Muharrik: Jurnal Dakwah dan Sosial – Vol.5, No.01, (2022), pp. 215 - 228
DOI: 10.37680/muharrik.v5i01.1069

Language and Brain: Neurological Aspects in Language Acquisition

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Received: November 01, 2021 | Revised: June 11 2022 | Approved: June 19, 2022

Abstract: The human nervous system consists of two parts, namely the spine and the brain. The brain itself consists of the brain stem and cerebral cortex, consisting of the right and left hemispheres. Each hemisphere is divided into four lobes: the frontal lobe, occipital lobe, temporal lobe, and parietal lobe, where each lobe has its function—the brain experiences both growth regarding its parts and mass or weight. The left and right hemispheres have their respective roles or functions, leading to a tendency to use hemispheres. The left hemisphere is more dominantly responsible for language, and logical and analytical matters. At the same time, the right hemisphere is more intuitive and imaginative. Concerning producing speech, the brain has a part called the Broca region. Then there is the Wernicke area which is responsible for speech comprehension. These two regions will work together for language processing in the brain. Besides, there is a system related to the workings of emotions in humans called the limbic system in the brain. This study wants to show the part of the human brain that off language processing usage in both men and women, in right-handed and ordinary people. The literature used is about various studies related to language and the brain.
Keywords: Brain, language, hemisphere, Broca's area, Wernicke's area

***Abstrak**: Sistem syaraf manusia terdiri dari dua bagianya itu tulang belakang dan otak. Otak sendiri terdiri dari dua bagian: batang otak dan korteks cerebral yang terdiri dari hemisfer kanan dan kiri. Masing-masing hemisfer terbagi menjadi empat lobus yaitu lobus frontal, lobus osipital, lobus temporal, dan lobus parietal di mana setiap lobus memiliki fungsi tersendiri. Otak mengalami perkembangan baik mengenai pertumbuhan bagian-bagiannya juga mengenai massa atau beratnya. Hemisfer kiri dan kanan memiliki peranan atau fungsi masing-masing yang kemudian memunculkan adanya kecenderungan penggunaan hemisfer. Hemisfer kiri lebih dominan bertanggung jawab pada hal bahasa, hallogis dan analitis. Sedangkan hemisfer kanan lebih kepada hal yang intuitif dan imajinatif. Dalam kaitannya dalam hal memproduksi ujaran, otak memiliki bagian yang disebut dengan daerah Broca. Lalu terdapat daerah Wernicke yang bertanggung jawab dalam hal pemahaman ujaran. Kedua daerah ini, akan bekerja sama demi terjadinya pengolahan bahasa di otak. Selain itu, dalam otak terdapat sebuah sistem yang berkaitan dengan kerja emosi pada manusia yang disebut dengan system limbik*
***Kata kunci**: Otak, bahasa, hemisfer, area Broca, area Wernicke*

Introduction

Language serves as the foundation of human cognition. However, this is still a matter of debate, partly because 'language' is often not well defined. Often the, language is equated with 'speech' or 'communication'. Still, it can be argued that language is described as a biologically determined computational cognitive mechanism that produces an infinite array of structured and hierarchical expressions. Recent brain imaging studies are consistent with the view of language as an autonomic, cognitive mechanism, leading to its view of neural organisation. Language involves a dynamic interaction of syntactic and semantic aspects that connect the inferior, and superior frontals in neural networks. temporal cortex functionally and structurally (Friederici et al., 2017)

The brain regulates all human behaviour. This includes language, so the neurological aspect is essential in language acquisition. Namely, the link between the human brain with language. Where the brain is the main organ in the human body related to linguistic or linguistic processes. The st, the ways and places where languages are processed is neurolinguistic. In the brain, the language process occurs in semantic encoding and grammatical encoding, while phonological encoding starts from the speaker's brain and is then carried out by the utterance in the speaker's oral cavity.

There are some differences between right-handed and left-handed people. It is often said that about 95% of right-handed people are “left brain dominant”. This is not the same as the “left brain” claim that this refers to the initial finding that most right-handed people rely more on the left hemisphere for speech and language. It is assumed that the reverse will be true for left-handers. But this is not the case. In fact, 70% of left-handed people also process more language on the left side of the brain (Willems et al., 2014). Researchers have discovered many other brain specializations, or "asymmetries," other than language. Much of it occurs in the right side of the brain, at least for right-handed people including things, like facial processing, spatial skills, and emotion perception. This assumption, coupled with the recognition that few left-handers have right-brain dominance for language, leading to them being ignored or worse, is actively avoided in many brain studies, because researchers assume that, like language, all other asymmetries will be reduced. How some lateralized (specialized) functions in the brain can actually affect the way we perceive things. We studied it using a simple perception test. For example, in a recent study, we presented facial images that were designed to

show half a face with one emotion and the other half with a different emotion, to a large number of right-handed and left-handed people.

Usually, people tend to see emotions shown on the left side of the face, which is believed to reflect specialization in the right side of the brain. This is related to the fact that the visual field is processed in such a way that there is a bias to the left side of the space. This bias is thought to represent processing by the right hemisphere, while a bias to the right is thought to represent processing by the left hemisphere (Karlsson et al., 2019). On the other hand, phonological decoding starts from the listener's ear, continues into the listener's brain with decoding, and ends with a semantic decode (Chaer, 2012). Neurological aspects need to be studied so that the results of experts' analysis about the brain's biological structure, the parts of the brain structure, and how a language is processed. In addition, it can also be known about which parts of the brain structure are in charge of producing language. There are also different functions of each brain hemisphere in normal and left-handed humans. These things will be examined in this paper. Research on language and the brain is discussed from several points of view, including gender differences that affect functional brain and language (Mascaro et al., 2017) (Xu et al., 2020), brain and language acquisition (Sakai, 2005) (Kuhl, 2010), (Wasserman, 2007).

Method

This study uses the type or approach of research literature study. Literature or literature study can be interpreted as a series of activities related to collecting library data, reading, taking notes and processing research materials. Descriptive research describes the social phenomena studied by describing the variable's value based on the indicators studied. This research includes descriptive research; descriptive research focuses on a systematic explanation of the facts obtained when the research was conducted. The data sources used for this research include books, journals, and internet sites related to the selected topics; several 20 books and journals discuss language and the brain. The data collection technique in this research is to do documentation, and then the data are analyzed deductively based on general facts about language and the brain then drawn to a specific conclusion.

Result and Discussion

Brain Structure, Function, and Development

a. Structure and Function of the Human Brain

In terms of size, the weight of an adult human brain is between 1 to 1.5 kilograms (Steinberg, 2001). For Westerners, this is only 2% of their body weight, and for Indonesian people, it may be less. However, with such a small size, the brain draws 15% of all blood circulation from the heart and requires 20% of human metabolic resources. Our entire nervous system consists of two main parts: (a) the backbone, consisting of a series of spinal cords and (b) the brain. The brain consists of the brain stem (brain stem) and the cerebral cortex (cerebral cortex). The backbone and cerebral cortex are the central nervous system for humans. Everything that is done by humans, both physical and mental activities, is controlled by this nervous system (Dardjowidjojo, 2003). The brain stem consists of parts called medulla oblongata, pons, and cerebellum. All three are related to the body's physical functions, such as breathing, heart rate, movement, reflexes, digestion, and emotional arising. The cerebral cortex deals with intellectual and language functions(Steinberg, 2001).

The cerebral cortex itself consists of two parts: the left hemisphere and the right hemisphere, which is connected by the corpus callosum. The physical appearance of the left hemisphere and the right hemisphere is almost a mirror reflection, but there are slight differences here and there, on the left hemisphere, namely the Wernicke region, which is wider than the same part in the right hemisphere(N Geschwind et al., 1997)(Dardjowidjojo, 2003). Each hemisphere is divided into four major parts called lobes, namely:

1. frontal lobe (frontal lobe), located in the front part of the brain;
2. Temporal lobe (temporal lobe), located on the side of the brain;
3. Occipital lobe (occipital lobe), located in the back of the brain;
4. Parietal lobe (parietal lobe), located in the upper part of the brain.

These four lobes have their respective duties. The frontal lobe is responsible for dealing with matters relating to cognition; the temporal lobe deals with things related to hearing; the occipital lobe deals with vision; and the parietal lobe takes care of the somaesthetic taste or taste found in the hands, feet, face, etc. In the frontal lobe, there is an area known as the Broca region. The name comes from a neurosurgeon named Piere Paul Broca, who investigated cases of speech disorders in humans and found

that "we speak using the left hemisphere". Then the area associated with speech was later known as the Broca area. Then in the temporal lobe area and somewhat protruding into the parietal area, there is an area related to comprehension known as the Wernicke region. The naming of this area is also the result of a study of a neurologist, Carl Wernicke.

In all lobes, there are what are called gyrus (gyrus) and sulcus (sulcus). Girus is a kind of hill or hill with its slopes, while sulcus is like a valley, the part that goes inside. Girus in the left hemisphere cortex and right hemisphere have their respective roles. The right hemisphere cortex governs elementary functions and the left side of the body, and the left hemisphere cortex controls the functions of the right body. If the right hemisphere is the presental cortex where the center of the body's movement is damaged, paralysis will occur on the left side of the body (Chaer, 2012).

To connect what we hear or see with what we say, a group of fibers is called the arcuate fasciculus (arcuate fasciculus)(Dardjowidjojo, 2003). The task of these fibers is to coordinate the hearing, vision, and understanding processed in the Wernicke area with the process of instruction in the Broca area. Near the Broca area, a little back, there is a path called the motor cortex. This cortex controls utterances such as the tongue, jaw, lips, teeth, and vocal cords.

In the temporal lobe, the primary auditory cortex (primary auditory cortex)responds to the sounds that are heard. There is a similar visual cortex in the occipital lobe, but its job is to respond to what is seen.

b. Human Brain Development

Language development is highly correlated with brain maturity and specialization. The development or growth of human brain cells takes place very quickly, from infancy to the end of adolescence. The introduction of a new environment in that age range triggers the birth of millions of new cells, and this growth will continue in adulthood, only relatively slowly. Development or growth of the human brain, according to Volve through consists of six stages, namely (Chaer, 2012):

1) Neural tube formation (3-4 weeks gestation);

2) cellular proliferation to form neuron and glia cell candidates (at 3-4 months gestation);

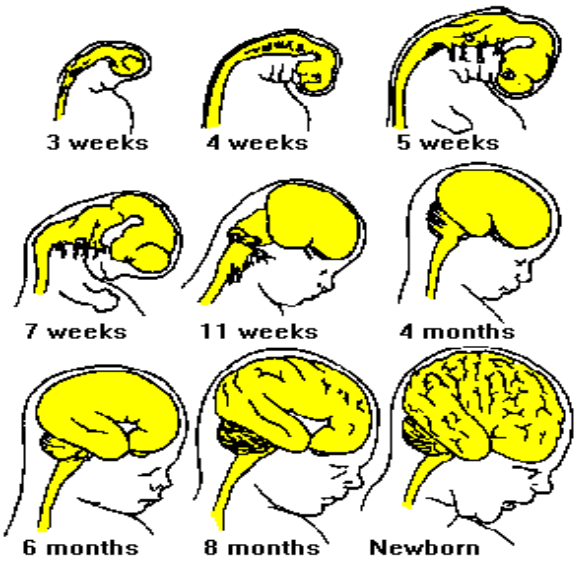
3) Cellular movement from sub-external germinal to the cortex (at 5-6 months of gestation);

4) cellular differentiation into specific neurons (at 7-9 months of age);

5) Development of axons and dendrites that cause increased synapses (dendritic development depends on the function of the area);

6) Selective selection of neurons, synapses, etc. for specifications.

The development stages 1-4during womb is not influenced by the outside world, while stages 5 and 6 continue after birthinfluened by the outside world or circumstances (Chaer, 2012). Can be seen in the following chart.



Brain development also occurs in its mass. The overall index of neural development is the gross weight of the brain, which changes most rapidly during the first 2 years of life, with three times the original weight of the brain at birth. By age 12 the brain usually reaches total weight. The following is the gross weight of the human brain from the age of 0-12 years and the percentage (Owens, 1992).

Gross Weight of the Human Brain		
Age	Weight (gram)	The percentage
0 month	335	25
6 months	660	50
12 months	925	70
24 months	1065	80
5 years	1180	90
12 years	1320	100

Diadaptasi dari *Neurology for the Speech Language Pathologist* oleh R. Love dan W. Webb. 1986, Boston: Butterwoths

Most of this increase is the result of myelination or sheath of the nervous system. The most fully developed sheath area. Myelination enhances the rapid transmission of information to nerves. Sex-related hormones partly control myelination, especially estrogen, which enhances its developmental process(N Geschwind et al., 1997)(Owens, 1992).

c. The Critical Age Hypothesis

Before reaching the age of 12, children can obtain any language that is natively presented to them. This is seen in the accent. This phenomenon is stated in the critical age hypothesis. In essence, the hypothesis says that between the ages of 2-12 years, a child can acquire any language with the ability of a native speaker. This happens because, before the age of 12 in children, there has not been lateralization, that is, the left hemisphere and the right hemisphere have not been "separated" for individual assignments. Both are still flexible and can still accept any assignment (Dardjowidjojo, 2003).

The lateralization process begins in early childhood or coincides with the period in which language acquisition occurs. It has been believed that childhood through puberty is the period when the brain is most ready to accept and learn specific languages. If the child does not acquire language during this period, for whatever reason, then he will have great difficulty when learning a language later on (Yule, 1990).

This hypothesis also assumes a relationship between human biological growth and the level of language acquisition. This hypothesis reads: (i) language mastery grows parallel to biological growth, and (ii) after puberty, the natural language acquisition has not happened again (Dardjowidjojo, 2003).

Lateralisation of Hemisphere Function

Lateralisation is a division of functions in which some functions occur in one hemisphere while others occur in another.

a. The role of the left hemisphere and right hemisphere

The left hemisphere controls all the limbs on the right, including the right face. In contrast, the right hemisphere controls the left limb and face. So, in terms of body control, the two hemispheres cross each other, the left controls the right, the right controls the left.

The eyes and ears are arranged somewhat differently. Although the numbers are different, there are nerve connections to the left and right hemispheres in each eye and ear. So from the left eye, there is a "cable connection" to the two hemispheres, only there is more to the right hemisphere than to the left hemisphere. This also happens to the opposite of the right eye. Because of this "cabling" system, if one of our eyes is disturbed or even blind, we can still see the object as a whole, likewise, in terms of hearing (Dardjowidjojo, 2003).

The left hemisphere is responsible for language, logical and analytical operations, mathematics, and verbal memory functions. Research shows that the language center is dominated by one hemisphere. The language center is the Broca region, in the front part of the brain, the Wernicke region, in the back of the brain, and the angular gyrus, in the very back of the brain (Steinberg et al, 2001: 318). In most humans, language skills are in the left hemisphere, almost 99 percent for ordinary people and 66 percent for left-handed people (Damasio & Damasio, 1992).

For more details, the specialization of the left hemisphere in language as in the following table(Taylor & Taylor, 1990)

Division of the Left Hemisphere and Right Hemisphere in Language		
Language	*Normal People*	*Lefties*
Left Hemisfer	95,5%	61,4%
Right Hemisfer	4,5%	18,8%
Bilateral	-	18,8%
Source: Segalowits & Bryden 1983, rearranged and retitled; by permission of Academic Press.		

The right hemisphere is involved in recognizing emotions, recognizing faces, and understanding the structure of global things without analysis. If the brain area that is related to the face is damaged, the person will not recognize the person's face, close family, and even his own face when looking in the mirror.

The right hemisphere is also associated with music and non-linguistic sounds, such as animal noise and sound. As we know, new research shows that the right

hemisphere has several language functions and can take over the full language function of the left hemisphere when it is surgically removed or damaged (Steinberg, 2001).

This can be proven in people whose right hemisphere is disrupted, it is found that their ability to sort events in a story or narration becomes chaotic. They are not able to map the first two and three people. These people also have difficulty drawing inferences. People disrupted by their right hemisphere cannot detect ambiguous sentences; they also have difficulty understanding metaphors and sarcasm (Dardjowidjojo, 2003). Specializes in the two hemispheres in the following chart (Taylor & Taylor, 1990):

Left and right hemisphere specialties	
Left Hemispheres	Right Hemispheres
Processing Mode	
Sequential	Simultaneous
Analytic	Wholistic
Verbal	Imagistic
Logical	Intuitive
Linguistic Material	
Verbal rehearsal	Imagery
Syntax	Receptive vocabulary
Speech output	Prosody
Phonetic letter	Single logograph
Literacy	Pragmatics, contextual

From this specialization, several trends have been identified between the use of the left and right hemispheres. Torrance via(Brown, 2008), lists several left and right hemisphere tendencies. Specialization of the left hemisphere, which performs logical processing and analysis, there will be a tendency that the left hemisphere likes certain information, likes multiple-choice tests, is not good at interpreting body language, and of course, solves problems logically. Then in linguistic material, the tendency to emerge is to prefer speaking and writing, relying on language in thinking and remembering, and rarely using metaphors. As for the right hemisphere, the processing specialization that is intuitive, imagistic, and holistic tends to like information that is uncertain and difficult to understand, likes open questions, is bright in estimating body language, and solves problems intuitively. In linguistic material, the tendency arises to like images and moving objects and often use metaphors.

b. Dominant Hemisphere

Although we can mention many different characteristics or roles of the left and right hemispheres, it is essential to remember that they operate together in a team. Most problem solving involves the capacity of both hemispheres, and often the best solution for a problem is the solution for each hemisphere to participate optimally (Brown, 2008). In the end, there is no dominant hemisphere because each has unique talents (Norman Geschwind, 1979)and brings different skills to a given task. Hemisphere is not competent to analyze data and response programs alone (Owens, 1992).

Linkage of the Brain to Language

a. Broca Area, Motorcycle Area, and Test Producer

Pierre Paul Broca was a pathologist and French neurosurgeon (1824-1880) who made the first significant discovery regarding the brain and language. He found a particular area involved with the area producing speech, then called the area of Broca. He found that damage to certain parts of the brain (Broca's area) was related to difficulty producing speech. It was noted that damage to the same area in the right hemisphere had no such effect. This finding was first used to state that language skills are located in the left hemisphere and have since described that the Broca region is involved in speech production(Yule, 1990). Broca notes that the speech area borders the motor cortex region, which controls the movements of the muscles of the articulator of the utterance: tongue, lips, jaw, soft palate, vocal cords, etc. He suggested that utterances were formulated in the Broca area and then articulated through the motor area sent to the articulator of the utterances for vocalization(Steinberg, 2001).

b. Waste system

Unlike the physical state of consciousness of the brain, a person's emotions are produced by beautiful chemicals related to the body's physiological processes so that, in the true sense, what affects the body influences the mind and emotions, and vice versa. The emotional center in the brain can be found in the limbic system, where the vast arsenal of emotions is regulated through the release of excitatory and inhibitory neurotransmitters. Excitement can be associated with chemical signals produced by noradrenaline release and pain associated with many neurotransmitters. The atmosphere is associated with serotonin and dopamine. In response to various stimuli,

emotions arise in the limbic system through travel along nerve pathways to the cortex's frontal lobe, where feelings are monitored and interpreted. Both brain structures subsequently affect the hypothalamus, which transmits messages that trigger an appropriate physical response (Turkington, 1996).

The limbic system connects the higher and lower functions of our brain, and it is called the "Emotional Center" and "Conscious System" of the brain. If we, as humans, must consider one part of our brain to be the core of our awareness, it will become the limbic system and, above all, the interaction between the limbic system and the cortex. Physical disorders or diseases of the limbic system cause changes in behavior (Gross, 2015).

Most neurological phenomena related to religious experience involve some form of over-activation of the limbic system. Conversely, Alzheimer's disease is associated with damage to the limbic system, and those who suffer tend to lose interest in religion, even those who have shown a lifelong interest in their religion (Spinella & Wain, 2006).

c. Language Processing

If the input is in oral form, the sounds are responded to by the temporal lobe, especially by the primary auditory cortex. After being received, digested, and processed, the sound of the language was sent to the Wernicke area for interpretation. The sounds are divided into syllables, words, phrases, clauses, and finally, sentences. After being given meaning and understanding its contents, there are two possible pathways. If the input is just information that does not need to be responded to, then the input is stored in memory. Someday maybe that information is needed. If the input needs to be responded to verbally, then the interpretation is sent to Broca's area through the arctic fasciculus (Dardjowidjojo, 2003).

In the Broca area, the response process begins. After it was decided what the verbal response sounded like, the Broca area ordered the motor cortex to carry it out. The implementation process in the motor cortex is also not simple. There an expression, there are at least 100 muscles out of 140,000 neuromuscular sequences involved. The motor cortex must consider the order of words and the order of sounds and features in each sound that must be spoken.

The processing path is somewhat different if the input is not in verbal form but written form. Input is not responded to by the primary auditory cortex but by the visual

cortex in the occipital lobe. This input is not sent directly to the Wernicke area but must pass through the angular gyrus that coordinates the understanding area with the occipital region. After this stage, the process is the same, that is, the Wernicke area understood the input, then sent to the Broca area if necessary verbal responses. If the response is also visual, the information is sent to the parietal area for visualization(Dardjowidjojo, 2003).

The tendency of oral production or output is better than writing production because it is necessary to optimize the work of the left and right hemispheres to produce writing. In writing, what is needed is the verbal ability and the ability to arrange sentence by sentence so that it is logical and has an element of beauty. So this is what causes writing activities to be considered more complex when compared to talking. In addition, good writing skills are also determined by the existence of well-developed writing culture. One thing we know is that language acquisition is very much determined by the complex interaction of aspects of biological, cognitive, and social maturity (Sholihah, 2018)so it can be said that biological maturity is the first and foremost thing that every human must have when producing a product language.

Conclusion

The neurological aspect is an essential aspect concerning language. That language can not be separated from the work of the brain as an organ. We know there is a process of processing and producing language in the brain and which parts are used in the language process. In addition to brain language, it also has an essential role in determining the responses that occur in our bodies. In addition to being related to physical work, brain work is also related to emotional work that occurs in humans. Thus this paper is very far from perfection. Hopefully, the input and suggestions will increase understanding and deepen knowledge regarding aspects of language neurology.

References

Brown, H. D. (2008). Prinsip Pembelajaran dan Pengajaran Bahasa. *Jakarta: Kedutaan Besar Amerika Serikat*.

Chaer, A. (2012). *Linguistik Umum*. Rineka Cipta. https://books.google.co.id/books?id=-zjpAAAACAAJ

Damasio, A. R., & Damasio, H. (1992). Brain and Language. *Scientific American*, *267*(3), 88–

109.

Dardjowidjojo, S. (2003). *Psikolinguistik*. Yayasan Obor Indonesia.

Friederici, A. D., Chomsky, N., Berwick, R. C., Moro, A., & Bolhuis, J. J. (2017). Language, mind and brain. *Nature Human Behaviour*, *1*(10), 713–722. https://doi.org/10.1038/s41562-017-0184-4

Geschwind, N, Devinsky, O., & Schachter, S. C. (1997). *Norman Geschwind: Selected Publications on Language, Epilepsy, and Behavior*. Butterworth-Heinemann. https://books.google.co.id/books?id=axQpAAAAYAAJ

Geschwind, Norman. (1979). Specializations of The Human Brain. *Scientific American*, *241*(3), 180–201.

Gross, R. (2015). *Psychology: The Science of Mind and Behaviour 7th edition*. Hodder Education.

Karlsson, E. M., Johnstone, L. T., & Carey, D. P. (2019). The depth and breadth of multiple perceptual asymmetries in right handers and non-right handers. *Laterality*, *24*(6), 707–739. https://doi.org/10.1080/1357650X.2019.1652308

Kuhl, P. K. (2010). Brain Mechanisms in Early Language Acquisition. *Neuron*, *67*(5), 713–727. https://doi.org/https://doi.org/10.1016/j.neuron.2010.08.038

Mascaro, J. S., Rentscher, K. E., Hackett, P. D., Mehl, M. R., & Rilling, J. K. (2017). Child gender influences paternal behavior, language, and brain function. *Behavioral Neuroscience*, *131*(3), 262.

Owens, R. E. J. (1992). *Language Development*. Macmillan Publishing Company.

Sakai, K. L. (2005). Language acquisition and brain development. *Science*, *310*(5749), 815–819.

Sholihah, R. A. (2018). Attitude, Aptitude, Routines, Pattern, Dan Simple Codes Dalam Pemerolehan Bahasa. *AL-ADABIYA: Jurnal Kebudayaan Dan Keagamaan*, *12*(2), 171–184. https://doi.org/10.37680/adabiya.v12i2.13

Spinella, M., & Wain, O. (2006). The Neural Substrates of Moral, Religious, and Paranormal Beliefs. *Skeptical Inquirer*, *30*(5), 35.

Steinberg, D. D. (2001). *Psycolinguistics: Language, Mind, and World*. Longman.

Taylor, I., & Taylor, M. M. (1990). *Psycholinguistics: Learning and Using Language*. Prentice Hall. https://books.google.co.id/books?id=yKBhAAAAMAAJ

Turkington, C. (1996). *The Brain Encyclopedia*. Facts on File.

Wasserman, L. H. (2007). The correlation between brain development, language

acquisition, and cognition. *Early Childhood Education Journal*, *34*(6), 415–418.

Willems, R. M., der Haegen, L. Van, Fisher, S. E., & Francks, C. (2014). On the other hand: including left-handers in cognitive neuroscience and neurogenetics. *Nature Reviews Neuroscience*, *15*(3), 193–201. https://doi.org/10.1038/nrn3679

Xu, M., Liang, X., Ou, J., Li, H., Luo, Y., & Tan, L. H. (2020). Sex Differences in Functional Brain Networks for Language. *Cerebral Cortex*, *30*(3), 1528–1537. https://doi.org/10.1093/cercor/bhz184

Yule, G. (1990). *The Study of Languages*. Cambridge University Press.