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Linkages Between Brain Size and Language Capacity

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ABSTRACT

The organ in the human body that controls all movements and functions, including language, is the brain. The cerebrum, especially the left hemisphere, is crucial for language activities. The human left brain is a domain that functions as a place of concentration and as a regulator and controller of language abilities. The left hemisphere also appears to be involved in sign language processing, similar to how it is involved in non-signers. The right brain is also involved in complex ways but differently for sign language users. Studies on brain and language continue to develop and have shown significant progress. However, findings sometimes appear inconsistent, particularly regarding the involvement of the right brain in language. Many studies suggest that the second language can sometimes be located in the right brain, though this is not always the case. There may be variables that determine the brain's language localization, but these have not yet been fully identified. One factor may be the age at which the second language is learned, as well as the unique growth and development of each individual.

Keywords: Brain, Human, Language

I. INTRODUCTION

Language is a unique human cognitive system governed by formulas that can be manipulated by humans to produce an unlimited number of linguistic sentences using a finite set of elements. These sentences are used by humans as a means of communicating and accumulating knowledge. Language is a verbal tool used to communicate. It is a system of arbitrary spoken symbols used by members of a language community to communicate and interact with each other based on the culture they share.

The three opinions above can be linked to Chomsky's Innateness Hypothesis, which suggests that humans are naturally equipped with an innate faculty that enables them to acquire and produce language. This hypothesis emphasizes that every human being produces language from their brain. Lieberman states that every human society has a language that evolved naturally.

Neurology, the science that studies the nerves of the brain, is related to linguistics, the science that studies language acquisition, because the center of language is located in the human brain. Thus, neurolinguistics, as a new field, studies the structure of language, language acquisition, language teaching, language disorders, and the brain mechanisms that underlie language, both in the form of speech and sentences.

Language acquisition from the neurolinguistic perspective includes two processes in the brain: the productive language process (encoding) and the receptive language process (decoding). Listening and reading are decoding activities processed in the brain, involving the left and right hemispheres, as well as the parietal and temporal lobes. Meanwhile, the encoding process is a productive language process in the brain.

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II. METHOD

Research Design
The study employs a descriptive qualitative approach involving literature analysis and case studies to identify the relationship between brain size and language ability.

Population and Sample
The research population includes previous studies that have examined the relationship between the brain and language. The sample is taken from scientific literature, including journals, books, and relevant research reports.

Data Collection Techniques
Data is collected through an in-depth literature review, which includes:

- Scientific articles and books: Reviewing publications from neurolinguistics and neuropsychology that discuss brain hemispheres, particularly the left and right hemispheres.
- Case studies: Analyzing individual cases with brain disorders affecting language ability to understand the mechanisms behind language production and comprehension.

Data Analysis
Data is analyzed using content analysis methods with the following steps:

1. Categorization: Categorizing findings based on brain structure and its function in language processing.
2. Interpretation: Interpreting the relationship between brain size and weight with language ability.
3. Comparison: Comparing findings from various sources to identify common patterns and differences.

Validity and Reliability
Validity is maintained by using various credible and relevant data sources. Reliability is ensured through consistency in the data collection and analysis process.

III. RESULTS AND DISCUSSIONS

Brain Structure and Function
Hemispheres in the Brain

Each half of the brain is called a hemisphere: the left hemisphere and the right hemisphere, arising from the brain system that connects to the spinal cord. The hemispheres maintain contact with each other through a collection of fibers called the corpus callosum, which can be likened to electrical cables that provide currents to facilitate communication. The brain, together with the spinal cord, is referred to as the central nervous system. Each hemisphere is covered by the cortex, an outer layer of cells. The cortex is related to the function of the human and animal brain.

Each hemisphere of the brain consists of four lobes: the frontal, temporal, parietal, and occipital lobes. These lobes have specific tasks:

- The frontal lobe is responsible for cognition.
- The temporal lobe handles hearing.
- The occipital lobe manages vision.
- The parietal lobe is involved in somesthetic sense, such as the feeling in the hands, feet, and face.

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The left hemisphere typically involves language. The corpus callosum not only connects the left and right hemispheres but also integrates and coordinates their functions.

Brain Size and Weight

The human brain weighs between 1 and 1.5 kilograms, with an average weight of 1330 grams. Compared to the brain sizes of whales and elephants, the human brain is smaller. However, what distinguishes humans from animals, particularly in terms of language use, is not the size and weight of the brain. Whales and elephants have larger brains than humans but cannot speak. In contrast, microcephalic humans, whose brains weigh about 400 grams (similar to the brain weight of a three-year-old chimpanzee), can speak normally, whereas chimpanzees cannot. Humans differ from animals due to the unique structure and organization of their brains. For Western humans, the brain accounts for only 2% of their body weight but consumes 15% of all circulating blood from the heart and requires 20% of human metabolic resources.

Language Areas and Their Functions

Broca's Area, Motor Area, and Speech Production Pierre Paul Broca, a pathologist and neurosurgeon from France (1824-1880), was the first to find a connection between the brain and language. He identified an area on the brain's cortex, named Broca's area, which influences speech production. Broca's area is close to the motor cortex, which controls the movement of speech organs such as the tongue, lips, palate, and vocal cords. According to Broca's theory, speech production begins in Broca's area, which then sends signals to the motor area through nerve fibers, finally reaching the speech organs to produce speech.

Wernicke's Area, Auditory Area, and Understanding Speech Carl Wernicke, a neurologist from Germany (1848-1905), discovered an area named Wernicke's area, located near the auditory cortex in the temporal lobe. This area is crucial for speech comprehension and is connected to the auditory area by nerve fibers. According to Wernicke, when listening to a word, the sound enters the ear, reaches the auditory area, and then proceeds to Wernicke's area. When reading, information enters through the eyes to the occipital lobe's cortex, which handles vision, then moves to the angular gyrus, which connects visual information to Wernicke's area for comprehension. Once processed in Wernicke's area, the language information is sent to Broca's area for speech production.

Language and the Hemispheres in Other Areas

The left hemisphere is primarily responsible for language, but the right hemisphere also plays an important role, though less intensively. People with damage to the right hemisphere may struggle with organizing stories or narratives, drawing inferences, detecting ambiguous sentences, and understanding metaphors and sarcasm.

IV. CONCLUSION

The brain is a vital area in terms of language mastery, understanding, and usage processes. The ability of humans to master language can sometimes disappear due to damage to the human brain. In this article, the author explains the phenomenon of language in the human brain and language ability disorders that can arise from the degradation or decline of brain function, or even damage to the brain, which can occur due to aging and individual life experiences.

The study of the human brain and its relationship to language has long been a research focus. Research and exploration of the human brain have progressed with the development of high-tech methods, rapidly increasing our knowledge of the brain and its functions. However, we are still in the early stages of scientific understanding. The coming decades will undoubtedly show exciting developments as new technological methods are developed to investigate language and the brain more precisely.

The human brain is generally divided into two parts: the left hemisphere and the right hemisphere. The left hemisphere is a domain of the human brain that functions as a place of

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concentration and as a regulator and controller of language abilities. The left hemisphere is involved in sign language, as is the case with non-signers. The right hemisphere is also involved in complex ways but differently for sign language users.

The study of the brain and language continues to develop and progress significantly. However, inconsistent findings sometimes appear, especially regarding the involvement of the right brain. Many studies reveal that the second language can sometimes be located in the right brain and sometimes not. There may be variables that determine hemispheric location but have not yet been identified. One factor may be the age at which a second language is learned and the unique growth and development of each individual.

Language and the human brain are closely related. Discussing language immediately brings the brain into the conversation, especially regarding the human ability to use, master, and communicate through language for the sustainability of human life. Over more than forty years, exploration of the brain has advanced with the development of high-tech methods. Our knowledge of the brain and its functions has improved rapidly. The coming decades will undoubtedly show exciting developments with the advancement of new technological methods to investigate language and the brain more precisely.

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