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Divorcing Speech Ability and Intelligence: Why the Two Can No Longer Be Strongly Linked Together

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Abstract

Human language is a complex cognitive ability that is still not fully understood by scientists. Except in rare occasions of extreme seclusion or disability, children are able to acquire language without explicitly being taught how. Though animals have the ability to communicate, their “languages” are not comparable to human language. Commonly, people believe that one’s language ability correlates directly to one’s intelligence. It is the purpose of this paper to explore that belief and test its veracity. My hypothesis is that this correlation does not exist or is at best weak. This will be done by looking at several language-related disorders and the effect they have on human speech.

Divorcing Speech Ability and Intelligence

Why the Two Can No Longer Be Strongly Linked Together

Introduction

Language is a capability that human beings often take for granted because it is used daily, all over the world, and with ease. Rarely do people consider their ability to speak to be a fascinating attribute and unique ability that is distinct from other animals. A famous German philologist, Max Muller (1887), is known for saying that “[l]anguage is our Rubicon, and no brute will dare to cross it” (p. 177). In other words, creating language is a capacity that is uniquely human. Though animals do indeed have forms of communication, such as bird songs and bee dances, such forms of language, according to scientific observation, are limited, unlike human speech.

The book *An Introduction to Language* explains that in a study of the bird songs of robins, researchers found that “[t]he robin is creative in his ability to sing the same thing many ways, but not creative in his ability to use the same units of the system to express many different messages with different meanings” (Fromkin, Rodman, & Hyams, 2007, 24). This book continues to draw distinctions between human and animal language, concluding that though animals do communicate, their communication is “stimulus controlled” (p. 24). There is no topic which human beings cannot discuss; the possibilities of subjects are endless for the human race. Animals, however, are limited by their instincts and environment to a finite number of communicative gestures and phrases according to their species.

Most humans are able to successfully exercise this unique language acquiring ability and produce meaningful phrases soon after their first year of life. Since babies master their

native language over the course of only a few years, being able to speak coherently may seem like a simple and basic skill. No one has to explicitly teach children the rules of grammar for them to correctly form most of their sentences. They pick up on grammar without even thinking about rules. In fact, if adults were to try to explain grammar rules to young children, the children would likely not understand them, even though those same children use the grammar rules regularly. Children begin to speak and develop language at predictable milestones depending on their ages. However, when learning a second language later in life, people realize how complex language systems are with all of the grammar involved in becoming fluent in the target language. Even after years of intense training, teens and adults who study other languages rarely master them to the point of sounding like native speakers.

Because children are such natural language learners, linguists such as Noam Chomsky propose that part of the brain is specifically in charge of language acquisition, and that it is no mere coincidence that the brain is able to pick up language so naturally (1959, 1962). Unlike Skinner's behaviorist approach, which claims that children must copy the language they hear to learn, Chomsky and his proponents believe that part of the brain is actually responsible for such acquisition (1957). In other words, in Chomsky's view, language learning is not just environmental, but is also biological.

Recent studies and discoveries about the parts of the brain seem to confirm Chomsky's idea that there actually is a part of the brain that is responsible for acquiring and processing language. Intelligence is defined by the *Random House Dictionary* (2009) as the "capacity for learning, reasoning, understanding, and similar forms of mental activity;

aptitude in grasping truths, relationships, facts, meanings, etc.” If language is purely learned by listening and copying as Skinner proposed, then one should expect that people who have normal to high intelligence to have also fair to very good speech abilities because they should be able to easily understand the grammatical relationships in language. If true, people with low intelligences should have very poor speech ability because they should not be able to apply grammatical patterns as easily as more intelligent people. It is the purpose of this paper to disprove this commonly believed high correlation between speech ability and intelligence.

Through looking at evidence based on current research, I hope to discover if this correlation between speech ability and intelligence is weak or strong, with the hypothesis in mind that the correlation is weak. I will examine the question of whether speech ability is more a product of certain areas of the brain than on one’s overall cognition level. Before going into the body information of this paper, I will first give background information on some of the new technology being used to study the brain because this technology can give a precise indication of what is occurring in the brain when one is exposed to language, whether written or spoken. In addition, the paper will discuss some general information about the brain structure and the division of its functions between its hemispheres. Another part of the background information that the paper will explore is the recent discovery of a gene which has been shown to be related to the ability to produce grammar. This gene is known as FOXP2, and its mutation plays a role in the disorders that are examined in the paper. I will finally give a brief description of the difference between content and function words in this

background section. Content and function words are important parts of speech for the discussion of the disorders that will be analyzed in this paper.

The body of the paper will then examine three disorders with symptoms that contribute evidence to the discovery of exactly how strong the link actually is between intelligence and speech ability. The first disorder is aphasia, followed by specific language impairment, and Williams syndrome. This examination will test if the commonly believed link between cognitive and speech abilities actually exists. Determining to what degree speech ability is connected to intelligence is important in order to further support or disprove current linguistic theories on language acquisition. Once decided that one theory is more accurate than another, researchers can move forward in their quest to comprehend what makes human speech so unique and how it develops.

Background

Technology

Scientific discoveries concerning the brain and its processes have quickly advanced at the end of the twentieth and the beginning of the twenty-first century as researchers using technology have developed instruments that view inside the brain and thus pinpoint exactly how intelligence and speech ability intermingle, if they do at all. Neurologists can use Computerized Axial Tomography (CAT), Magnetic Resonance Imaging (MRI), and Functional Magnetic Resonance Imaging (fMRI) to get cross-sectional images of the brain. The fMRI is more widely used today because it allows doctors to “observe both the structures and also which structures participate in specific functions” of the brain (“Roll of Functional MRI,” para. 1). With these cross-sections, they are able to see which areas of the

brain are damaged (Pinker, 1994). Such technologies allow physicians to identify what is causing a patient's neurological problems without having to perform dangerous surgeries that would otherwise be necessary. Because the danger is reduced, doctors have the ability to do more research and tests on brain functions. This new technology leads to new techniques of testing the brain.

In his book *The Language Instinct* (1994) Steven Pinker introduces some of the tests and techniques that are currently being used to examine the brain and the parts in which language faculties are stored. An example of a technique that has come about with the development of advanced brain technology is one performed by injecting a slightly radioactive watery liquid into patients' brains in a practice called Positron Emission Tomography (PET). When this injection is made, doctors can see, via computer images which light up in certain areas of the brain, the parts of the mind that are most active when using language. If part of the brain that should be responding during a test is inactive, the physician can determine that that part is damaged.

Another fairly recent technology used to measure brain activity is one that uses electroencephalograms (EEGs), which enables neurologists to see when the patient's brain reacts to language as it is read by a patient or spoken to him or her. When using EEGs, electrodes are placed on the patient's scalp to identify when a brain signal is sent in response to a linguistic stimulus. In other words, the patient may read words or a neurologist may read words to the patient to see if the brain is correctly being stimulated by the speech. Pinker (1994) also informs us that scientists use "Magneto-Encephalography, which is like the EEG but that can pinpoint the part of the brain that the electromagnetic signal is coming from" (p.

306). This technology is helping and will continue to help scientists map the parts and isolate the functions of each part of the brain, including the areas that deal with language ability. Eventually, this technology may help to prove, with physical evidence, that speech ability and intelligence share a weak link.

Brain Lateralization

In addition to knowing the basic technologies that have been developed to view and test the brain, having a proper basic understanding of the areas of the brain that are prominent in controlling language is foundational for understanding this search for the answer to whether one's intelligence necessarily determines the quality of one's speech. The technology mentioned above has greatly helped researches to discover these brain separations. Scientists now know that certain regions of the brain control certain functions and that the right side of the brain is indeed different than the left in what it controls. People are often either described as "right-brained" or "left-brained" because of these functional differences in the hemispheres. However, the separations of brain functions are not completely rigid between the left and right sides.

In the 1800s, when little was known about the specific functions of the different areas of the brain, a man named Franz Joseph Gall introduced the notion that different areas of the brain controlled specific body or mental functions. His view, known as "localization," was quite revolutionary for the period because the idea in his time was that the brain was a mass that collectively performed functions (Fromkin, Rodman, & Hyams, 2007). Though not every idea Gall had about the brain was true, localization is a valid theory, even today.

Much like Gall, this paper intends to demonstrate that the brain has more specialized functions than have been recognized in the past, and that the region of the brain that controls speech is an entity of its own, quite separate from overall intelligence. The book *Chomsky: Ideas and Ideals* talks about the separation of the functions of the brain by stating, “Chomsky has strikingly suggested that, just as the heart and the rest of the circulatory system are organs within their own structure and functions, language is a kind of ‘mental organ’ interacting with other mental organs” (Smith, 1999, p. 23). The part of the brain known as the corpus callosum, which is a bundle of nerve fibers, connects and allows communication between the left and right hemispheres. Interestingly, our brains are contralateral—that is, the left side of the brain is responsible for the right side of the body while the right hemisphere is responsible for the left side of the body.

The parts of the brain that have been found to be responsible for language ability are primarily located in the left hemisphere. Therefore, damage or mutations to some parts of the left part of the brain result in language usage difficulty. However, the right hemisphere of the brain is more responsible for non-verbal communication and also aids in sound processing. This division of responsibilities by the hemispheres of the brain is known as “lateralization” (Fromkin, Rodman, & Hyams, 2007, p. 45). Also, brain functions are not necessarily locked into the parts of the brain that are usually responsible for them. When a hemisphere of the brain is removed to cure epilepsy, for example, a procedure known as hemispherectomy, the other hemisphere of the brain usually takes over many of the functions that the removed hemisphere used to control. However, it does seem that under normal circumstances, the left region of the brain does handle issues of language to a greater degree.

With this in mind, one can understand why damage or disease affecting the left hemisphere of the brain could cause harm to one's speaking ability. More specific regions within the left hemisphere will later be mentioned to show exactly what the effects of damage to the left side of the brain can do and whether such damage can leave one's intelligence intact.

FOXP2: "Speech and Language Gene"

Technology has not just been helpful in showing the activity of the brain. Gene mapping has also advanced significantly with the improvement of technology used to study genetics. One gene has recently become crucial to the discussion of language and the brain, and particularly sheds light on the relationship between intelligence and speech ability. This important gene that is expanding scientists' knowledge of this topic is known as FOXP2. It was recently discovered to play an important role in speech development and abilities, due to the desire to find the cause of specific language impairment, which will be discussed later in this paper. However, this gene is not solely responsible for any part of language acquisition. FOXP2 is just one among many factors that contribute to one's ability to speak, overall. However, mutation of FOXP2 does have significant effects on speech. These effects give support to the hypothesis that speech ability is not very connected to one's intelligence. Some of the disorders associated with these mutations are discussed later in this paper with the intent of demonstrating that one's speech abilities are to some degree a separate entity from one's intelligence.

According to an article written by Gary Marcus and Simon Fisher (2003) called "FOXP2 in Focus: What can genes tell us about speech and language," FOXP2 is located on chromosome 7 and is part of a group of genes known as "forkhead-box" genes (p. 257). The

gene has been found to aid in other processes, such as embryo development of body tissues. Speech, therefore, is not the only function that this gene aids in. Despite the fact that FOXP2 is so important to speech, humans are not the sole possessors of the FOXP2 gene. Animals, such as rats and chimpanzees, also possess this gene, but in forms that differ from the human gene, though by only a few amino acids.

Marcus and Fisher (2003) explain that “[o]nly three amino acid differences distinguish the versions of FOXP2 protein found in mouse and man” (p. 261). In an article called “Ultrasonic vocalization impairment of Foxp2 (R552H) knockin mice related to speech-language disorder and abnormality of Purkinje cells,” the authors state that “[h]uman FOXP2 and mouse FOXP2 show quite similar expression patterns in the developing brain” (Fujita et al., 2007, para. 3). The article describes an experiment in which baby mice’s FOXP2 genes were mutated similarly to how humans with speech defects are mutated. Scientists observed that, in addition to other physical symptoms, the mutated mice could not produce their natural noise. This experiment gives strong evidence to how important the FOXP2 gene is for proper speech, and also proves that language acquisition is actually the responsibility of a specific part of the brain, as Chomsky theorizes.

An article, “Expression analysis of the FoxP2 homologue in the brain of the honeybee, *Apis mellifera*” reveals that “[t]he transcription factor FOXP2 is related to acoustic communication in vertebrates and, although widely expressed in various tissues, its mutations cause a speech disorder in humans and disrupt vocalization in mice” (Kiya, Itoh, & Kubo, 2008, p. 53). The experiment adds evidence that speech ability and acquisition is quite dependent on specific parts of the brain rather than on intelligence. Some scientists

think that comparing this gene in humans with its animal counterpart can aid in our understanding of what makes human language possible and unique. Other scientists believe that the presence of this gene in other animals is a proof of evolution. What scientists can know for sure is that this gene is confirmation of the idea that certain parts of the brain act to promote language acquisition.

Lexical Categories (Parts of Speech)

In order to understand how the FOXP2 gene alters one's speech ability as is revealed by some of the disorders that are discussed below, I will first introduce some distinctions between parts of speech. It is common knowledge that sentences are composed of various parts of speech. Nouns, verbs, adjectives, and articles are some of the parts of speech that make up the basic elements of a sentence. The words that compose sentences can also be divided into two categories: content words and function words. One book describes content words as those that "denote concepts such as objects, actions, attributes, and ideas that we can think about like *children, anarchism, sour, and purple*" (Fromkin, Rodman, & Hyams, p. 74). Content words have meaning built into them without necessarily being part of a larger context. Nouns, adjectives, and verbs would, therefore, fit into this category. Function words, on the other hand, serve as the glue of a sentence. They connect the content words together so that they form meaningful phrases. The same book remarks that "they specify grammatical relations and have little or no semantic content." Prepositions, articles, and pronouns, for example, are all considered function words, because without content words, they hold no inherent meaning. People suffering from two of the impairments that are discussed in this paper, aphasia and specific language impairment, tend to have difficulty

with function words rather than with content words, but maintain an overall normal cognition. This information is important in the continuing debate over the correlation between speech ability and intelligence.

Aphasia

Aphasia is a disorder that can make this correlation between cognition and language easier to see. Observing aphasia patients is one way to view intelligence and speech working separately within one human being. This language impairment is the result of head trauma, such as a stroke, or disease to certain parts of the brain resulting in language processing and production difficulties. Doctors can use fMRIs to locate the area and amount of brain damage (Fromkin, Rodman, & Hyams, 2007). Therefore, aphasia is not a hereditary or genetic related impairment. According to the American Speech-Language-Hearing Association, “Aphasia causes problems with any or all of the following: speaking, listening, reading, and writing” (American Speech-Language-Hearing Association, “What is Aphasia?” para. 1). There are different levels of severity of aphasia depending on where the patient is injured and to what degree of damage is done. Because this disorder is so broadly defined, it is divided into several sub-categories of aphasia that display more specific symptoms according to the region of the brain that is affected.

The American Speech-Language-Hearing Association notes that when people have difficulty with word usage and understanding, then they have global aphasia. It is described as global because it encompasses all of the typical symptoms attributed to aphasia. On the other hand, if they primarily just have problems with language comprehension, they have receptive aphasia. Those who suffer mostly from word usage problems have expressive

aphasia. In addition, patients with aphasia often develop dyslexia. It is therefore evident that aphasia is similar to autism and other disabilities in which symptoms are extensive, and not easily defined.

The most well-known and written-about types of this impairment are Broca's and Wernicke's aphasia. Because of the vast complexity of the brain, and the fact that technology has only recently aided in the study of it, these impairments were not properly named or studied until the late 1800s, and even then, the studies of this disorder were very basic. Despite having relatively recently been identified, Victoria Fromkin, Robert Rodman, and Nina Hyams (2007), explain that many possible cases of aphasia have been reported throughout history. They give the example of doctors in ancient Greece who wrote that some of their patients experienced a strange loss of speech ability and movement on the right side of their bodies, which are symptoms that are characteristic of those who suffer from aphasia.

Because aphasia is caused by isolated damage to the left hemisphere, it does not cause a decrease in the patient's overall intelligence. In other words, their thinking and reasoning skills remain on a normal level except when dealing with language. Fromkin, Rodman and Hyams argue that "the language difficulties suffered by aphasics are not caused by general cognitive or intellectual impairment...whatever loss they suffer has only to do with the language faculty" (2007, p. 42). Consequently, this impairment serves as an example of poor speech ability coexisting with unaffected overall intelligence.

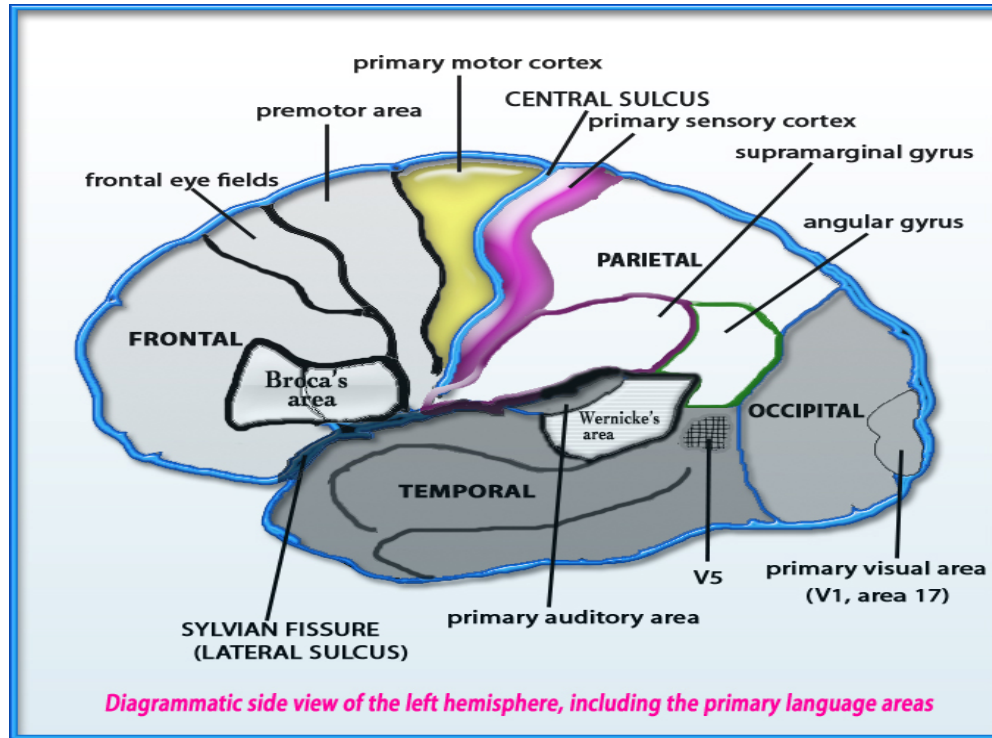


Figure 1

“Neuropsychology of Art: Neurological, Cognitive and Evolutionary Perspectives,” by .Z.Dahlia
(http://www.psypress.com/zaidel/images/figures/figure1_4.jpg)

Broca’s aphasia was named after a surgeon named Paul Broca who identified a certain damaged area of the brain as the root of language impairment for some of his aphasic patients in 1864. This damaged area of the brain was located in the front portion of the left hemisphere, next to the corpus callosum. Patients with damage to the left front portion of their brain exhibit several intriguing symptoms. One such symptom is difficulty in speaking fluidly. Patients with Broca’s aphasia struggle to find the correct word to say in the context of a conversation. In their efforts to recall the words they wish to say, they may pause or stutter for extended amounts of time and often use filler words such as “um.” For example, the following is a sample conversation taken from the book, *An Introduction to Language* (2007), of a person with Broca’s aphasia:

Doctor: Could you tell me what you have been doing in the hospital?

Patient: Yes, sure. Me go, er uh, P.T. [physical therapy] non o' cot, speech...two times...read...r...ripe...rike...uh write...practice...get...ting...better.

Doctor: And have you been going home on the weekends?

Patient: Why, yes...Thursday uh...uh...uh...no...Friday...Bar...ba...ra...wife...and oh car...drive...purpike...you know...rest...and TV.

(Fromkin, Rodman, & Hyams, p. 39)

This sample shows that the patient has a hard time thinking of the correct word to express in the situation but that he does indeed understand what is being asked. In addition to delayed speech, patients usually have difficulty with sentence structure and with the use of function words, or those words that lack inherent meaning, such as articles. The lack of function words can be seen in the example above. It is interesting to realize that a brain injury could be the cause of such a specific language ability loss. Because Broca's patients are better able to use and understand content words rather than function words, they may misunderstand sentences in which function words reveal the subject and object of the sentence rather than the order with which the words are placed in the sentence, such as occurs in passive sentences.

Attempting to have a conversation with a person suffering with Broca's aphasia would most likely be frustrating for the patient, as well as the other participant in the conversation, as it would move slowly and may make little sense. Broca's patients usually comprehend what others are saying and may know the essence of what they would like to say without the ability to recall the exact words they need to use to convey their message. This

inability to quickly recall desired words is called anomia (Fromkin, Rodman, & Hyams, 2007). People suffering with Broca's aphasia may be in a constant state of mental frustration due to anomia.

In 1874, Carl Wernicke's identified another area of the brain just ten years after Broca's discovery that, when damaged, causes a much different characteristic speech impairment. Like the Broca's area, the Wernicke's area is located along the corpus callosum. The region he identified became known as the Wernicke's area and aphasia caused by damage to this area is known as Wernicke's aphasia. The Wernicke's area is located in the rear portion of the left hemisphere. In contrast to the victims of Broca's aphasia, Wernicke's patients can easily and quickly form sentences, and usually they are formed with correct syntactic structure. However, the sentences that are spoken often do not make sense semantically. Instead, they may consist of invented words mixed with words that are related to the desired word, yet still not correct (Fromkin, Rodman, & Hyams, 2007). Wernicke's patients seem to be less aware of what they are saying and of what they are being told than do Broca's patients. Still, people who suffer from Wernicke's aphasia maintain normal non-verbal intelligence levels despite their language ability issues. *An Introduction to Language* (2007) also gives an example of some phrases spoken by a patient with Wernicke's aphasia after being asked how his health was: "I felt worse because I can no longer keep in mind from the mind of the minds to keep me from mind and up to the ear which can be to find among ourselves" (Fromkin, Rodman, & Hyams, p. 40). One can see in this example that there is no way to understand what the Wernicke's aphasic patient is trying to say and that there is no delay in the response, as there was in the Broca's aphasia example.

These two types of aphasia contribute to the evidence that one's language abilities are not necessarily dependent upon one's intelligence. While sometimes patients with aphasia have brain damage that is extensive enough to cause a decrease in overall cognition, in other cases, only language is affected. Smith (1999) says in *Chomsky: Ideas and Ideals*, "[s]omeone suffering from aphasia in this way may manifestly retain his or her intelligence in the absence of linguistic ability" (p. 24-25). This disorder gives researchers the rare ability to look at intelligence and aspects of speech as quite independent elements.

To ensure that this disorder is not related to any kind of hearing deficiencies on the part of the aphasiac, deaf aphasiacs were tested, and their language deficiencies matched those of hearing individuals with aphasia (Fromkin, Rodman, & Hyams, 2007). If speech ability were linked directly to a person's intelligence, damage could not be done to the brain that would affect one component without affecting the other. In other words, because aphasia affects speech ability without affecting one's overall IQ, this disorder strongly suggests that there is little correlation between intelligence and speech capability.

Specific Language Impairment

Specific Language Impairment (SLI) is a disorder, which like aphasia, causes its sufferers to have linguistic deficiencies. Patients with SLI have difficulty putting grammatical rules into practice due to a mutation of a gene in the part of the brain that would normally process grammar, FOXP2. The impairment can affect a person temporarily, as it does many children, or it may permanently affect one's speech. As one article states, "Specific language impairment is the most frequently diagnosed form of developmental

language disorder, affecting up to 7% of children who are 5 or 6 years of age” (Vernes et al., 2008, para. 3). The type of Specific Language Impairment that I discuss is called “dysphasia,” and its sufferers never recover or get over the disorder with age.

Though people with this impairment, when tested, usually have normal or even high intelligences, their brains cannot understand the idea of applying inflection and other grammatical rules. For example, rather than naturally and unconsciously thinking that if “boy” becomes “boys” in the plural, that “girl” must become “girls,” dysphasia patients must memorize each word in their mental lexicon individually, even if the rule for forming the plural are clearly told to them. Therefore, instead of learning all of the forms of the verb “walk,” such as walks, walked, walking, and applying the forms to other verbs, people may have to memorize each verb and its form separately. In his book *The Development of Language* (2001) Jean Berko Gleason asserts that “children with SLI have different underlying grammatical rule systems in which certain features of the grammar are missing or undeveloped” (p. 376). The mutated FOXP2 gene does not allow the natural learning and application of inflection to occur as it should.

Gleason (2001) also tells that people with SLI have difficulty with sarcasm and the subtleties of speech, and tend to interpret language in a very literal way. He says that this often causes social difficulties for those who suffer from specific language impairment. This impairment tends to run in families and seems to be a dominant genetic disorder. Also, studies have shown that there is no difference in the likelihood of a male to develop the disease rather than a female, and vice versa.

One family from Britain, known as the KE family, has been extensively studied by linguists because of the great number of family members who have the dysphasia disorder. Because the disorder is genetic and dominant, this family has a multi-generational case of this speech impairment. Myrna Gopnik is known for being the linguist who first studied the family in depth, over the course of several years. In an article she wrote, she says that there were thirty members of the family who suffered with SLI, and these thirty people composed three generations, who were between the ages of 2 and 74 (Gopnik & Crago, 1990). Her study, therefore, provides valuable information about the disorder and its long-term effects on the sufferer's lives. Many of the family members had the disorder while others did not have the mutated FOXP2 gene, and therefore did not suffer from dysphasia. Taking a closer look at the following research of this disease will help to deepen the argument that speech ability is not dependent upon intelligence.

Gopnik (1990), the linguist who did longitudinal studies on the KE family, found that the members of the family with the disorder had physical difficulty pronouncing words, as well as mental difficulty applying grammar rules that she used in her experiments. For example, in one experiment in which Gopnik asked her subjects to identify objects she was saying, the specific language impairment subjects showed difficulty distinguishing between singular and plural amounts of objects. She gave the example of the patient being confused when asked to point to a book on the table; the patient did not know whether to point to a pile of books, or a solitary book. Such results demonstrate that SLI patients have difficulty not only with grammar production, but also with grammar comprehension. However, this grammatical confusion, as stated above, is not due to a lack of intelligence. The article

“Fox P2 in Focus” argues that “[e]xamination of the cognitive profiles of members of the KE family indicates that this is not a generalized intellectual delay” (Marcus, Simon, & Fisher, 2003, p. 258). The following graph was produced by Gopnik as a comparison of her normal subjects and her dysphasic subjects while performing the experiment explained above. The colors of the bars on the graph have been altered to be more easily viewed.

Ability to discriminate s-marked plurals in simple commands.

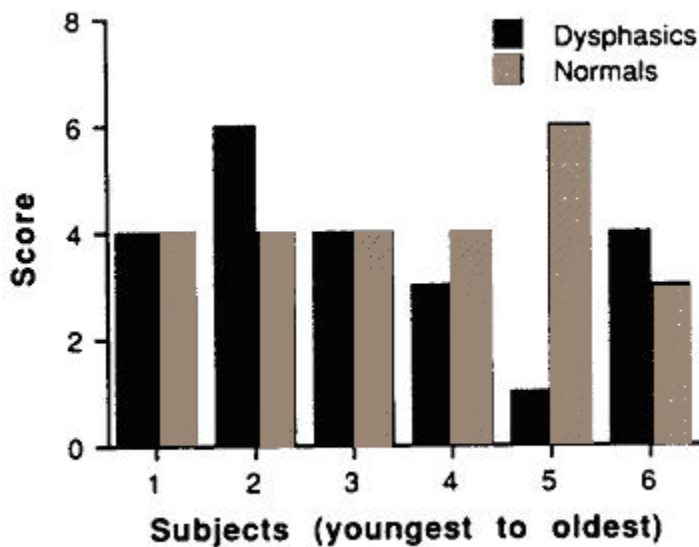


Figure 2
Gopnik & Crago, 1990

As the bar graph shows, normal patients are represented as the right bars in each pair, while dysphasic patients are represented on the left. Though some of the SLI patients were able to competitively score with the normal patients, or sometimes even surpass their abilities, when they did fail to identify plural markers, they failed to a much higher degree than their counterparts.

While conducting experiments, Gopnik (1990) notes that “[e]ven when the dysphasics managed to get some items right, they appeared to do some not by using the

normal internalized, unconscious set of rules for constructing plurals, but rather by finding a rule and applying it to all cases” (p. 18). Interestingly, Gopnik found that her subjects were able to produce irregular verb forms much more often than regular verb forms. This is because, as stated earlier, lexical items are memorized individually, and the irregular verb forms are easier to memorize because they are different than the rule-based regular verb forms.

She also reports that her SLI subjects took much more time to come up with answers in the experiment because their responses did not come automatically like the normal patients’ answers did. The part of the brain that would usually subconsciously apply rules is damaged, so SLI patients have to make a concerted effort in such exercises. Another experiment was performed by asking the patients to identify whether a sentence was grammatically correct or incorrect. Incorrect sentences contained tense and number errors.

The SLI patients scored very low on this evaluation compared to their normal control group (Gopnik & Crago, 1990). The unimpaired family members were used as the normal controls for these experiments because they not only used grammar correctly, but they shared an environment, and therefore more in common, than random control subjects would. This graph demonstrates how poorly specific language impairment patients scored in this experiment:

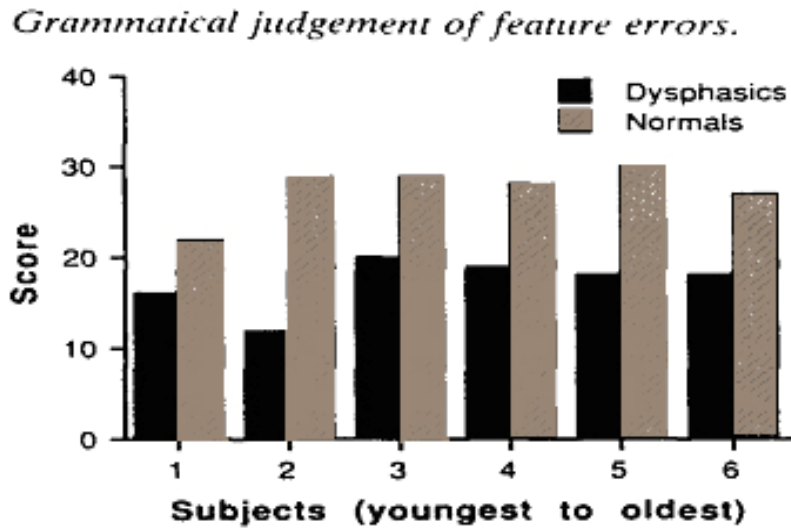


Figure 3
Gopnik & Crago, 1990

As the graph shows, family members with SLI were at an extreme disadvantage in the recognition of grammatical errors due to their impairment. Each dysphasic child scored much lower in this experiment than the normal children that they were compared with.

Gopnik (1990) observes that as the family members grew into adulthood, they were able to mask their language deficiencies better because they had taken speech therapy classes for years, but their language deficiencies quickly became apparent as tests were conducted and they were forced to apply grammatical rules that made them not be able to rely on their memory. For example, Gopnik would give the family members a created word and would then ask them to apply inflectional or derivational grammar rules to the word. Without having ever memorized these created words, the patients were unable to successfully apply the rules. No amount of classroom instruction could help them fully overcome their language disabilities. This fact accentuates the idea that language ability is not necessarily congruent with intelligence.

It would seem that surely, intelligence levels must play a role in this disorder since even little children can quickly and naturally learn how to apply grammar rules without explicit instruction from parents or teachers. A surface conclusion would be that if a person cannot perform a mental exercise that is simple to a child, then that person must have low cognitive abilities. However, this family's intelligence was not the cause of their speech ability problems, according to research done by Gopnik and others.

Chomsky's theory of innate speech ability seems to correlate with the results of this study, because if the region of the brain responsible for natural language acquisition were somehow to be damaged, language learning difficulties could arise without overall cognition being affected. Researcher, Steven Pinker says in his book *The Language Instinct* (1994): "Most of the language-impaired family members were of average intelligence, and there are sufferers in other families who are way above average" (p. 332). This finding supports my hypothesis that intelligence is unrelated, therefore, to the language ability.

Williams Syndrome

People who suffer from Williams syndrome, unlike those with aphasia and Specific Language Impairment (SLI), are known for having particularly low intelligences. This disorder will serve as an opposite, yet complementing example to the two other disorders. The intriguing aspect of this disease is that patients who suffer from it tend to have strikingly good speech abilities. Although Williams syndrome patients may make some grammatical mistakes when they speak, their ability to manipulate words and create syntactically sound sentences is incredible. Jean Berko Gleason asserts that "[l]exical development in WS [Williams syndrome] appears to be exceptionally strong" (2001, p. 359). Patients with this

impairment often have comparable general cognitive intelligence scores as Down's syndrome and autistic patients, and are therefore considered to be at least mildly retarded.

The Williams syndrome condition is due to a mutation on chromosome 7, where the FOXP2 gene is also located, as was discussed earlier in this paper. Other symptoms that accompany the syndrome are spatial judgment difficulties, memory, heart, kidney, along with other organ problems, depending on the patient. In addition, Williams syndrome sufferers have characteristic facial features, such as those that accompany down's syndrome and fetal alcohol syndrome patients. Because of these characteristic facial features that accompany this disorder, Williams syndrome is also known as "elfin-face syndrome." Williams syndrome patients have difficulty drawing and doing other activities that requires spatial planning and layout.

One interesting symptom of Williams syndrome, as described in Jones et al.'s (2000) article, is that patients with the disorder can be overly friendly, even to people they do not know. They may walk up to complete strangers and start conversations just for the sake of conversing. The article goes on to explain that "in circumstances typically eliciting social reservation (e.g., encountering strangers), infants, toddlers, children, and adults with WMS [Williams syndrome] frequently come directly up to and begin engaging strangers" (Jones p. 31). The article tells that such behavior is often a concern for parents of children who suffer from Williams syndrome. Williams syndrome patients truly enjoy and need interaction with other human beings, and they will seek it, regardless of whether the person they are interacting with desires their company. People with this syndrome have an amazing ability to recognize faces, even of people that they have only seen once, and even after long periods

of time have passed (Jones et al.). This unusual facial recognition capability, combined with highly developed language abilities, makes the people who suffer with Williams syndrome quite engaging and socially proficient individuals.

In their article comparing Williams syndrome with other disorders, “Hypersociability in Williams syndrome,” Jones et al. (2000) describe an experiment in which adolescents with Williams syndrome and with down’s syndrome were asked to describe pictures that they were shown by researchers. They were asked to describe the pictures in a narrative form. The researchers explain that the Williams syndrome patients were able to tell a story about the pictures with much greater detail than the Down’s syndrome patients, and with much more expression and engagement with the audience.

Not only do the WS patients describe the pictures, but they also add exclamations and expressions about how the characters in the pictures are feeling (Jones et al., 2000). It may be difficult to imagine a mildly retarded person describing a picture using advanced vocabulary and appropriate social expressions, but patients with this rare disorder display these very capabilities, though, as mentioned above, they may sometimes make minor grammar mistakes. The following excerpt from the article gives an example of a Williams syndrome narrative of a picture compared to a Down’s patient:

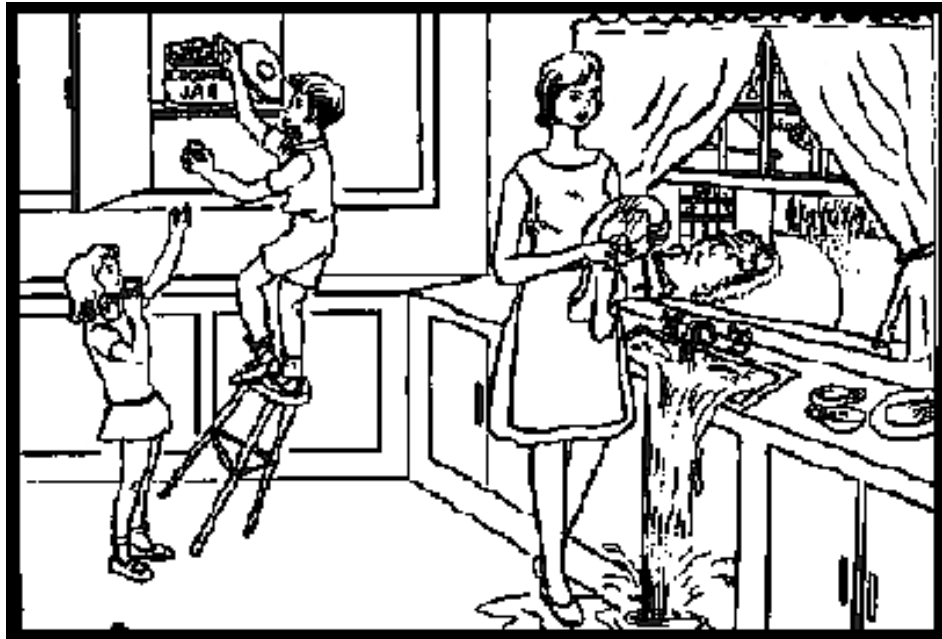


Figure 4
Jones et al., 2000, p. 32

WMS Age 10: (Laughs). Oh no. The mommy left the tap on (pointing to the water). And the boy is trying to get a cookie but the chair is tipping over. (in a high voice, as if addressed to the mother) Mom, won't you save the boy? (Returning to normal tone) Gosh. She better quickly save her boy. Her son and her daughter. Oh, there's going to be a flood on her floor.

DNS Age 10: Mom wash dishes. A bowl fell. Boy slips, boy pushed. Boy helps mom with dishes. Mom big mess in water. Pushing. (Examiner: Can you tell me anything else about the picture?) (Shakes head.)

(Fromkin, Rodman, & Hyams, p. 39)

In this example, there is clearly a big distinction between the amount of emotion and words used to explain what is happening in the picture by the Williams syndrome subject.

Also, one can observe that the Williams syndrome patient used many more function words than did the Down's patient. Bellugi, Wang, and Jernigan (1994) performed a test comparing patients with both Down's and Williams syndrome. Patients with Williams syndrome were much better at recognizing and correcting errors in phrases that they were presented with. This finding is quite an anomaly to logic, considering that people with Williams syndrome do not have higher intelligence than patients with Down's.

The article goes on to explain that "the language profiles of these two syndromes suggest that certain linguistic skills may become functionally independent from general cognitive ability" (p. 23). The researchers are therefore affirming the idea that language ability is not necessarily dependent on intelligence. Williams syndrome seems to prove, or at least add evidence to the argument, that speech ability cannot be fully dependent on intelligence. If this were not the case, people with Williams syndrome would have similar speech capabilities as those with Down's syndrome.

Smith (1999) says this concerning about intelligence and language in a section written about Williams syndrome: "the level of intelligence required for language acquisition has been grossly overestimated. Linguistic ability and intellectual ability dissociate" (24). Gleason's book puts it this way: "[c]ases in which cognition is grossly impaired, but language appears more typical may cause us to question the relationship between cognition and language" (2001, p. 347). In other words, what had once been thought about the relationship between cognition and language must be brought under scrutiny because disorders such as this one make it difficult to maintain the thought that higher intelligence necessarily produces higher speech ability and vice versa.

Conclusion

As with all scientific fields, linguistic and neurological studies have advanced greatly within the past few decades. With the increase in knowledge in these areas, questions about brain function are becoming more feasible to correctly answer through research. Linguistic theories, such as those proposed by Chomsky and Skinner, are now able to be tested to a much greater extent due to the new technology that allows scientists to have greater understanding of how the brain works. The question that has been explored in this paper is whether or not cognitive ability is necessarily an indicator of speech ability, the hypothesis being that the correlation is not strong. The descriptions of aphasia, specific language impairment and Williams syndrome are examples that should dispel the readers belief that intelligence has a strong link to speech ability. The recent development of genetic study and the discovery of the FOXP2 gene seem to point to a separation of the faculty of language from intelligence, since mutations to the gene have negative effects on language acquisition, without affecting IQ. Language disorders such as those this paper has discussed, aphasia, specific language impairment, and Williams syndrome allow researchers the unique opportunity to examine speech ability, or the lack there of, independently of intelligence.

Although speech impairment and low intelligence frequently do coexist with one another, aphasia, specific language impairment, and Williams syndrome build a strong case against the commonly held idea of correlation that people have about the issue. The fact that they do coexist does not mean that they are necessarily correlated, rather that there is some sort of link between the two. This paper has attempted to prove, using language disorders as evidence, that this link is weak, and that the strength of one does not necessarily determine

the strength of another. The normal intelligence and poor speech ability that is present in aphasia and specific language impairment demonstrate that damage, disease, or mutation can decrease language ability while leaving non-verbal intelligence intact.

Quite opposite these two, Williams syndrome shows that intelligence can be greatly impaired, while speech capabilities can remain relatively normal. This phenomenon cannot be ignored in favor of holding outdated views on intelligence and speech ability. While it may be more frequent to have language impairments in addition to low intelligence, the knowledge that this is not always the case makes it clear that the brain's functions are more separated and specific than has traditionally been thought. As research continues, and conclusions such as the one in this paper are made, the specifics of brain function will continue to unravel. This knowledge can help to undo assumptions about language and its place in the brain and can help further a correct understanding of how intelligence influences speech ability.

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