%	-0.02	0.88
T-F	Auditory Processing (Ga)	1.59%	-0.13	0.34

T-F	Fluid Intelligence/Reasoning (Gf)	0.04%	0.02	0.88
T-F	Cognitive Processing Speed (Gs)	1.80%	0.13	0.31
T-F	Short-term Memory (Gsm)	0.01%	-0.01	0.95
T-F	GIA extended	0.52%	0.07	0.59
J-P	Comprehension-Knowledge (Gc)	3.57%	0.19	0.15
J-P	Long-term Storage and Retrieval (Glr)	0.25%	0.05	0.70
J-P	Visual-Spatial Abilities (Gv)	0.09%	-0.03	0.82
J-P	Auditory Processing (Ga)	2.02%	-0.14	0.28
J-P	Fluid Intelligence/Reasoning (Gf)	0.04%	0.02	0.89
J-P	Cognitive Processing Speed (Gs)	0.37%	0.06	0.64
J-P	Short-term Memory (Gsm)	0.14%	-0.04	0.78
J-P	GIA extended	3.20%	0.18	0.17

Five significant correlations were found in the data. Below is a table of those relationships.

#### MBTI Preference vs. Woodcock Johnson Test Raw Analysis

##### Highly Significant Correlations

MBTI	WJ-3 Test	% of Variance	Corr. Value	Corr. Sig.
S-N	Comprehension-Knowledge (Gc)	11.16%	0.33	0.01
S-N	Long-term Storage and Retrieval (Glr)	6.20%	-0.25	0.06
S-N	Auditory Processing (Ga)	6.40%	-0.25	0.05
S-N	Fluid Intelligence/Reasoning (Gf)	10.30%	0.32	0.01
S-N	Short-term Memory (Gsm)	9.49%	-0.31	0.02

As can be seen, all of the significant correlations are with the Sensing and Intuition dimension of the MBTI in the .25-.33 range. They therefore account for between 6 and 11% of the variance in these 5 WJ-3 factors; however, the composite GIA is not correlated with S-N. These data show that five of the WJ-3 intra-cognitive scores are moderately correlated to the S-N MBTI preference.

The Comprehension-Knowledge (Gc) score has only 1 chance in 100 of not being related to S-N and S-N explains about 11% of the variance in Gc. Intuition is more likely to be associated with a higher Gc score. The Long-term Storage and Retrieval (Glr) score (significant at the .055 level) has 5 or 6 chances in 100 of really not being related to S-N, and about 6% of the variance explained. In this case it is the Sensing preference that is more likely to be associated with a higher Glr score. The Auditory Processing (Ga) score has 5 chances in 100 of not being related to S-N. About 6% of the variance is explained by the S-N preference. Again, Sensing is likely to be associated with a higher Ga score. The Fluid Intelligence/Reasoning (Gf) score has about 1 chance in 100 of not being related to the S-N preference. It explains about 10% of the variance and Intuition is the preference to be associated with a higher Gf score. The Short-term Memory (Gsm) score has about 2 chances in 100 of not being related to the S-N dimension, explaining 9-10% of the variance. This time it is the Sensing preference that is more likely to be associated with a higher Gsm score. With two stronger intuitive and three less robust sensing preference findings canceling out, there is no overall S-N relationship to GIA.

The GIA extended score for the E-I, and J-P preferences of the MBTI have been given a special notation, as there is a modest correlation of over 3% percent of the variance explained but a significance level that does not meet our minimum requirements. Below is the data from the analysis:

MBTI Preference vs. Woodcock Johnson Test Raw Analysis

Significant Correlations

MBTI	WJ-3 Test	% of Variance	Corr. Value	Corr. Sig.
E-I	Long-term Storage and Retrieval (Glr)	3.10%	-0.18	0.18

E-I	GIA extended	3.92%	0.20	0.13
J-P	Comprehension-Knowledge (Gc)	3.57%	0.19	0.15
J-P	GIA extended	3.20%	0.18	0.17

The significance level is reasonably close to our cutoff and thus it is still worth noting this given our small sample. The negative correlation of EI with GIr means that extraverts outperformed introverts on this dimension. The perceptives were getting the higher scores on Gc, than the judging types.

## Conclusion

With a total of 60 cases in the data set, we found 5 relationships between S-N and WJ-3 scales at or below the .05 level of significance. This round of data analysis also revealed four other findings above the .10 significance threshold that are worthy of note. They are worth of note because two of them deal with the overall composite GIA extended scale for overall intelligence and the S-N scale doesn't correlate with that due to internal inconsistencies within the WJ-3 scales dealing with overall intelligence. In conclusion, it is likely that a composite MBTI scale could be assembled from E-I and J-P that would correlate with the composite GIA scale.

As shown in Figure 2, the majority of significant findings are associated with the S-N MBTI personality dimension. The quantities of S's and N's in the data set were slightly skewed, with 25 cases who responded as S's, and 35 as N's. The S-N scale was strictly dichotomous. We did not take into account the reliability ratings representing the clarity of preference, or turn S-N into a continuous scale based on them.



Though the psychology literature includes studies that have used these coding practices the MBTI experts and advocates frown on turning MBTI dimensions into pseudo continuous variables, and for good reason. On the other hand we could have legitimately created three categories, clear S, indeterminate and clear N to refine their analysis. The reality is that this project team was consumed and delayed by data collection consideration and had little time left for analysis after doubling the size of the data set and changing some of the prior data entry decisions and procedure).

As shown in Figure 2 (Appendix A), very few of Brock's hypothesized findings were apparent in the findings. The only hypothesis to correspond to a finding is that N's will have a significant advantage in short-term memory.\* This finding accounts for about 10% of the variance. The rest of the actual findings were not predicted, and most predictions were not supported by the data.

### ***Recommendations for Future Study***

For the past several years, the future recommendation for this project has been to obtain more cases to gain a more significant and statistically plausible data set to study. This is the first year in which the data set is large enough to seek out trends within the data. This being the case, it is now reasonable to target study participants that will enrich the data set in the direction needed. For instance, special consideration should be paid to equalizing the difference in the number of S and N cases as most of the findings involve the S/N pair of personality preferences.

The general population is 60-65% S, but the WPI student body is 55-60% N. Clearly data collection needs to move off campus to diversify both the WJ-3 range

\* It is a stretch even in this case, since the correlation is negative. That means the Sensing types were really stronger on this dimension.



under study and the S-N variable balance in cases. In addition, there is a slight skew on the E-I pair of personality preferences which may affect the inconclusive finding that extraversion correlates with GIA, also. The finding is inconclusive because the correlation significance coefficient is slightly outside the range of our more lax data requirements (10%). With a significance level of .12, it is very possible that with more cases, and an even split of E's and I's that this number may drop down to an acceptable range. Finally, the number of T's far outweighs the number of F's in this study. No significant correlations were found, and it appears that none will emerge, however this can not be conclusive until many more F's are recruited into the study.

# Appendix A

		MBTI Types							
		E	I	S	N	T	F	J	P
Woodcock-Johnson Tests	Comprehension-Knowledge				■				
	Processing Speed		■						
	Visual-Spatial Abilities			■					■
	Auditory Processing			■					
	Fluid Reasoning				■	■			
	Long-term Storage/Retrieval				■				
	Short Term Memory				■				
	General Intelligence				■				

Figure 1 - Hypotheses

		MBTI Types							
		E	I	S	N	T	F	J	P
Woodcock-Johnson Tests	Comprehension-Knowledge			▨	■				
	Processing Speed		■						
	Visual-Spatial Abilities			■					■
	Auditory Processing			■	▨				
	Fluid Reasoning			▨	■	■			
	Long-term Storage/Retrieval				▨				
	Short Term Memory				▨				
	General Intelligence	▨			■				
Key	Hypothesized	■							
	Finding	▨							
	Hypothesized Finding	▨							
	Inconclusive Finding	▨							

Figure 2 - Findings

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