

Linguistics

Neurolinguistics

Language and the Brain



Dr. Basima Othman

Neurolinguistics

The study of the relationship between language and the brain is called neurolinguistics.

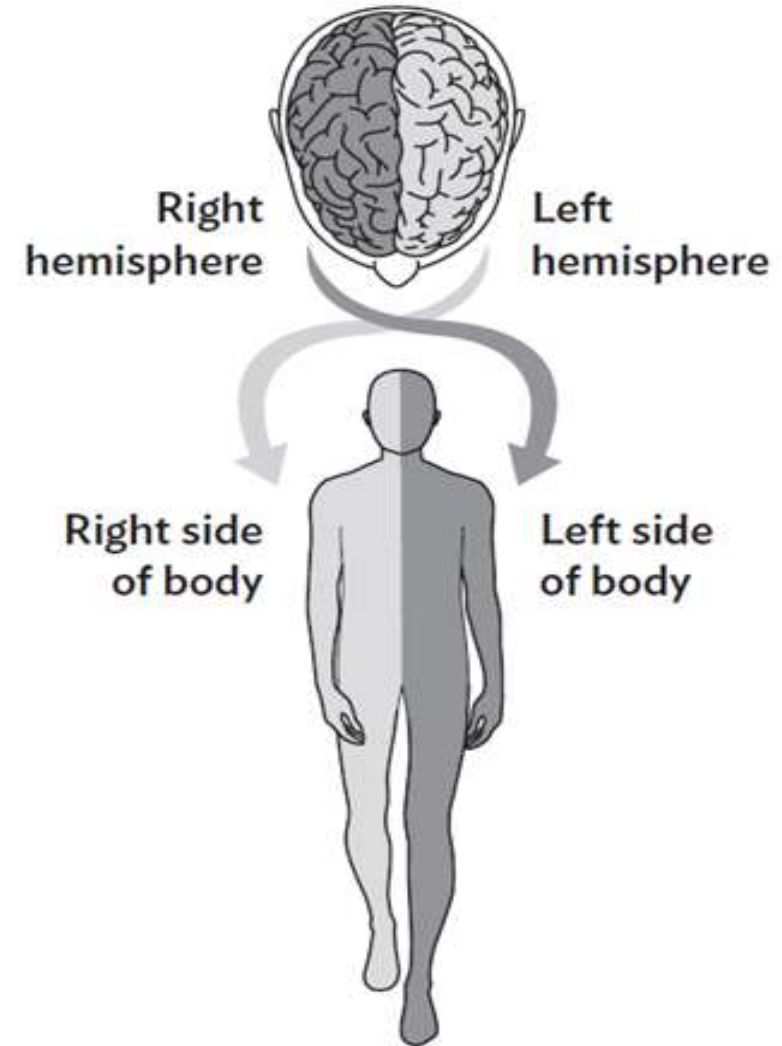
Attempts to understand the complexities of human cognitive abilities and especially the acquisition and use of language are as old and as continuous as history itself.

- What is the nature of the brain?
- What is the nature of human language?
- And what is the relationship between the two?

The Human Brain

The brain is the most complex organ of the body. It is composed of cerebral hemispheres, one on the right and one on the left.

- The **left** hemisphere controls the right side of the body
- The **right** hemisphere controls the left: so if you meet someone paralyzed down the right side of their body after a stroke, you know that the stroke affected the left side of their brain.



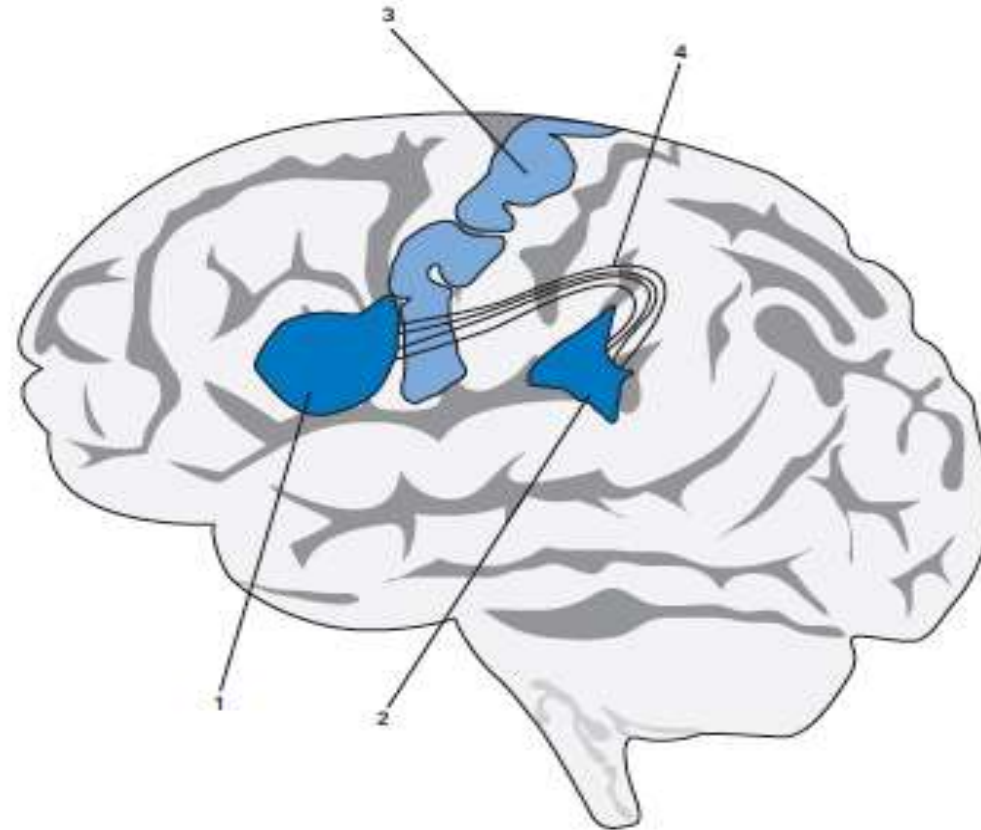
Contralateral brain function

Thus, **contralateral brain function** refers to the process in which the left hemisphere controls the right side of the body, and the right hemisphere controls the left side.

If you point with your right hand, the left hemisphere is responsible for your action. Similarly, sensory information from the right side of the body (e.g., right ear, right hand, right visual field) is received by the left hemisphere of the brain, and sensory input to the left side of the body is received by the right hemisphere.

Four Major Language Areas in the Brain

- 1- Broca's area
- 2- Wernicke's area
- 3- Motor cortex
- 4- Arcuate fasciculus



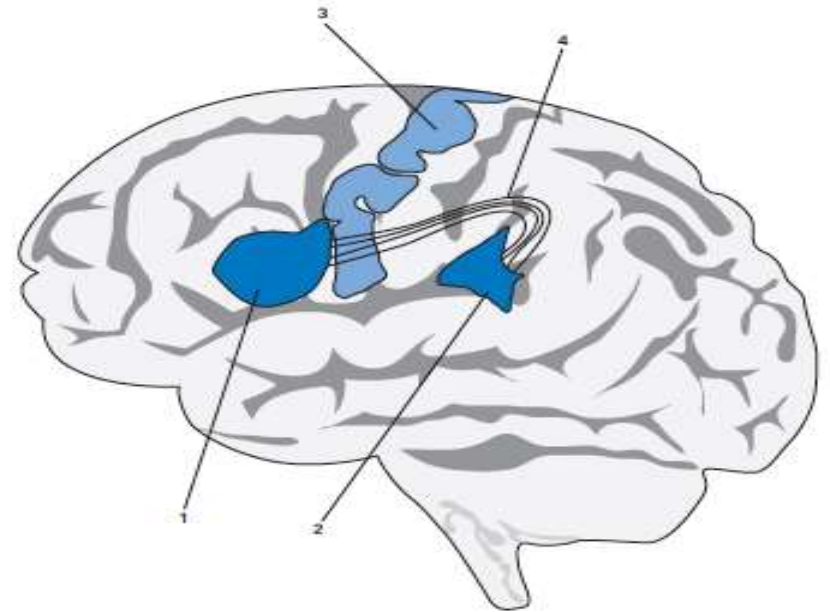
Four major language areas in the brain

1- Broca's area

- In the right hemisphere
- Responsible for language production
- Damage causes production impairment

2- Wernicke's area

- In the left hemisphere
- Responsible for language comprehension
- Damage causes comprehension impairment



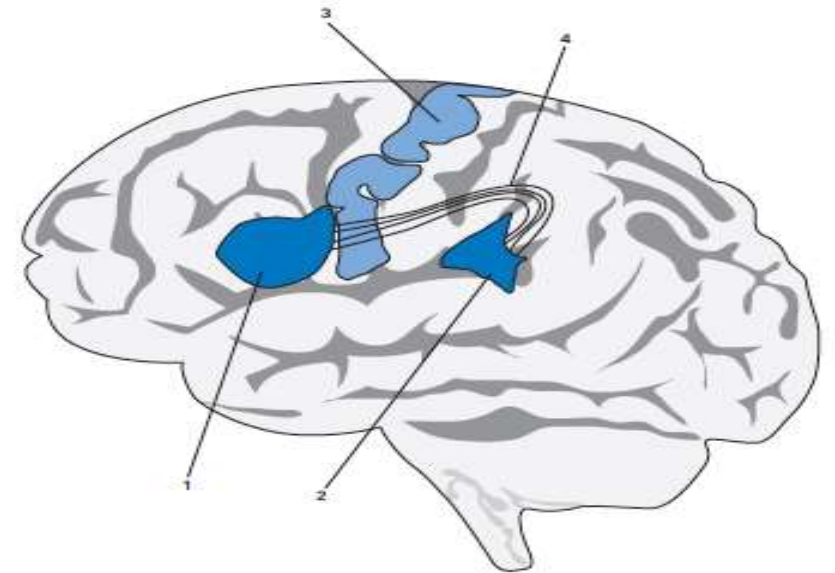
Four Major Language Areas in the Brain

3- Motor cortex

- Controls movement of the muscles (for moving hands, feet, arms, etc.)
- Close to Broca's area is the part of the motor cortex that controls the articulatory muscles of the face, jaw, tongue, and larynx.

4- Arcuate fasciculus

- A bundle of nerve fibers
- Connects Broca's and Wernicke's areas
- Connects production and comprehension



The Localization View

Specific aspects of language ability can be accorded specific locations in the brain. This is called **the localization view**.

It has been used to suggest that the brain activity involved in hearing a word, understanding it, then saying it, would follow a definite pattern.

Thus, the idea is that language is localized in a particular area of the brain through the following **three stages**:

1. The word is heard and comprehended via **Wernicke's** area.
2. This signal is then transferred via the **arcuate fasciculus** to **Broca's** area where preparations are made to produce it.
3. A signal is then sent to a part of the **motor cortex** to physically articulate the word.

Minor Malfunctions of the Brain

The following **minor production difficulties** may provide possible clues to how our linguistic knowledge is organized within the brain and they happen **occasionally**:

- The tips of the tongue
- The slips of the tongue
- The slips of the ear

The Tips of the Tongue

There is, for example, the tip of the tongue phenomenon in which we feel that some word is just escaping from us, that we know the word, but it just won't come to the surface. Speakers generally have an accurate phonological outline of the word. It suggests that our “word-storage” system may be partially organized based on some phonological information and that some words in the store are more easily retrieved than others.

When we make mistakes in this retrieval process, there are often strong phonological similarities between the target word we're trying to say and the mistake we produce. For example, fire **distinguisher** (for “**extinguisher**”) and transcendental **medication** (instead of “**meditation**”). Mistakes of this type are sometimes referred to as malapropisms.

Slips of the Tongue and Ear

Slips of the Tongue are shown in the following Expressions such as:

- Make a long shory stort (instead of ‘make a long story short’)
- A poppy of my caper (instead of ‘a copy of my paper’)
- Use the door to open the key.

Slips of this type are sometimes called **spoonerisms**

Slips of the Ear: this type of slip may provide some clues to how the brain tries to make sense of the **auditory signal** it receives. These have been called slips of the ear and can result, for example, in our hearing **great ape** and wondering why someone should be looking for one in his office. (The speaker actually said “**gray tape.**”)

Aphasia

Those people suffer from different types of language disorders, generally described as “**aphasia**.”

Aphasia is defined as an impairment of language function due to localized brain damage that leads to difficulty in understanding and/or producing linguistic forms. Mainly there are three types of **Aphasia**:

1. **Broca’s aphasia**
2. **Wernicke’s aphasia**
3. **Conduction aphasia**

Broca's aphasia: Damage to **Broca**

The serious language disorder is known as Broca's aphasia. It is characterized by:

- **Non-fluent Speech:** Individuals with Broca's aphasia typically have difficulty speaking fluently. Their speech may be slow and effortful.
- **Telegraphic Speech:** Their speech often consists of short, choppy utterances, similar to telegraphic speech.
- **Agrammatism:** There is a tendency to omit grammatical elements such as articles, prepositions, and verb inflections. Sentences may lack proper syntax.
- **Difficulty with Word Retrieval:** Individuals may struggle to find the right words (**anomia**) or have difficulty naming objects. To overcome their word-finding difficulties, speakers use different strategies such as trying to describe objects or talking about their purpose, as **in the thing to put cigarettes in** (for **“ashtray”**).

Example of Broca's Aphasia

Here is an excerpt of a conversation between a **patient** with Broca's aphasia and a **doctor**:

- **doctor**: Could you tell me what you have been doing in the hospital?
- **patient**: Yes, sure. Me go, er, uh, P.T. [physical therapy] none o'cot, speech . . . two times . . . read . . . r . . . ripe . . . rike . . . uh write . . . practice . . . get . . . ting . . . better.
- **doctor**: And have you been going home on weekends?
- **patient**: Why, yes . . . Thursday uh . . . uh . . . uh . . . no . . . Friday . . . Bar . . . ba . . . ra . . . wife . . . and oh car . . . drive . . . purpikie . . . you know . . . rest . . . and TV.

Wernicke's Aphasia: Damage to **Wernicke**

Wernicke's aphasia is characterized by:

- **Fluent Speech:** Individuals with Wernicke's aphasia typically speak fluently and effortlessly.
- **Comprehension difficulties:** While individuals with Wernicke's aphasia can produce speech fluently, they may struggle to maintain coherent conversations or participate in discussions due to comprehension deficits and production errors.
- **Lack of Self-Monitoring:** Due to impaired language comprehension and production, individuals with Wernicke's aphasia often have difficulty monitoring and correcting their own speech errors. They may not recognize when they produce nonsensical or inappropriate speech.

Wernicke's Aphasia: Damage to **Wernicke**

Thus, this type of language disorder that results in difficulties in auditory comprehension. Someone suffering from this disorder can actually produce very fluent speech which is, however, often difficult to make sense of. People with Wernicke's aphasia produce fluent speech with good intonation, and they may largely adhere to the rules of syntax. However, their language is often semantically incoherent. For example, one patient replied to a question about his health with:

- *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.*
- *I can't talk all of the things I do, and part of the part I can go alright, but I can't tell from the other people.*

Exercise

The following utterances were made either by Broca's aphasics or Wernicke's aphasics. Indicate which is which by writing a "B" or "W" next to the utterance.

- a. Goodnight and in the pansy I can't say but into a flipdoor you can see it.
- b. Well . . . sunset . . . uh . . . horses nine, no, uh, two, tails want swish.
- c. Oh, . . . if I could I would, and a sick old man disflined a sinter, minter.
- d. Words . . . words . . . words . . . two, four, six, eight, . . . blaze am he.

Conduction Aphasia

This type of aphasia is associated with damage to the arcuate fasciculus and is called conduction aphasia. What the speaker hears and understands can't be transferred very successfully to the speech production area. Individuals suffering from this disorder sometimes mispronounce words, but typically do not have articulation problems. Conduction aphasia is characterized by:

- **Mispronounced speech** where sounds within words are substituted or transposed. For example, saying "pish" instead of "fish" and fosh instead of wash.
- **Facing difficulties with Repetition:** Individuals with conduction aphasia often struggle with immediate repetition of words or short phrases, even when they have just heard them.
- **Good Conversational Skills:** Despite the repetition deficit, individuals with conduction aphasia often maintain good conversational skills and can engage in meaningful exchanges, relying on intact language comprehension and fluent speech production.

To summarize the three forms of Aphasias:

These examples demonstrate the distinctive speech patterns associated with each type of aphasia. Individuals with **Broca's** aphasia typically produce **ungrammatically** correct sentences, while those with **Wernicke's** aphasia often produce fluent but **nonsensical** and **incoherent** speech. **Conduction** aphasia involves difficulty with **repetition** and fluent spontaneous speech, often characterized by hesitation and frequent use of **filler words** like "um" or "uh."

1. **Broca's Aphasia:** "Car... drive... fast."
2. **Wernicke's Aphasia:** "The cat outside rain meow"
3. **Conduction Aphasia:** "She... um... said... uh... that... um... he... um... went... uh..."

Exercise: Read the following descriptions of speech patterns and characteristics associated with different types of Aphasias. Identify which type of Aphasia each description corresponds to: **Broca's** Aphasia, **Wernicke's** Aphasia, or **Conduction** Aphasia.

- The individual's speech is halting and telegraphic, with limited vocabulary and grammar. They struggle to form complete sentences and often experience difficulty with word retrieval.
- Speech is fluent but lacks coherence. The individual may use inappropriate words or filler sounds, making their speech difficult to understand. There is often an unawareness of the errors they make in speech.
- Difficulty in repeating words or phrases accurately is evident. Speech may be interrupted by frequent pauses or filler words like "um" or "uh." Despite fluent spontaneous speech, repetition is notably impaired.

Psycholinguistics

Language and the Mind

Dr. Basima Othman

Psycholinguistics

Psycholinguistics is the study of language and the mind. It explores what goes on in the human mind as an individual acquires, comprehends, produces, and stores language.

Language is extremely complex. Yet very young children—before the age of five—already know most of the intricate system that is the grammar of their native language (first language acquisition). Before they can add $2 + 2$, children are conjoining sentences, asking questions, using appropriate pronouns, negating sentences, forming relative clauses, and inflecting verbs and nouns and in general having the creative capacity to produce and understand a limitless number of sentences.

Mechanisms of First Language Acquisition

1. Do Children Learn through Correction?
2. Do Children Learn through Imitation?
3. Do Children Learn Language through Analogy?
4. Do Children Learn through Structured Input?

Behaviorism

Skinner (1957)

Early theories of language acquisition were heavily influenced by behaviorism, a school of psychology prevalent in the 1950s.

As the name implies, behaviorism focuses on people's behaviors, which are directly **observable**, rather than on the **mental systems** underlying these behaviors. Language was viewed as a kind of verbal behavior, and it was proposed that children learn language through **imitation**, **correction**, **analogy**, and **structured input**.

Chomsky's reply (1959)

Mental System

Two years later, in a devastating reply to Skinner entitled Review of Verbal Behavior (1959), Noam Chomsky showed that language is a complex cognitive system that could not be acquired by behaviorist principles.

Chomsky states:

We are designed to walk. That we are taught to walk is impossible. And pretty much the same is true of language. Nobody is taught language. In fact, you can't prevent the child from learning it.

1- Do Children Learn through Correction?

- Child: Nobody don't like me.
- Mother: No, say "Nobody likes me."
- Child: Nobody don't like me. (dialogue repeated eight times)
- Mother: Now, listen carefully; say "Nobody likes me."
- Child: Oh, nobody don't likes me.



Another conversation between a father and his child

CHILD: Want other one spoon, Daddy.

FATHER: You mean, you want the other spoon.

CHILD: Yes, I want other one spoon, please Daddy.

FATHER: Can you say “the other spoon”?

CHILD: Other ... one ... spoon.

FATHER: Say “other.”

CHILD: Other.

FATHER: “Spoon.”

CHILD: Spoon.

FATHER: “Other spoon.”

CHILD: Other ... spoon. Now give me other one spoon?

2- Do Children Learn through Imitation ?

Imitation is involved to some extent. The early words and sentences that children produce show that they are not simply imitating adult speech. Many times the words are barely recognizable to an adult and the meanings are also not always like the adult's.

Children do not hear words like holded or tooths they produce between the ages of two and three. For example:

- Child: She holded the baby rabbits and we patted them.
- Adult: Did you say she held them tightly?
- Child: No, she holded them loosely.

3- Do Children Learn through Analogy?

It is also suggested that children put words together to form phrases and sentences by analogy, by hearing a sentence and using it as a model to form other sentences. But this is also problematic. Consider another example. The child hears the following pair of sentences:

The boy was sleeping. Was the boy sleeping?

Based on pairs of sentences like this, he formulates a rule for forming questions: “Move the auxiliary to the position preceding the subject.”

3- Do Children Learn through Analogy?

The child then acquires the more complex relative clause construction: **The boy who is sleeping is dreaming about a new car.** He now wants to form a question. What does he do? If he forms a question on analogy to the simple yes-no question, he will move the first auxiliary **is** as follows:

***Is the boy who sleeping is dreaming about a new car?**

Studies of spontaneous speech, as well as experiments, show that children never make mistakes of this sort. Syntactic rules, such as the rule that moves the auxiliary, are sensitive to the structure of the sentence and not to the linear order of words. The available evidence shows that children know about the structure dependency of rules at a very early age

4- Do Children Learn through Structured Input?

Yet another suggestion is that children can learn language because adults speak to them in a special “simplified” language sometimes called motherese. In our culture adults do typically talk to young children in a special way. We tend to speak more slowly and more clearly, we may speak in a higher pitch and exaggerate our intonation.

However, motherese is not syntactically simpler. It contains a range of sentence types, including:

- syntactically complex sentences such as questions (Do you want your juice now?)
- embedded sentences (Mommy thinks you should sleep now);
- imperatives (Pat the dog gently!);
- negatives with tag questions (We **don't** want to hurt him, **do we?**).

Analogy, imitation, reinforcement and structured input **cannot** account for language development ,

Because these four proposals are based on the assumption that what the child acquires is a set of sentences or forms and they also place too much emphasis on the **environment** rather than than on the **grammar-making abilities** of the child

The four proposals do not explain the **creativity** that children show in acquiring language, why they go through **same stages**, or why they make some kinds of “**errors**” but not others, for example, “**Give me other one spoon**” but not “**Is the boy who sleeping is dreaming about a new car?**”

Chomsky

Children Construct Grammars

Language acquisition is a creative process. Children are not given explicit information about the rules, by either instruction or correction.

They extract the rules of grammar from the language they hear around them, and their linguistic environment does not need to be special in any way for them to do this.

Observations of children acquiring different languages under different cultural and social circumstances reveal that the developmental stages are similar, possibly universal.

Chomsky

Children Construct Grammars

These factors lead many linguists to believe that children are equipped with an innate template for language—which we have referred to as Universal Grammar (UG)—and that this template aids the child in the task of constructing a grammar for her language. This is referred to as the innateness hypothesis.

Chomsky asserts with his theory that this inborn knowledge helps children to acquire their native language effortlessly and systematically despite the complexity of the process.

Chomsky: The Innateness Hypothesis

So, children do not produce questions by moving the first auxiliary as in (1) below. Instead, they correctly invert the auxiliary of the main clause, as in (2). (We use ___ to mark the position from which a constituent moves.)

1. *Is the boy who ___ sleeping is dreaming of a new car?
2. Is the boy who is sleeping ___ dreaming of a new car?

To come up with a rule that moves the auxiliary of the main clause rather than the first auxiliary, the child must know something about the structure of the sentence. Children are not told about structure dependency. No amount of imitation, correction, analogy, or structured input will lead the child to formulate this structure.

Stages of the First Language Acquisition



The Acquisition Schedule

All normal children develop language at roughly the same time, along much the same schedule:

- **Cooing and babbling**
- **The one-word stage**
- **The two-word stage**
- **Telegraphic speech** (developing morphology, syntax, and semantics)

The biological schedule is tied very much to the maturation of the infant's brain. We could think of the child as having the biological capacity to cope with distinguishing certain aspects of linguistic input at different stages during the early years of life. Long before children begin to talk, they have been actively processing what they hear.

Cooing and Babbling

0 – 8 months



The earliest use of speech-like sounds has been described as **cooing**. During the first **few** months of life, the child gradually becomes capable of producing sequences of **vowel-like** sounds, particularly high vowels similar to /i/ and /u/. **By 4 months** of age, the developing ability to bring the back of the tongue into regular contact with the back of the palate allows the infant to create sounds similar to the velar **consonants** /k/ and /g/, hence the common description as “**cooing**” or “**gooing**” for this type of production.

By the time they are five months old, babies can already hear the difference between the vowels /i/ and /a/ and discriminate between syllables like /ba/ and /ga/. Between 6 and 8 months, the child is sitting up and producing several different vowels and consonants, as well as combinations such as ba-ba-ba and ga-gaga. This type of sound production is described as babbling.

The one-word stage

9 – 18 months

Between 9 and 18 months, children begin to produce a variety of recognizable single-unit utterances. This period traditionally called the one-word stage, is characterized by speech in which single terms are uttered for everyday objects such as “milk,” “cookie,” “cat,” “cup” and “spoon”.

Other forms such as /ʌsæ/ may occur in circumstances that suggest the child is producing a version of What’s that, so the label “one-word” for this stage may be misleading, and a term such as “single-unit” would be more accurate.

The two-word stage

18 months – 2 ½ years

The two-word stage can begin around 18 to 20 months, as the child's vocabulary moves beyond 50 words.

By the time the child is 2 years old, a variety of combinations, similar to **baby chair**, **mommy eat**, **cat bad**, will usually have appeared. The phrase **baby chair** may be taken as an expression of **possession** (= this is baby's chair), as a **request** (= put baby in chair), or as a **statement** (= baby is in the chair), depending on different circumstances.

Telegraphic speech

2 ½ years – 4 years

Between **2 ½ years – 4 years**, the child begins producing a large number of utterances that could be classified as “multiple-word” speech. This period is described as **telegraphic speech**.

The telegraphic stage has been traced through **the linguistic features** in the steady stream of children’s speech:

- A. Developing **morphology**
- B. Developing **syntax** (forming **questions** and **negatives**)
- C. Developing **semantics**

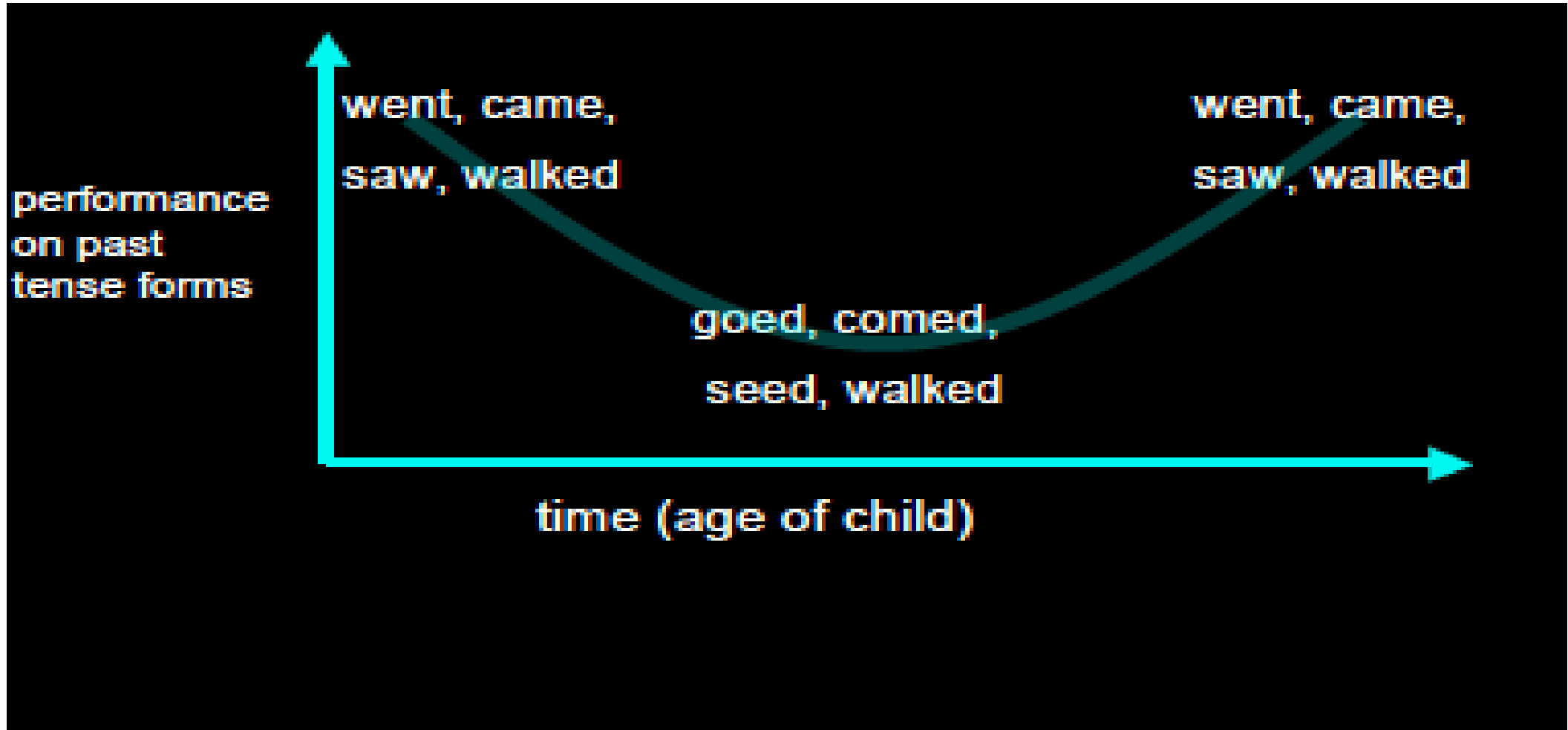
A. Developing morphology

Here, the grammatical function of the nouns and verbs is used. The first to appear is usually the **-ing** form in expressions such as cat **sitting**, mommy **reading** book.

The next morphological development is typically the marking of **regular** forms with the **-s** plural and the **-ed** inflection, as in **boys** and **foots**, **played** and **speaked**. Regularization:- **irregular** forms are replaced by **regular** ones (**bringed**, **goed**, and **foots**). It provides the clearest evidence of **rule learning** when children treat **irregular** verbs and nouns as if they were **regular**. Children generally go through three phases in the acquisition of an irregular form:

Phase 1	Phase 2	Phase 3
broke	breaked	broke
brought	bringed	brought

U-shaped development



B. Developing syntax

In the formation of questions and negations, there are three stages:

- **Stage 1** (between 18 and 26 months): adding a Wh-form (Where, Who, ..etc.) before the expression as in (**Where kitty?**). putting **No** or **Not** before the expression, as in (**no fall**)
- **Stage 2** (between 22 and 30 months): using more Wh-forms, as in (**Why you smiling?**). using more negative forms, as in (He **no** bite you.)
- **Stage 3** (between 24 and 40 months): using the required movement of the auxiliary in English questions, as in (**Where will mum go?**). using auxiliaries with **Not** , as in (He **did not** bite you.)

C. Developing Semantics

During the two-word stage, children use their limited vocabulary to refer to a large number of unrelated objects. **Overextension**: here, children overextend the meaning of a word based on similarities of shape, sound, and size. e.g. use the **ball** to refer to an **apple**, an **egg**, a **grape**, and a **ball**. This is followed by a gradual process of narrowing down as more words are learned.

Even though the child is still to acquire a large number of other aspects of his or her first language through the later years of childhood, it is normally assumed that, by the age of five, the child has completed the greater part of the basic language acquisition process.

The Critical Period

The Critical Period

During childhood, there is a period when the human brain is most ready to receive input and learn a particular language. This is called the “**the critical period**” for language acquisition.

The general view is that the critical period for first language acquisition lasts from birth until **puberty**. If a child does not acquire language during this period, for any one of several reasons, then he or she will find it almost impossible to learn language later on.

The Critical Period

Under normal circumstances, a child is introduced to language virtually at the moment of birth. Adults talk to him and each other in his presence. Children do not require explicit language instruction, but they do need exposure to language to develop normally. Children who do not receive linguistic input during their formative years do not achieve native-like grammatical competence.

The critical age period assumes that language is biologically based and that the ability to learn a native language develops within a fixed period, from birth to middle childhood. During this critical period, language acquisition proceeds easily, swiftly, and without external intervention. After this period, the acquisition of grammar is difficult and, for most individuals, never fully achieved. However, those individuals can learn a large vocabulary.

Genie

Genie is an American feral child who was a victim of severe abuse, neglect, and social isolation. Her circumstances are prominently recorded in the annals of linguistics and abnormal child psychology. Her father began keeping her in a locked room from the age of eighteen months until nearly fourteen years.

The extent of her isolation prevented her from being exposed to any significant amount of speech, and she did not acquire language during her childhood as a result



To sum up The Critical Period

Thus, beyond the critical period, the human brain seems unable to acquire the grammatical aspects of language, even with substantial linguistic training or many years of exposure.

However, it is possible to acquire words and various conversational skills after this point.

This evidence suggests that the critical period holds for the acquisition of grammatical abilities, but not necessarily for all aspects of language.