WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Decoding Language: The Prominence of Broca's And Wernicke's Areas in Neurolinguistics

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ABSTRACT

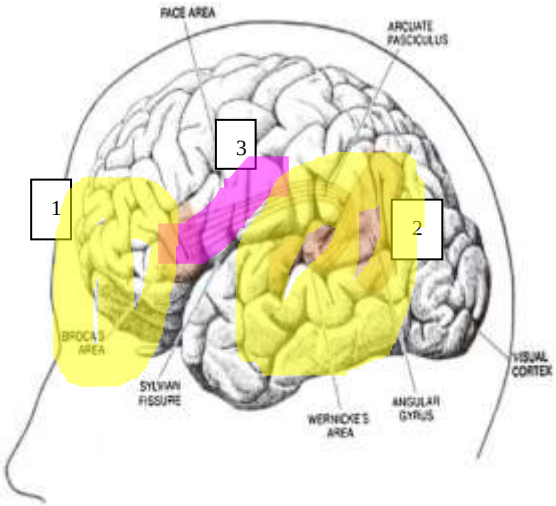
Almost every area of the human brain is activated during communication. Although the use of language dominates, other cognitive processes such as attention, memory, emotion, and executive functions play a crucial role. For decades, neuroscience has been trying to pinpoint the neural networks responsible for explaining how our brain "understands," "speaks," and "writes" to treat aphasic illnesses.This theoretical work explores whether specific anatomical features of Wernicke's and Broca's areas are unique to language. Investigating whether the specific anatomical features of the Wernicke's and Broca's regions relate to function of language. The localization of the crucial lesion for Broca's aphasia has long been debated, despite the fact that this is probably the most extensively investigated form of aphasia. The argument is supported by the use of citing examples to demonstrate that left hemispheric damage is the major cause of language disorders and that diverse left hemispheric damage causes varied language disorders.

Keywords: Aphasia, Broca’s area, Wrenicke’s area, language comprehension and language production.

Introduction

Neuro-Linguistics is the field of research that lays emphasis on the relationship between language and the brain. It may sound like a more modern term, but its roots go back to the 19th century. Discoveries in several fields enable linguists and neurologists to connect the links between language and the brain, which was only established in September 1848, and it has massive implications for a person's ability of language. A construction foreman named Phineas Gage met with an accident while working in the site. He had persistent major injuries, and it appeared as though a metal rod had almost entered his head through his upper cheek. The physicians determined that the recovery is not possible as that is a major injury. Even though he has a serious injury to his left brain, his sense of speech seems to be intact.

Since then, numerous researches have been carried out to investigate the speech region of the brain. By continuing to conduct in-depth research on the grey matter of the human brain, we can better understand the linguistic centers of the brain. When we dissect a human brain by disconnecting the brain stem from the spinal cord and cut the corpus callosum, we are exposed to right and left hemispheres. Geschwind's findings suggest that a study of the left hemisphere, which is believed to be in responsible for generating speech. The shaded region in the diagram below represents the area where speech is produced and word comprehension takes place. The existence of these regions was discovered primarily through the investigation of the brains of deceased individuals with known specific language impairments. That is, by identifying the brain regions with specific damage in the brains of people who had observable language difficulties, neurologists have attempted to estimate where the language abilities for a typical user must be.



The neurologist identified two different regions, later known as Broca's and Wernicke's regions. Technically known as the anterior speech cortex, the region of the brain indicated on the left side of the brain shown as 1 is more commonly known as Broca's area. French surgeon Paul Broca observed in the 1860s that serious difficulties speaking were correlated with damage to a particular region of the brain. No similar effects were associated with damage to the corresponding area in the right hemisphere. Subsequently, the left hemisphere has been found more closely associated than the right with language skills, and since that time, there have been claims that the production of speech was impossible without an intact Broca's area. Wernicke's area, indicated as 2, is believed to be a part of the posterior speech cortex. In 1870, German physician Carl Wernicke discovered the area of the brain that was damaged and was characteristic of comprehension problems. It was later found that damage in the area leads to problems with comprehension. The motor cortex, indicated in part 3, is an area that generally controls muscular movements. Next to the motor cortex is the region that controls the articulatory muscles of the face, tongue and larynx. The region has been said to be the motor cortex where electrical stimulation is often used to interfere with normal speech production, scientists have come to know that small amounts of electric current has effects on speech, if applied on specific parts of the brain.

It is believed that the brain is involved in hearing, speaking, and understanding language. The bundle of nerve fibers that is seen between Wernicke's and Broca's areas is said to be arcuate fasiculus. After identifying the four components, the neurologists could fix the aspects of language is related to the four different areas of the brain, which is said to be localization view. Wernicke's area, the arcuate fasciculus, and Broca's area are all significant in transmitting language from one individual to another. The words are heard and understood and then uttered physically via the motor cortex after they pass through Wernicke's area and the arcuate fasciculus. A number of discoveries enabled the neurologists to make sense of the speech mechanics. Freud used Steam Engine metaphor to illustrate how the brain works inside referring to numerous features of brain activities. He used it to explain the mechanism of suppression. These methods are those in which an attempt is made to identify the physical expressions of brain's linguistic activities.

Tongue Tip and Ear Slips

The neurologist identifies the root cause of the issues depending on the abnormalities in the different parts of the brain. The universal problem that every individual would have faced is the difficulty in recalling a word that they have used repeatedly. During research, it is revealed that the word storage system in a human can fetch terms that are familiar to them, but it is hard to recall words that are not so commonly used. The intended word and how we pronounce it normally show deep phonetic similarity. This results in malapropism, which was, in fact named after Mrs. Malaprop, a key character in Sheridan's Rivals and a habitual maker of near-mistakes. Spoonerism or a slip of the tongue is another common mistake. Take, for instance, the phrase "long short story," which is also at times written as "long shory stort." This error is a slip of the tongue and is also known as spoonerism. Slips of the tongue largely occur because of sound transposition between one word and another. For example, Black Bloxes or the sound of a word used in anticipation of another term, as in the case of noman numbers instead of Roman numbers. Besides this, there is another type of slip, which is supposed to be of reversal type, which can be illustrated by the phrase and sentence beel fetter or loop before you weep. It has been argued that slips of this kind are never random, never yield a phonologically inappropriate sequence, and always reveal different stages in the articulation of linguistic expressions. Though it is said to be articulation errors, neurologists believe it to be slips of brain.

There is, at times a slip of the auditory signal received, which is termed as ear slips. Hence, when this happens, one is liable to say "great ape" instead of "grey tape" in the office. When the young child speaks of a bear named Gladly, where she actually heard the song "gladly the ross I'd bear" at church. It's supposed to be a hybrid of malapropism that was derived from ears (transcendental meditation). These slips can be said to be minor, though major illnesses are mentioned in the case history.

Aphasia

Most people have probably done this at least once, but think about those with the syndrome. Those who are suffering from problems with language are described as aphasia. Aphasias are found to affect the parts of the brain that have to do with language. They are most often located on the

left side of the temporal lobe or frontal lobe in the brain. Aphasias may be caused by certain brain injuries such as stroke, head injury, tumour, or neurological disease. A condition where there is a disorder of language because of an injury to a part of the brain is referred to as aphasia. The major cause may be due to a stroke, when the blood vessels in the brain get blocked or ruptured. The nature of the disorders results in different forms of aphasia, which can remarkably change a person's capability to communicate through language.

Broca's Aphasia

One of the founders of aphasiology is Paul Broca. For more than a century, acquired language disorders have been studied with broca aphasia as the central point, now well established as a specific clinical entity. It was the first aphasia to be associated with a specific focal brain lesion. Broca introduced a new outlook and a rational approach to the study of aphasia. The French neurologist Broca published a case study from a patient nicknamed "Tan" or "Tan Tan" because "Tan" was the only syllable he could speak. Tan said "Tan" with proper inflection as many times as was needed as if he was making an emphatic point. He had a moderate amount of difficulty in comprehension and he was seemingly frustrated that he could not talk. A post-mortem examination of his brain showed that the lesion had mainly involved the lower parts of the left frontal lobe. And hence the name, Broca's area is given to this region. Patients with Broca's aphasia typically present with agrammatism, relatively sparing, although not always normal, auditory processing, and poor speech production. This patient has a severe language problem that makes it difficult to talk clearly distorted articulation and it will produce an uphill speech. The patients with Broca's aphasia, which results from injury to the frontal lobe, lack motor skills on their right side of the body and often understand speech but struggle to produce it. Even though they are using only one word or only a few words, plenty of labor and exertion goes into producing even those. Most of the time, patients realize how their problems reduce their production and damage their psyche.

Patients suffering from most of the agrammatic aphasia omissions utilize functional morphemes and inflections in place of lexical morphemes.

When such a condition emerges, they refer to it as agrammatic aphasia. For example, take the sentence "I eat sandwich drink juice for dinner" as reported by a patient with agrammatic aphasia. Those Broca's aphasia patients, who meet the criteria for agrammatism speech that is essentially devoid of properly utilised closed class or function words, come under this category. These patients typically speak slowly and laboriously. Some people could also have difficulties with phonetics. Early research only referred to such production problems when describing the nature of the agrammatism deficit. More recent research has also brought to light subtler comprehension disadvantages. Not every patient suffers from the same set of problems. Because of this fact, there exists much controversy on the legal status of agrammatism; to some, it is just a collection of unrelated symptoms that each might profit more from being investigated separately. Others ignore the agrammatic's other language abilities and consider the production deficits as definitional. Still, others try to give explanations that would cover all of the observed symptoms. A very serious disorder may result in a very serious and dangerous situation, where the patients will pause for a long time before speaking, will stutter a lot, and will experience difficulty articulating. However, language comprehension is superior to language production. It is also known as "expressive aphasia" or "non-fluent aphasia," and it is one of the most common forms of the condition. Broca's aphasia typically affects the following individuals:

Broca's aphasics have trouble articulating words. They may be unable to repeat back what you say to them, but they frequently repeat themselves numerous times or repeat short phrases again and again. More severe forms can lead to mutism or the ability to make only one sound at a time. Comprehension is only minimally affected. Those who have Broca's aphasia can no longer speak, although they do retain the comprehension of what others are saying. In fact, they can even realize when their speech is disrupted. Repetition is also a victim of Broca's aphasia; a patient will have problems repeating back anything you say to them. Damage to Broca's area, most commonly from strokes, tends also to destroy an area of the surrounding brain that is responsible for the control of muscles. Therefore, people with Broca's aphasia will also tend to suffer from some degree of paralysis on one side of their body.

Wernicke's Aphasia

Sensory aphasia is the type of aphasia where a person has the problem of hearing comprehension which generally is said to be Wernicke's Aphasia. Wernicke's aphasia is because of damage done to the temporal lobe which results in making patients speak fluent but entirely senseless phrases and sentences devoid of any direction most often with nonexistent and irrelevant words. Whereas some patients are not even aware of their mistakes others find it very hard to comprehend their speech and sentences. Though speaking clearly, someone with this medical condition finds it hard to make his points coherently, which makes it difficult for listeners to understand. There will be no relation between the words and the way that the speaker used expressions. Their speech seemed reasonably "fluent," that is, the speed and intonation sounded normal, but it contained odd semantic components. In the place of simple words, the patients would usually speak in complicated descriptions, or "circamlocutions." Occasionally, due to phonetic substitutions, words would hardly be recognisable. On other occasions, the patients would make up entire new words; which is known as "neologisms." The cognition of these patients was substantially hampered as compared with Tan Tan, a patient of Broca's who seemed to have normal comprehension. The lesion in Wernicke's cases was in the region at the posterior and superior part of the temporal lobe now known as Wernicke's area. Their lesions lay behind the lesion which Broca had found in Tan Tan. Wernicke's aphasia, the syndrome he described is now recognised as. Let us quote an example from Lesser and Milroy, 1993, where the speaker tries to make use of the strategies when he cannot think of the word 'kite' for an object in a picture.

Its blowing, on the right, er there's four letters in it, and I think it begins with a C- goes –when you start it then goes right up in the air I would have to keep racking my brain how I would spell that word – that flies, that doesn't fly, you pull it round, it goes up in air. This type of aphasia is often called "fluent aphasia" or "receptive aphasia," and it is quite common as well. Wernicke's aphasia is commonly found in the following:

That means they have no problem talking. But they often say something that is opposite or doesn't make sense. People who have it could invent new words or use the wrong language. Doctors call this "word salad." These individuals have a hard time understanding what other people are

saying. They might be able to understand very basic sentences, but the more complicated a sentence or phrase is, the harder it will be. The repetition ability of a person with Wernicke's aphasia might be impaired as this interferes with it. Because Wernicke's area of the brain is next to areas of the brain that control vision, those who suffer from this type of aphasia generally have impaired vision as well. Anosognosia – the inability of your brain to notice or identify any symptoms of illness – often afflicts those who suffer from Wernicke's aphasia. As a result, those with this type of aphasia usually either are not aware of it or can't comprehend it.

Conduction Aphasia

On the other hand, Conduction aphasia is one of the aphasias that has been linked with damage to the arcuate fasciculus. The patient with this disorder may not have problems with the pronunciation of words or the comprehension of words like those with Wernicke and Broca's aphasia. The only problem they face is a rhythmic disruption which is evident in the stops and hesitations they make. For example, take the words base and wash, which are pronounced as vaysse and fosh respectively, and see how difficult it is for them to reproduce the word. It should be noted that some types of aphasia are considered to be an underlying cause for other syndromes, as well, instead of being credited to the diseases above-mentioned. In this kind of aphasia, fluency is disrupted but not comprehension. Those who suffer from this find it very hard to pronounce the words out, mainly when you ask them to repeat what you said. The following tabular column helps us understand ailments brought on by brain injury.

S.no	Disorder	Speech Production	Language Comprehension	Reiteration	Identification	Lesion Area
1.	**Broca's Aphasia**	Not Fluent	Good	Poor	Poor	Anterior
2.	**Wernicke's Aphasia**	Fluent	Poor	Poor	Poor	Posterior
3.	**Conduction Aphasia**	Fluent	Good	Poor	Poor	Arcuate Fasciculus

Dichotic Listening

A reliable and valid measure of linguistic lateralization in the brain is dichotic listening performance. While there is an acceptance that dichotic listening is a test of language perception, there is little evidence of language functions with respect to dichotic listening performance. More specifically, language comprehension should be strongly concordant with perception of linguistic stimuli. In the present study, we analyzed reading comprehension, language abilities, and dichotic listening with an example.

Genie was a young girl who was admitted to the Children's Hospital of Los Angles in 1970. Having spent most of her life prior to this occasion chained to a chair in a cramped, dingy room and frequently thrashed by her father every time she made a sound since he couldn't stand the noise, and she was just thirteen years of age. Genie had no radio or television and the only human contact was with her mother, who was permitted only to feed her for a short time each day. Genie had been physically, sensorially, socially, and emotionally deprived all of her life. Predictably, Genie could not speak when she was initially placed in care. However, after a short period of time, she began to react to other people's speech and tried to imitate their sounds and make attempts at communication. She then started to speak and understand a great deal of the English words, which leads to provide some evidence against that language acquisition is impossible after the critical period. Nevertheless, Genie's diminished capacity for speaking with complicated grammatical structures does appear to offer some evidence for the argument that part of the left hemisphere of the brain is genetically programmed to receive a language program during development and that if such a program is not provided, as in the case of Genie, then the capacity is suppressed.

Tests on Genie showed that she had zero left hemisphere verbal capacity. So how did she go on to develop even a small amount of a language? According to those same tests, genie seemed to be using her right hemisphere for linguistic functions, which is an extraordinary finding. This finding, which is supported by other studies of right brain functioning, points to the possibility that our language ability is not limited to one or two localized areas but rather is founded on more complex interconnections throughout the whole brain. She showed a very strong left ear advantage for verbal as well as nonverbal signals in a dichotic listening test. It was noted that Genie passed through some of the same early stages reported in typical child language acquisition when he first began to use speech.

Summing up

We now know that language functions are intertwined with so many other cerebral activities and stretch far and wide across our brains. We also embrace the multifunction of the brain as well as functional reorganisation underlying mechanisms. Other parts of the left hemisphere central have also been damaged, in association with the different forms of aphasia. Anywhere within the "language area" around the Sylvian fissure which has moderate damage will struggle with finding the specific lexical items. Most anterior lesions, including those in the Broca's area, are associated with problems producing the sounds of language properly and constructing grammatical sequences of words. Damage to posterior regions around Wernicke's area is associated with issues with comprehension and "empty" speech. Damage to any of these areas can cause problems with repetition, but when the connections between the two areas are cut, difficulties with repetition only or primarily result. Aphasia can also be caused by damage to the subcortical structures that underlie the language areas because they interfere with the connections needed for language production. The study is limited to the brain's language areas and the aphasias related to them. Indeed, the study of neurolinguistic programming can be delved into more as it is truly relevant. NLP pertains to the nervous system, language, and how language is used in different situations.

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