The Architecture of the Mind-Language

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PREFACE

The writer would like to express heartfelt gratitude to Allah SWT for His grace, mercy, and blessings, which have given the writer the strength and opportunity to complete this paper. This book chapter titled "The Architecture of the Mind-Language" has been successfully completed.

The Architecture of the Mind-Language explores the relationship between language, the mind, and the brain from a psycholinguistic perspective. This book examines how humans acquire, produce, understand, and process language, accompanied by a discussion of various theories and key phenomena, such as speech errors, tip-of-the-tongue, the mental lexicon, and speech perception.

This comprehensive textbook and course guide explores the intricate relationship between human language and the mind through an interdisciplinary psycholinguistic approach. Integrating theories and methodologies from linguistics, psychology, neuroscience, and cognitive science, the book details the mental processes that enable humans to acquire, comprehend, produce, and represent language in real time.

In closing, I hope this book will be serve as a reference and be of benefit to all readers and the general public.

Tangerang, Juni 2026

Penulis

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Introduction to Psycholinguistics: The Intersection of Language And Mind

Nargis

An introductory course that explores the relationship between language and the human mind from a psycholinguistic perspective. The course examines the cognitive and psychological processes involved in language acquisition, language comprehension, language production, and language processing. Students will investigate how humans perceive, store, retrieve, and use language, as well as how linguistic knowledge is represented in the brain.

Upon completing this course, students are expected to demonstrate foundational knowledge of psycholinguistic concepts and theories, analyze language phenomena using psycholinguistic approaches, evaluate empirical research, and apply psycholinguistic principles to language teaching, learning, and communication.

➢ Definition of Psycholinguistics

Psycholinguistics is the interdisciplinary field that studies how language is acquired, processed, produced, comprehended, and represented in the human mind. It combines theories and methods from linguistics, psychology, neuroscience, and cognitive science to explain the mental processes involved in understanding and using language. Psycholinguists investigate how people recognize words, construct sentences, interpret meaning, store linguistic knowledge in memory, and acquire first and additional languages.

According to Jean Berko Gleason and Nan Bernstein Ratner (2017), psycholinguistics is the scientific study of the mental processes that underlie language acquisition and language use. The field examines how speakers and listeners encode, decode, and comprehend linguistic information in real time.

Similarly, John Field (2003) defines psycholinguistics as the study of the psychological and neurobiological factors that enable humans to acquire, use, comprehend, and produce language. This perspective emphasizes the relationship between language and cognitive processes such as perception, memory, attention, and problem-solving.

According to Danny D. Steinberg and Natalia V. Sciarini (2006), psycholinguistics explores how language is represented in the brain and how speakers produce and understand language through cognitive mechanisms. The discipline also investigates language disorders, bilingualism, and the neurological basis of language.

Overall, psycholinguistics seeks to answer fundamental questions such as:

a. How do humans acquire language?
b. How are words and sentences stored in memory?
c. How do people understand spoken and written language?
d. What cognitive processes are involved in speech production?
e. How does the brain process language

➢ The Intersection of Language and Mind

Psycholinguistics seeks to explain one of the most remarkable abilities of the human mind: the capacity to understand and produce language effortlessly. Every day, individuals encounter countless sentences they have never previously heard or read, yet they comprehend them almost immediately and often respond with novel and meaningful ideas. Although this process appears automatic in everyday communication, it involves highly sophisticated cognitive mechanisms that operate within fractions of a second.

When a person listens to speech or reads written text, the brain must transform acoustic signals or visual symbols into meaningful linguistic representations. This transformation requires the coordinated operation of multiple cognitive processes, including speech perception, word recognition, syntactic parsing, semantic interpretation, memory retrieval, and contextual integration. Rather than processing language as isolated words, the human mind continuously constructs and updates mental representations that allow speakers and listeners to interpret intended meanings accurately and efficiently.

The extraordinary ability to convert sounds or written symbols into structured meaning has long fascinated researchers from linguistics, psychology, neuroscience, and cognitive science. Understanding how these mental processes function is the central concern of psycholinguistics. By investigating how language is acquired, represented, processed, and produced, psycholinguistics provides valuable insights into the relationship between language and the human mind.

The Architecture of the Mind-Language

These insights not only deepen our understanding of normal language use but also contribute to research on bilingualism, language disorders, literacy development, artificial intelligence, and language education.

As an interdisciplinary field, psycholinguistics addresses fundamental questions about the nature of human language processing. How do people recognize words so rapidly? How does the brain construct grammatical structures during comprehension? Why can individuals understand sentences they have never encountered before? Exploring these questions helps explain the remarkable efficiency and creativity of human language, revealing language as one of the most sophisticated cognitive systems humans possess.

This is the central mystery of psycholinguistics—the scientific study of the psychological and neurobiological factors that enable humans to acquire, use, comprehend, and produce language.

➢ The Three Core Pillars

Psycholinguistics essentially investigates the lifecycle of a thought as it travels into, through, and out of the human mind. It focuses on three fundamental dimensions: Traxler & Gernsbacher, 2006)

a. Language Comprehension: How do we perceive and understand speech and text? This ranges from decoding fast acoustic signals (phonology) to parsing sentence structures (syntax) and extracting literal and implied meanings (semantics and pragmatics). Comprehending language involves a variety of capacities, skills, processes, knowledge, and disposition that are used to derive meaning from spoken, written and sign language. Language comprehension is an important aspect of day to day functioning in adulthood. Comprehension of written and spoken language relies on the ability to correctly process word and phrase meanings, sentence grammar, and discourse or text structure. Difficulties in any of these domains can produce comprehension problems. Age-related memory declines have been reported in many studies comparing younger and older adults on language comprehension tasks.

b. Language production is the process of producing spoken or written language. It encompasses all the stages involved in transforming an intended message or concept into a linguistic form that can be articulated or written (Levelt, 1989). Language production begins with idea generation, followed by conceptualization, lexical selection, grammatical encoding, phonological encoding, and articulation (Levelt, 1989; Harley, 2014). It is a complex mental process that is influenced not only by cognitive mechanisms but also by the speaker's cultural and social experiences, which shape how ideas are formulated and expressed in language (Clark, 1996; Gleason & Ratner, 2017). Language Production: How do we translate abstract, non-verbal thoughts into a linear sequence of spoken words or signs? Psycholinguists study this by looking at the micro-planning of speech and analyzing structural slip-ups like "slips of the tongue."(Levelt, W. J. M. 2020)

c. Language Acquisition: How do children manage to master the incredibly complex rules of their native tongue in just a few short years without formal instruction? This pillar also encompasses how adults navigate the distinct mental challenges of learning a second language. (Aitchison, J. 2006), Meanwhile Jean Berko Gleason and Nan Bernstein Ratner (2017) argued that language acquisition is the developmental process by which children learn to comprehend and produce language naturally through exposure and interaction with others. This process occurs rapidly during the early years of life and reflects the interaction between biological predispositions and environmental input.

➢ Why Psycholinguistics Matters

Every day, the average person utters roughly 16,000 words. We read road signs, decode text messages, overhear conversations in crowded coffee shops, and internalize a constant stream of inner monologue. To the healthy brain, this happens effortlessly. Language feels as natural as breathing. But beneath this illusion of simplicity lies one of the most complex computing feats in the known universe. Psycholinguistics is the scientific study of how the human mind acquires, comprehends, produces, and represents language. It matters because it pulls back the curtain on the invisible cognitive machinery that defines the human experience. Without it, we are passengers in a vehicle we don't know how to drive.

While linguistics focuses on the formal rules, structures, and grammars of languages *in the abstract*, psycholinguistics is fascinated by the *real-time execution*. It asks not just what the rules are, but how a flawed, limited biological brain actually runs the software of language under time pressure.

By bridging the gap between cognitive psychology, linguistics, and neuroscience, psycholinguistics attempts to answer a profound question: *Is language a unique, hardwired biological instinct exclusive to humans, or is it the ultimate byproduct of our general, massive computing power?*

Understanding this relationship doesn't just unlock the secrets of the human mind; it drives the modern development of artificial intelligence, provides critical tools for diagnosing speech and reading disorders, and shapes how we teach languages globally.

➢ Conclusion

Psycholinguistics provides a comprehensive framework for understanding the intricate relationship between language and the human mind. As an interdisciplinary field, it integrates insights from linguistics, psychology, neuroscience and cognitive science to explain how individuals acquire, process, produce, comprehend, and mentally represent language. Through the study of cognitive mechanisms such as perception, attention, memory, and reasoning, psycholinguistics reveals that language is not merely a system of words and grammar but a complex mental activity supported by sophisticated cognitive and neurological processes.

The three core pillars of psycholinguistics language comprehension, language production, and language acquisition provide a comprehensive framework for understanding the complete cycle of human language. Language comprehension investigates how individuals decode sounds or written symbols and construct meaning from them. Language production explains how ideas are transformed into coherent spoken or written expressions through a series of complex cognitive processes. Language acquisition explores how children naturally develop their first language and how additional languages are learned throughout life. Together, these pillars demonstrate that language is not a passive body of knowledge but an active, dynamic, and highly organized mental system.

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Book Chapter

Speech Production, Speech Errors, and The Tip-of-the-Tongue Phenomenon

Dinda Riska Shafira, Nulia Tria Hasanah, Ummu Athiyah, Zahroh Fatikhatun Aulia

This course covers the process of speech production, various speech errors, and the "tip-of-the-tongue" phenomenon, or the situation where a person knows a word but has temporary difficulty recalling or pronouncing it. Students learn how humans produce speech, organize their thoughts, select words, and articulate sounds in the communication process. In addition, this course also covers types of speech errors and the relationship between language production, memory, and cognitive processes in human communication.

➢ Introduction to Speech Production

Speech production is the process of converting thoughts into spoken language. According to Willem Levelt, speech production involves several interconnected stages that occur rapidly and systematically. These stages do not operate in isolation but function as a modular and incremental system, in which the output of one stage serves as the input for the next. Levelt views the speaker as an information processor who simultaneously manages various cognitive operations to produce coherent and meaningful speech.

➢ Stages of Speech Production

a. Conceptual Preparation (The speaker forms an idea or message to express.)

Conceptual preparation is a pre-verbal stage in which the speaker determines what to communicate before any linguistic form is applied. This stage involves two sub-processes: macroplanning, in which the speaker establishes the overall communicative goal and selects relevant information; and microplanning, in which the speaker breaks down that information into smaller conceptual units with the appropriate informational perspective.

b. Lexical Selection and Lemma Access (The brain selects appropriate words from the mental lexicon.)

Once a preverbal message is formed, the brain searches for and selects the most appropriate words through a process called lexical access. The mental lexicon is the brain's internal dictionary that stores all the words known to a speaker along with their meanings, grammatical properties, and relationships to other words.

c. Morphophonological Encoding (The selected words are organized into sound structures.)

Once the appropriate lemma has been successfully identified, the brain then proceeds to encode the morphological and phonological properties of each word. Morphological encoding involves the application of grammatical rules such as the addition of affixes, inflections, or derivational forms required by the sentence context, while phonological encoding involves determining the sequence of phonemes, syllable structure, and stress or accent patterns of each word. The unit accessed at this stage is the lexeme, which is the phonological representation of a word distinct from the lemma accessed in the previous stage.

d. Phonetic Encoding (The brain prepares the articulatory plan for pronunciation.)
   Once a word's phonological structure has been determined, the brain then prepares a detailed articulatory plan a set of motor instructions that specify how the speech organs will move to produce the intended sounds. This process transforms the abstract phonological representation into a concrete physical movement plan, encompassing tongue position, lip movement, degree of mouth opening, vocal cord vibration, and the airflow required for each sound. The resulting phonetic plan is then temporarily stored in the articulatory buffer before being sent to the motor system for execution.
e. Articulation (The physical organs of speech produce spoken language.)
   Articulation is the stage at which a message is finally produced physically and can be heard by the listener. The speech organs including the tongue, lips, teeth, palate, vocal cords, and oral cavity work together in a highly coordinated manner to produce the sounds that form words and sentences. According to Yule (2020), human articulation ability depends on unique anatomical structures, including the position of the larynx, which allows for the production of a wide variety of sounds. Articulation occurs incrementally, meaning that a speaker can begin to utter the first part

of a sentence while the subsequent parts are still in the planning stage at the cognitive level.

f. Self-Monitoring (The speaker checks and corrects possible errors during speech production.)
   Self-monitoring is the process by which speakers continuously evaluate and check the speech they are producing in order to detect and correct any errors that may occur. According to Levelt (1989), self-monitoring occurs at two levels: internal monitoring, in which the speaker checks the preverbal message and phonological plan before articulation, and external monitoring, in which the speaker listens to their own speech through auditory feedback. If an error is detected at either level, the speaker will halt their speech and make spontaneous corrections. This stage demonstrates that speech production is not a one-way process, but rather a dynamic system that continuously receives and responds to feedback.

➢ Speech Errors

Speech errors are unintended mistakes made during speaking. They are important in psycholinguistics because they reveal how language is processed in the human mind. Carroll (2008) emphasizes that speech errors are not random occurrences; rather, they follow systematic patterns that reflect the internal organization of the language processing system

➢ Types of Speech Errors

a. Exchange (Two elements switch positions.)
   Example: "I hissed all my mystory lectures."

Transposition is a type of error in which two linguistic units whether sounds, morphemes, or words simultaneously swap positions

b. Anticipation (A future sound appears too early.)
Example: "leading list" instead of "reading list."
Anticipation occurs when a sound or element that should be further back in the sequence appears earlier than its correct position, replacing the sound that should be there. The anticipated sound slips into an earlier position while still being present in its original position later in the utterance.

c. Perseveration (a previous sound is repeated.)
Example: "pantrum" instead of "tantrum."
Perseveration is the opposite of anticipation; it occurs when a sound or element produced in the previous word persists and reappears in an unexpected position. This error indicates that the phonological activation of the previously spoken word does not immediately fade away, but rather persists and can interfere with the processing of subsequent words.

d. Blend (Two words combine into one.)
Examples: brunch, smog.
Blending errors occur when a speaker is torn between two semantically related word choices and both are activated simultaneously, resulting in a blended form

e. Word Substitution (A wrong word is selected.)
Example: saying "cat" instead of "dog."
Word substitution occurs when a speaker selects the wrong word from their mental lexicon, resulting in an utterance with a meaning different from the intended one.

➢ Causes of Speech Errors

a. Activation of related words in the mental lexicon
When the brain tries to recall a desired word, other words with similar meanings or sounds are often triggered at the same time through a process called activation spread. Because several related words become active simultaneously in the mental lexicon, they compete with one another during speech production. Spreading activation among similar sounds or meanings

b. Mis-selection of words during rapid speech processing
When a speaker talks too quickly, the language processing system may not have enough time to carefully check each word or sound before it is spoken. As a result, mistakes are more likely to occur during speech production.

➢ Tip-of-the-Tongue (TOT) Phenomenon

Tip-of-the-Tongue (TOT) is a condition in which a person knows a word but temporarily cannot recall or pronounce it. Aitchison (2012) explains that TOT is closely connected to the two-stage model of lexical access, in which the first stage involves successful activation of the lemma and its meaning, while the second stage involves retrieving the phonological form of the word, which is where the failure occurs.

➢ Characteristics of TOT

a. Feeling certain that the word is known
In a Tip-of-the-Tongue (TOT) state, the speaker feels strongly convinced that they actually know the target

word, even though they cannot remember or pronounce it at that moment. This sense of familiarity is what distinguishes TOT from simply not knowing a word at all. Because the speaker is certain that the word exists in their memory, they usually continue to actively try to recall it rather than giving up immediately.

b. Remembering partial information such as the first letter or syllables

   Even when speakers cannot fully recall the pronunciation of a word, they are often still able to recall certain aspects of it, such as the initial sound, the number of syllables, the stress pattern, or other words that sound similar.

➢ Temporary inability to retrieve the word

The inability to retrieve the word is not permanent; the word typically returns to consciousness after some time, after receiving a contextual cue, or sometimes spontaneously without any external prompt.

More frequent under stress, fatigue, or nervousness

Psychological and physiological factors such as stress, fatigue, and nervousness can impair the efficiency of the cognitive system involved in lexical retrieval, making it more difficult for the brain to successfully complete the phonological encoding process.

➢ Process of TOT

a. The brain activates the concept.
Based on the communicative context, the brain identifies the conceptual content that needs to be expressed and begins the process of lexical retrieval.

b. The meaning of the word is identified.
The lemma associated with the target word is successfully accessed, meaning the speaker knows what the word means, what grammatical category it belongs to, and how it functions in the sentence.

c. The sound form fails to activate completely.
At this stage, the phonological encoding process, which normally occurs after lemma access, fails to fully activate the sound form of the target word. As a result, the speaker knows the meaning of the word but cannot fully recall its pronunciation. According to Willem Levelt (1989), this problem occurs during the morphophonological encoding stage, where the lexeme that is, the phonological representation of the word cannot be fully accessed.

d. The speaker experiences the Tip-of-the-Tongue state.
The speaker is caught between successful lemma access and failed phonological retrieval, resulting in the frustrating sensation of knowing a word without being able to produce it.

➢ Examples of TOT Experiences

a. Forgetting someone's name
The speaker clearly recognizes the person and can recall contextual details about them, but the name itself remains temporarily inaccessible.

b. Forgetting a specific vocabulary word
   This is particularly common when dealing with low-frequency words, technical terms, or words in a foreign language that have not been used or practiced recently.
c. Remembering a definition but not the exact term
   The speaker can accurately describe the meaning or function of a concept but cannot retrieve the specific term that names it, which reflects successful lemma access but failed phonological retrieval.

➢ Causes and Effects of Speech Errors and TOT

Causes

a. Memory limitations
   According to Baddeley (2012), working memory has a limited capacity to temporarily store and process information. When cognitive demands exceed this capacity, difficulties in lexical retrieval can occur, increasing the likelihood of speech errors and Tip-of-the-Tongue (TOT) experiences.The capacity of working memory is limited, so when a speaker tries to process too much information at once, the retrieval of words from long-term memory may be disrupted. This can make it more difficult for the speaker to recall the intended word accurately during communication. Additionally, words that are rarely used typically have weaker representations in the mental lexicon, making them more prone to retrieval failure and more likely to result in "tip-of-the-tongue" experiences or speech errors.

b. Limited vocabulary knowledge
   Nation (2013) argues that vocabulary knowledge plays a crucial role in language production. Words that are not frequently used tend to have weaker mental representations, making them more difficult to retrieve during communication. A limited vocabulary means that fewer words are firmly stored and well-organized in the mental lexicon, which increases the likelihood of speech errors and "tip-of-the-tongue" (TOT) experiences. This condition is particularly common among language learners because words that are rarely practiced or used frequently tend to have weaker phonological connections in memory, making them harder to retrieve during communication.
c. Stress, fatigue, or nervousness
   According to Eysenck, Derakshan, Santos, and Calvo (2007), anxiety and stress can reduce attentional control and cognitive efficiency, which may interfere with language processing and word retrieval. Conditions such as stress, fatigue, and nervousness can reduce overall cognitive efficiency and interfere with the phonological encoding process, which is considered one of the most vulnerable stages in lexical retrieval. As a result, speakers may have greater difficulty retrieving and producing words accurately. This is why speech errors and Tip-of-the-Tongue (TOT) states tend to occur more frequently in high-pressure situations such as public speaking, oral examinations, presentations, or job interviews.
d. Speaking too quickly
   Speaking too quickly reduces the amount of time available for each stage of language processing to

function accurately and efficiently. As a result, the brain may not be able to complete every processing stage properly before speech is produced.

➢ Effects

a. Interrupted fluency
Clark and Clark (1977) state that speech errors often lead to hesitations, repetitions, and self-repairs that disrupt the natural flow of speech. Speech errors and "tip-of-the-tongue" (TOT) moments can cause unexpected pauses, repetitions, or self-corrections that disrupt the natural rhythm and fluency of speech.

b. Unclear communication
Particularly in cases of word substitution, the listener may receive a message that is semantically different from what the speaker intended, leading to misunderstanding.

c. Reduced confidence or embarrassment
Awareness of one's own speech errors, especially in public settings, can lead to language anxiety, which in turn may increase the frequency of further errors by adding to the speaker's cognitive load. According to Yule (2020), language production errors can affect the clarity of a message and may cause misunderstanding between speakers and listeners.

d. Temporary communication breakdowns
While most speech errors and TOT states are brief and self-correctable, they can still create momentary disruptions in the flow of conversation that affect the overall effectiveness of communication.

➢ Conclusion

Speech production is a complex cognitive process that allows humans to transform ideas into spoken language. During this process, speech errors and Tip-of-the-Tongue experiences may occur naturally. These phenomena are not signs of cognitive failure but rather valuable reflections of how the language system operates within the human mind, as emphasized by Aitchison (2012) and Carroll (2008). Understanding these phenomena helps learners recognize the relationship between language, memory, and cognition, while also improving communication awareness and confidence. Furthermore, for language educators, awareness of these phenomena is particularly important, as it shifts the perspective on learners' errors from mere mistakes to meaningful data that reveal the ongoing processes of language learning and cognitive development.

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Book Chapter

Articulation, Foreign Accent Syndrome Revisited, and Speech Perception

Almas Fauziah Silmi, Nifa Roudotul Zannah, Zahratus Syifa

This module examines the interrelationship between language, mental processes and neurological functions in the production and perception of speech. The material covers how sounds are produced via the speech organs such as the tongue, lips, jaw, vocal cords and oral cavity, as well as the phenomenon of coarticulation in everyday communication. Students also study Foreign Accent Syndrome (FAS), a condition in which a person sounds as though they are speaking with a foreign accent due to neurological or psychological changes, which can affect prosody, pronunciation, rhythm and syllable patterns. Furthermore, this course discusses speech perception and acoustic analysis using spectrograms, including formants and formant transitions, to understand how humans both produce and recognise speech sounds.

➢ Articulation

a. Speech Production Mechanisms

This material discusses how humans produce speech sounds through the coordinated cooperation of various speech organs. Students will study the process of speech production, beginning with language planning in the brain and continuing with the execution of articulatory movements by the human speech apparatus. The discussion includes the functions of various articulators, such as the lips, tongue, teeth, hard palate, soft palate (velum), jaw, and glottis, in producing different speech sounds.

In addition, students will study the concepts of articulatory phonology and gestural score, which explain how the movements of the speech organs are systematically coordinated to produce speech. This material also explores the concepts of place of articulation, manner of articulation, and voicing to help students understand how consonants and vowels are formed in human language (Yule, 2020).

b. Foreign Accent Syndrome (FAS)

This section discusses Foreign Accent Syndrome (FAS), a rare speech disorder in which a person is perceived as speaking with a foreign accent despite not having acquired a new language or accent. According to Keulen et al. (2016), FAS may result from neurological damage, psychological factors, or a combination of both. Students will learn how changes in speech production can affect prosody, rhythm, intonation, articulation, and syllable patterns. This material also examines various cases of FAS to understand the relationship between the brain, language production, and listeners' perception of accent. In addition, students will explore how subtle changes in pronunciation can lead listeners to perceive a speaker as having a different accent, even though the speaker continues to use the same language.

c. Speech Perception

One perspective on speech perception suggests that acoustic signals are converted into representations that are matched with stored linguistic patterns to identify language structures. This process is often viewed as passive pattern matching, relying on relatively stable neural representations with minimal cognitive involvement. In contrast, another perspective considers speech perception an active process in which attention and experience influence speech analysis from the early stages. Active processing does not necessarily involve conscious control but reflects how context and prior experience can shape auditory encoding. This view highlights the roles of attention, learning, and listening goals in helping listeners understand speech under difficult conditions, such as background noise or hearing impairment. Recent studies indicate that speech perception results from interactions among multiple brain regions through both feedforward and feedback mechanisms. Therefore, understanding how speech ambiguity and contextual factors influence cognitive resources, including attention, learning, and working memory, is essential. To fully explain speech perception, theories should move beyond a purely cortex-centered approach and consider the dynamic nature of auditory processing, which may also contribute to improved treatments for hearing disorders and hearing loss (Heald & Nusbaum, 2014).

d. Coarticulation and its effects on speech perception.

The way we produce a phoneme changes with context; the same /d/ sound has very different acoustic patterns in syllables like /di/ and /du/, yet listeners perceive it as the same phoneme an example of perceptual constancy. When those formant transitions are played alone, they sound like chirps, showing that context matters. Coarticulation also smears information across time, which can help listeners, as in silent center vowels where a missing vowel is still identified from surrounding consonants. However, this complexity makes it hard to map acoustic signals directly onto phonemes (Traxler, 2012).

e. The motor theory of speech perception

This theory proposes that listeners recover the articulatory gestures that produced the sound, not just the acoustic signal. A specialized speech module preempts normal auditory processing, explaining why transitions sound like chirps in isolation but like phonemes in syllables. This module also produces categorical perception, such as the sharp boundary between /b/ and /p/ at a voice onset time of about 20 milliseconds. The McGurk effect, where conflicting visual and auditory information leads to a fused perception like "da" shows that speech perception uses multiple senses, including touch (Traxler, 2012).

Motor theory was revived by the discovery of mirror neurons in monkeys, which fire during both action and observation. Human studies using fMRI and TMS suggest that listening to speech activates motor cortex areas involved in producing those sounds. However, the theory faces serious problems. Infants perceive speech contrasts they cannot produce, animals like quail and chinchillas show similar categorical perception without human articulators, and brain-damaged patients who cannot speak can still understand speech. Moreover, duplex and categorical perception also occur for non-speech sounds like violin plucks, contradicting the idea of a speech-specific module (Traxler, 2012).

f. The general auditory approach

This approach argues that speech perception uses the same mechanisms as other environmental sounds. The voicing boundary, for instance, matches a basic auditory simultaneity threshold of about 20 milliseconds. The fuzzy logical model (FLMP) combines bottom-up acoustic analysis with top-down knowledge, activating multiple potential phonemes and then using context to select the best match. This explains the Ganong effect (hearing ambiguous sounds as real words) and phonemic restoration (filling in missing phonemes when a noise replaces them), showing that sentence meaning and word knowledge shape what we hear. While the general auditory approach does not yet explain everything, it avoids many of the motor theory's weaknesses (Traxler, 2012).

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Book Chapter

Mirror Neurons and the Motor Theory of Speech Perception

Ine Hamdiah, Assylla Syafani, Noviyanti

This module examines mirror neurons and their relationship with language, the brain, speech perception and human communication. Students learn how this system functions when a person performs an action or observes others doing the same, including in the understanding of speech, expressions, emotions and social behaviour. The course material also highlights the relationship between mirror neurons and the motor theory of speech perception, which explains that humans understand the sounds of language by associating them with the articulatory movements used to produce those sounds. Furthermore, students explore the role of mirror neurons in imitation, empathy, social learning and interpersonal interaction, whilst analysing the links between brain activity, language production and perception, and human behaviour in everyday communication.

➢ Mirror Neurons

Mirror neurons are special cells in the brain that work when someone acts and also when they watch another person doing the same action. In psycholinguistics, mirror neurons are connected to speech and communication because researchers believe that the brain does not only listen to sounds, but also processes the movements behind those sounds. For example, when someone watches a person say the word "banana," the listener's brain may automatically imagine the movement of the lips and tongue used to pronounce the word. This process may help people understand speech more easily. Mirror neurons are also related to imitation because children usually learn language by listening to adults and copying the way they speak. A child who repeatedly hears the word "mama" may slowly imitate the pronunciation and finally be able to say the word correctly. This is why many researchers believe that mirror neurons support language learning and communication skills. Besides helping in speech perception, mirror neurons may also help people understand emotions and intentions during conversations because humans often observe facial expressions, gestures, and tone of voice while communicating (Pulvermüller, 2017).

➢ The Motor Theory Enjoys a Renaissance

The Motor Theory of Speech Perception explains that people understand speech by connecting sounds with the mouth movements used to produce them. This theory became popular again after researchers found that motor areas in the brain become active during speech perception. For example, when people hear sounds like /p/ and /b/, the brain may unconsciously recognize the lip movements involved in producing those sounds. This shows that speech perception is connected not only to hearing but also to the motor system in the brain. Recent brain studies support this theory because they show that listening and speaking processes work together during communication.

Researchers also explain that when people listen carefully to someone speaking in a noisy place, the brain may automatically simulate the speaker’s articulatory movements to help understand the words more clearly. Because of this, many scientists believe that speech perception and speech production are closely connected processes in the brain.

Discoverers of mirror neurons suggested these cells might provide the neurological framework needed to support the motor theory of speech perception. Under this hypothesis, specific mirror neurons in Broca's area would activate both when a person speaks a set of phonemes and when they hear those same sounds, effectively linking speech production and comprehension. However, this theory relies on the unproven assumption that humans actually possess mirror neurons.

Because tracking individual human neurons remains technologically impossible, researchers use alternative experimental methods to investigate whether the human motor cortex is involved in understanding speech. The rationale behind these studies is straightforward: if the motor theory is correct, perceiving speech requires accessing mental representations of speech gestures, which must reside in the brain regions managing articulatory movements—specifically the motor and premotor cortices in the frontal lobes. Consequently, listening to speech should trigger activation in the motor cortex.

Advocates argue that mirror neurons serve as the physical bridge connecting auditory perception to the motor systems used in speech production. While mirror neurons have been identified in the monkey equivalents of the human motor cortex, premotor cortex, and parietal lobes, their presence in humans remains unconfirmed. Nevertheless, proponents interpret any evidence of the human motor cortex responding to speech as validation for their model. Some researchers even hypothesize that mirror neurons facilitate modern human speech perception because our language faculties originally evolved from an ancient system of hand gestures (Gentilucci & Corballis, 2006).

➢ The Mirror Neuron Theory of Speech Perception Jumps the Shark

Although many researchers support mirror neuron theory, some experts think the theory is sometimes used too broadly. They argue that speech understanding does not always depend on motor systems. For example, some people with damage in motor areas of the brain can still understand speech normally. Babies are also able to recognize familiar voices and speech sounds before they can speak clearly. This means that hearing and auditory processing may be more important than motor simulation in understanding language. Some researchers also believe that mirror neuron theory became too popular because it was used to explain many different human behaviors, even when there was not enough strong evidence. Because of this, some researchers believe that mirror neurons alone cannot fully explain speech perception. They argue that language understanding is a more complex process involving memory, hearing systems, attention, and other cognitive functions in the brain

Things get even more unusual when looking at the leg muscles. If you were to ask a typical psycholinguist or neurolinguist whether the section of the motor cortex that manages leg movements should play a role in understanding speech, they would likely say no or find the idea bizarre. Yet, the same Transcranial Magnetic Stimulation (TMS) techniques that trigger responses in tongue muscles also produce responses in leg muscles when people listen to speech

From the perspective of the motor theory (and its mirror neuron variation), it makes sense that listening to speech activates tongue-related brain regions, because the theory claims our speech-understanding tools live in the motor cortex. However, it makes far less sense to claim that speech perception relies on the area controlling our legs. While the authors of the leg study argued that speech relies on a massive "action–language network" connecting speech to arm gestures and eventually to leg movements, a neutral observer might view these bizarre results differently. Instead of proving the motor theory, these findings might suggest that the TMS research technique itself is flawed or unreliable

On the other hand, there are other logical reasons why the motor cortex might light up when we hear speech. One possibility is that listening to speech naturally prepares us to react behaviorally, triggering circuits for both verbal and non-verbal actions. Another idea is that these motor neurons are part of an internal monitoring and error-correction system. For instance, when people hear their own voices electronically altered in real-time, they unconsciously adjust their speech in under 150 milliseconds to fix the error. Brain scans show this quick feedback loop connects the temporal and frontal lobes, meaning the motor cortex might just be responding to speech data processed elsewhere so it can dynamically adjust our spoken output. Finally, the motor activation could simply be a verification process: we might quietly and internally recreate a speech sound to compare it against what we just heard to make sure we understood it correctly.

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The Architecture of the Mind-Language

Book Chapter

Word Processing: The Mental Lexicon, Lexical Semantics, and Meaning Representation

Noor Adzima Madiena, Nisriina Fatih Aulia, Shofia Fithri Mahmudah, Suci Indah Sari

This course covers word processing, focusing on the mental lexicon, lexical semantics, and how meaning is represented in the mind. Students learn how words are stored and organised in the mental lexicon, how words are accessed and processed, and how word forms, meanings, and concepts are interrelated. The course also reviews theories and models concerning the representation of meaning and the semantic relationships between words that play a role in language comprehension and production. Through this course, students are expected to gain an understanding of how the brain and mind process words whilst representing meaning in communication.

➢ Overview: The Mental Lexicon

Language is made up of words, but how exactly does the human mind store and retrieve them? This chapter explores the mental lexicon: the internal system in which our knowledge of words is organized. To understand word processing, we must distinguish between two types of mental representation that work together but operate differently.

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The first is the phonological and orthographic code, which captures how a word sounds and how it looks. The second is the semantic code, which captures what a word means. Words can be related to one another because they sound similar (e.g., gave, cave), look similar (e.g., wow, mow), or share similar meanings (e.g., horse, donkey). Prominent accounts in psycholinguistics propose that word forms are stored in lexical networks, while word meanings are stored in a separate but linked semantic memory system (Balota, Yap, & Cortese, 2006; Collins & Loftus, 1975).

➢ The Anatomy of a Word: How We Mentally Represent Word Form

Words are not atomic units; they are hierarchically organized structures. Classical linguistic theory analyzes word form from the bottom up: phonetic features combine to form phonemes; phonemes combine into syllables (consonant-vowel, or CVC combinations); syllables combine into morphemes, the smallest meaningful unit in a language; and morphemes combine into words.

For example, the word cats is polymorphemic: it contains the morpheme cat (referring to the animal) and the bound morpheme -s (indicating plurality). By contrast, cat alone is monomorphemic. This hierarchical structure has important implications for how the mind processes and retrieves word forms from memory.

Regarding meaning, the chapter distinguishes between two aspects: sense and reference. Sense refers to the dictionary-like, conceptual knowledge associated with a word for example, that cats are mammals, they have fur, and they are kept as pets. Reference, on the other hand, concerns what a word points to in a given context. A word like 'the bigger one' can refer to different objects in different situations, even though its sense stays the same.

➢ Lexical Semantics

The Problem with Dictionary Definitions

One natural assumption about word meaning is that the mind stores words like a dictionary: each word has a fixed set of defining features that captures its core meaning. However, this approach faces serious empirical challenges.

Take the word game. Football, chess, solitaire, and hide-and-seek are all games but there is no single feature common to all of them (Gabora, Rosch, & Aerts, 2008; Murphy & Medin, 1985). Or consider bachelor: technically defined as a human, adult, male, and unmarried yet a monk fits all these criteria without being considered a true bachelor (Pinker, 1994). Furthermore, not all instances of a category are equally representative. Most people judge fire engine red as a better example of red than reddish hair (Rosch, 1973). If word meanings were simple types with fully interchangeable tokens, all instances should be equally valid. These difficulties led researchers to abandon the core-features approach and seek richer, more flexible theories of lexical representation.

Semantic Network Theory

One influential alternative is Semantic Network Theory (Collins & Loftus, 1975; Collins & Quillian, 1972). Rather than storing a list of features, this theory proposes that word meanings are represented as networks of interconnected nodes and links. Each node represents a concept, and links encode the relationships between concepts.

Key types of links include:

a. Is a links: encode category membership (e.g. goose is a waterfowl, waterfowl is a bird)
b. Has links: encode properties (e.g. goose has feathers, goose has wings)
c. Can links: encode abilities or functions (e.g. goose can fly)

An important feature of this system is transitive inference: because goose is connected to waterfowl, and waterfowl is connected to bird, the system can infer that a goose is a bird without a direct link. This conserves memory resources by allowing subordinate concepts to inherit properties from superordinate nodes.

➢ Key Concept: Spreading Activation

When a word node is activated, that activation automatically spreads to connected nodes like ripples on a pond. The spread is (a) automatic: it cannot be consciously controlled, and (b) diminishing: nodes directly connected receive strong activation, while more distantly connected nodes receive progressively weaker activation. This process explains why encountering one word facilitates recognition of related words.

Semantic Priming: Evidence for Spreading Activation

Semantic priming is one of the most well-documented phenomena in psycholinguistics. Priming occurs when exposure to one word (the prime) speeds up recognition of a related word (the target). In classic studies by Meyer and Schvaneveldt (1971, 1976), participants responded faster to the word duck when it was preceded by goose than when preceded by an unrelated word like horse. The explanation: hearing goose activated waterfowl, bird, feathers, and can fly all of which partially overlap with the representation of duck, giving it a head start.

Spreading activation also explains mediated priming priming effects that occur through an intermediate word. The pair lion stripes produces a small priming effect not because they are directly linked, but because lion activates tiger, and tiger is directly linked to stripes (Balota & Lorch, 1986; McNamara & Altarriba, 1988). The effect is weaker than direct priming, consistent with activation diminishing across multiple links.

Automatic vs. Strategic Priming

Jim Neely's (1977) influential experiment demonstrated that spreading activation is automatic and cannot be consciously overridden. Participants were told that after seeing body part, they should expect a bird name to follow. Despite this expectation, when the target appeared immediately after the cue, body part related words (arm, leg, hand) were primed not bird names. Bird-name priming only emerged after a delay, when participants had time to consciously generate a list of expected words.

This points to two distinct processes: (1) fast, automatic spreading activation from the prime to semantically associated concepts, and (2) a slower, strategic attention shift driven by conscious expectations. Clinical evidence supports this distinction: some aphasic patients retain automatic priming but show impaired strategic priming (Hagoort, 1997).

Associative Priming vs. Semantic Priming

A subtle but important distinction in the priming literature concerns the difference between associative and semantic relatedness. Two words can be associated (they frequently appear together in language, like fountain pen) without sharing semantic features. Conversely, two words can share semantic features (like bread–cereal) without having a strong associative relationship.

Rhodes and Donaldson (2008) used ERP methodology to test whether these two types of relatedness produce different neural responses. They found that purely semantically related pairs (bread–cereal) evoked a neural response similar to unrelated pairs and did not reduce the N400 effect an ERP component sensitive to semantic anomaly. In contrast, associatively related pairs regardless of whether they also shared semantic features consistently reduced the N400. This suggests that semantic priming in automatic processing is primarily driven by associative co-occurrence, not shared features alone.

Behavioral and neuropsychological data also support the distinction: Alzheimer's dementia patients retain priming for associatively related words but lose it for purely semantically related pairs (Glosser & Friedman, 1991).

➢ Associationist Accounts of Word Meaning: HAL and LSA

The associationist finding that co-occurrence between words plays a central role in semantic memory led some researchers to ask a more radical question: could word meaning be entirely captured by patterns of co-occurrence in large samples of real language? Two computational models, HAL and LSA, explore this hypothesis.

HAL Hyperspace Analog to Language

HAL (Burgess & Lund, 1997) was trained on a corpus of over 200 million words drawn from USENET internet forums. It tracks 70,000 different words and, for each pair of words, calculates a co-occurrence score based on proximity: words adjacent to each other receive a score of 10; words separated by one word receive a score of 9; and so on, up to a distance of 10 words. The result is a 70,000 × 70,000 matrix. Each word is represented as a vector of 140,000 numbers its "meaning fingerprint" based entirely on the pattern of its linguistic context. HAL has been successfully used to model semantic priming in lexical decision tasks and to predict categorization behavior (Burgess & Lund, 1997).

LSA Latent Semantic Analysis

LSA (Landauer & Dumais, 1997) takes a different approach. Its original corpus contained nearly five million words from an encyclopedia, divided into 30,000 contextual episodes (passages). Rather than tracking word-to-word proximity, LSA tracks word-to-episode relationships: how often each word appears in each episode. It then applies factor analysis to identify underlying patterns, reducing the 30,000 dimensional representation to approximately 300 meaningful dimensions. Like HAL, each word is ultimately represented as a vector but in this compressed, 300-dimensional space.

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LSA has been used to model synonym recognition, aspects of children's vocabulary development (Landauer & Dumais, 1997), evaluation of text summary quality (Kintsch et al., 2000), and even the prediction of which brain regions activate in response to specific words (Mitchell et al., 2008).

Table 1. Comparison of HAL and LSA Two High-Dimensional Co-Occurrence Models of Lexical Semantics

Feature	HAL	LSA
Corpus	200M+ words (USENET)	5M words (encyclopedia)
What it tracks	Word-to-word co-occurrence (10-word window)	Word-to-episode co-occurrence
Representation	70,000 × 70,000 matrix → 140,000-value vector	Factor-analyzed → 300-dimension vector
Key strength	Models priming and categorization	Models synonymy, vocabulary growth, and text quality
Shared advantage	Objective, replicable, no subjective feature lists	Objective, replicable, no subjective feature lists

Both models share a key methodological advantage over feature-based approaches: they eliminate the need for subjective decisions about which features belong in a word's representation. The semantic similarity values they produce are fully objective, replicable, and falsifiable making them scientifically tractable in ways that introspection-based accounts are not (Buchanan, Westbury, & Burgess, 2001).

➢ The Symbol Grounding Problem

Despite their impressive predictive power, both semantic network theory and the HAL/LSA models face a fundamental objection: the symbol grounding problem (Harnad, 1990; Glenberg & Robertson, 2000; Zwaan & Rapp, 2006). The core issue is this: if the meaning of a word is defined by its connections to other words all of which are themselves just symbols then the system as a whole remains ungrounded. Symbols only point to other symbols, in an endless loop, without ever connecting to anything in the real world.

This problem is vividly illustrated by Searle's (1980) Chinese Room argument. Imagine being locked in a room with a rulebook that tells you how to respond to Chinese characters with other Chinese characters. To an outside observer, your responses appear perfectly fluent but you understand nothing. You are manipulating symbols according to rules, without any semantic content. Searle's argument is that this is exactly what a semantic network or HAL/LSA does: it processes symbols by mapping them to other symbols, but none of those symbols carry meaning in themselves.

The Symbol Grounding Problem in Brief

If the meaning of goose is defined by its connections to bird, feathers, and can fly, and the meaning of bird is defined by its connections to goose, wings, and animal, then we have a circular system where symbols only point to other symbols. Nothing in the system connects to the real world. Replace every label in the network with an arbitrary symbol (like «, !, ‡) and the system still functions identically which is a sign that the labels themselves carry no meaning.

➢ Embodied Semantics

The Indexical Hypothesis

Embodied semantics proposes a solution to the symbol grounding problem: word meanings are not grounded in other symbols, but in perceptual and motor experience (Glenberg & Robertson, 2000; Barsalou, 1999). When you hear the word cat, you do not merely activate a pattern of abstract nodes you mentally simulate what a cat looks, sounds, and feels like, drawing on the same perceptual apparatus you would use to perceive an actual cat.

Glenberg and Robertson (2000) formalize this in the indexical hypothesis, which proposes three key processes for how meaning is constructed from language:

a. Indexing: words are tied to actual objects in the world or to analog (perceptual) representations of those objects in memory.
b. Affordance derivation: from those indexed representations, the perceiver extracts affordances what actions the object enables, given the physical properties of the body and the world.
c. Meshing: the affordances of all indexed objects in an utterance are combined to determine what actions and events are possible or plausible.

Experimental Evidence

Glenberg and Robertson (2000) tested the indexical hypothesis against LSA in a sentence plausibility task. Participants read a context sentence (e.g., Marissa forgot to bring her pillow on her camping trip) followed by one of two continuations:

a. Afforded: As a substitute for her pillow, she filled up an old sweater with leaves.
b. Non-afforded: As a substitute for her pillow, she filled up an old sweater with water.

Leaves fits the affordances of the situation (you can fill a sweater with leaves and use it as a pillow), while water does not. Crucially, LSA assigned the same co-occurrence value to both continuations meaning that from a purely associationist standpoint, both should be equally plausible. Yet participants consistently rated the afforded continuation as more sensible. The indexical hypothesis predicted this result LSA could not.

Further evidence comes from Glenberg and Kaschak (2002), who found an action-sentence compatibility effect: participants responded faster to sentences implying motion toward the body (e.g., He opened the drawer) when their response required a toward-body movement, and vice versa. If meaning were entirely abstract and symbolic, physical movement direction should have no bearing on sentence comprehension yet it does.

Additional support comes from ERP and TMS studies showing that action-related words activate the motor cortex specifically the part of the motor strip that controls the body part most associated with the described action (Hauk, Johnsrude, & Pulvermüller, 2004;

Pulvermüller et al., 2005). Parkinson's disease patients, who have impaired motor function, show reduced priming for action-related words; when their motor symptoms are treated with medication, this difference disappears (Boulenger et al., 2008). Taken together, this body of evidence strongly supports the view that semantic representations are grounded in perceptual and motor experience.

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The Architecture of the Mind-Language

Book Chapter

Lexical Access

Adinda Zahra Hidayat, Hilmah Rahmatul Amalia, Khanaia Audria Titania

This course examines lexical access as a mental process involved in understanding and producing language. Students learn how words are stored, activated, and retrieved from the mental lexicon when speaking, listening, reading, or writing. The course material also highlights the factors that influence lexical access, such as word frequency, context, semantic relationships and phonological similarity. In addition, the course covers the development of lexical access theories from first- to third-generation models, ranging from serial and bottom-up processes, through interactive models that emphasise the role of context and prior knowledge, to distributed and connectionist models that explain word processing through interconnected cognitive networks.

➢ Lexical Access

Lexical access is the cognituve process of retrieving word information form the mental lexicon during language comprehension and production. The mental lexicon is often described as a menta dictionary containing phonological, othographic, semantic, and grammatical information related to words. When individuals hear, read, speak, or write words, the brain rapidly activates lexical representations and selects the appropriate item based on the linguistic input

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Lexical access involves several cognitive stages. First, sensory input is received, either through auditory input in spoken language or visual input in written language. Second, lexical candidates stored in memory become activated. Third, the most appropriate lexical item is selected based on matching phonological, semantic, syntatic, or contextual information. Finally, the selected word is integrated into ongoing comprehension or production.

Psycholinguistic studies show that lexical access is influenced by factors such as:

Word Frequency

a. The Rule: High-frequency words (words you see or hear constantly, like *the*, *water*, or *run*) are accessed much faster than low-frequency words (rare words like *eloquent*, *axolotl*, or *obfuscate*).
b. How it works: Think of word frequency like a pathway in a forest. Every time you encounter a word, you walk down its path, making it wider and easier to travel. The pathways for high-frequency words are heavily beaten tracks, so your brain navigates to them almost instantly. Rare words have overgrown pathways, meaning your brain takes a few milliseconds longer to clear the brush and retrieve the word.

Contextual Information

a. The Rule: The situation, sentence, or environment surrounding a word primes your brain to expect it, speeding up retrieval.
b. How it works**:** If someone says, "*She spread the warm butter on the baked...*", your brain pre-activates the word

potato or *bread*. Because the context acts as a spotlight pointing directly toward a small group of relevant words, your mental lexicon doesn't have to search through millions of unrelated terms. If the sentence instead ended in an unexpected word like "*bicycle,*" your processing speed would noticeably drop because the context didn't prepare you for it.

Semantic Associations

a. The Rule: Words that are related in meaning are stored close together in a network. Hearing one word automatically "wakes up" its neighbors.
b. How it works: This is known as semantic priming. If you hear the word *doctor*, your brain automatically sends a ripple of energy to closely related concepts like *nurse*, *hospital*, and *medicine*. If you are tested immediately after hearing *doctor*, you will recognize and access the word *nurse* significantly faster than an unrelated word like *bread*.

Phonological Similarity

a. The Rule: Words that sound alike compete with one another during speech recognition.
b. How it works: When you hear the beginning of a word, like "*cap-*", your brain instantly activates a cohort of similar-sounding candidates: *captain*, *captive*, *capsule*, and *capricorn*. As the speaker finishes the word, the candidates compete until only one wins. Because of this phonological competition, hearing a word that has many "neighbors" (words that sound almost identical, like *cat*, *bat*, *hat*, *rat*) can actually cause a tiny,

measurable delay in access while your brain sifts through the lookalikes.

Orthographic Similarity

a. The Rule: Words that look alike in written form influence how quickly you read and recognize them.
b. How it works**:** Similar to phonological neighbors, orthographic neighbors are words that differ by just one letter (e.g., *trail* and *train*, or *cat* and *cot*). When reading, seeing the word *trail* will briefly activate *train*. If a word looks like many other words, it creates visual competition in the visual cortex, requiring your brain to double-check the exact spelling to ensure accurate lexical access.

Your mental lexicon doesn't store words like an alphabetical dictionary. Instead, it is a dynamic, interconnected web where access speed is dictated by habit (frequency), expectations (context), meaning (semantics), sound (phonology), and appearance (orthography).

To explain how lexical access occurs, psycholinguists have proposed several theoretical models, which developed through first generation, second generation, and third generation approaches.

➢ First Generation Models

First generation models explain lexical access as a serial, bottom up, and largely autonomous process. In these models, word recognition depends mainly on sensory input, and information flows step by step from lower level input toward lexical identification.

Logogen Model (Morton, 1969)

The Logogen Model proposes that each word in the mental lexicon has its own recognition unit called a logogen.

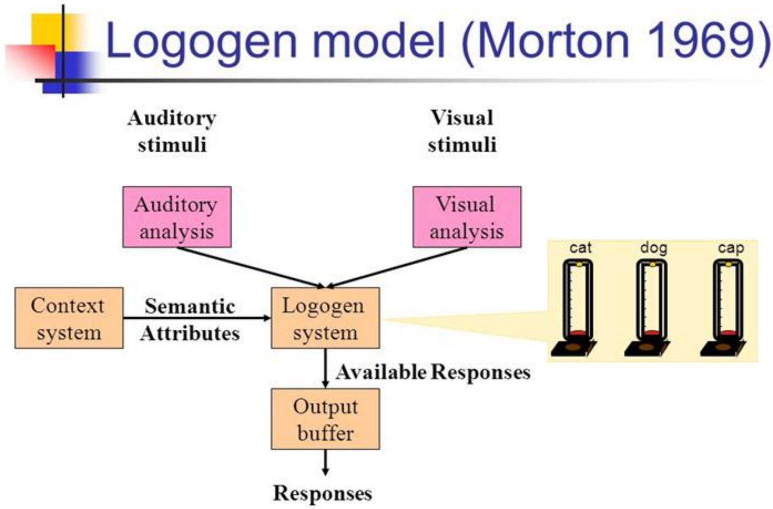

Figure 6.1 A schematic of the information flow in John Morton's (1969) logogen model.

A. How the model works:

Sensory input (spoken or written) provides evidence for a word.

Activation accumulates in the relevant logogen.

When activation reaches a threshold, the word is recognized.

B. Main characteristics:

Uses threshold activation

High frequency words have lower thresholds

Recognition depends primarily on bottom up input

Words are processed individually

C. Strengths:
   Explains word frequency effects
   Simple explanation of lexical recognition
D. Limitations:
   Too dependent on threshold mechanisms
   Limited explanation of competition among multiple word candidates
   Does not sufficiently explain contextual interaction during lexical access

FOBS Model (Forster's Search Model)

The FOBS (Forster's Autonomous Search Model) suggests that lexical access occurs through a serial search process in the mental lexicon.

A. How the model works:
   Input activates a search through lexical bins.
   Entries are searched in order.
   The matching word is selected once found.
B. Main characteristics:
   Serial search
   Autonomous lexical access
   Based heavily on bottom-up information
   Frequency affects search order
C. Strengths:
   Explains structured lexical search
   Accounts for some frequency effects
D. Limitations:
   Too slow for real time spoken word recognition
   Cannot explain early activation of multiple lexical candidates
   Inconsistent with evidence showing parallel activation

Original Cohort Model (Marslen Wilson)

The Cohort Model was developed to explain lexical access in spoken word recognition.

How the model works:

The process involves three stages:

a. Activation / Contact

   As soon as the initial sounds of a word are heard, all words that match the onset become activated.

   Example:

   Input: cap Activated cohort:

   (a) captain

   (b) capital

   (c) capture

   (d) capsule

   This activated set is called a cohort.

b. Selection

   As more auditory input arrives, words that no longer match are eliminated.

c. Integration

   The selected word is integrated into sentence meaning and grammatical structure.

A. Main characteristics:

   Strong emphasis on word onset

   Recognition occurs at the recognition point

   Incremental spoken word processing

   Parallel activation of candidates

B. Strengths:

   Explains rapid spoken word recognition

   Introduces the concept of recognition point

   Supported by phoneme monitoring experiments

C. Limitations:
Original version did not explain frequency effects well
Too dependent on onset information
Less flexible for degraded or noisy input

➢ Second Generation Models

Second generation models emerged because first generation theories were considered too limited. These models explain lexical access as an interactive, parallel, and context sensitive process.

TRACE Model (McClelland & Elman)

TRACE is an **interactive activation model** for lexical access.

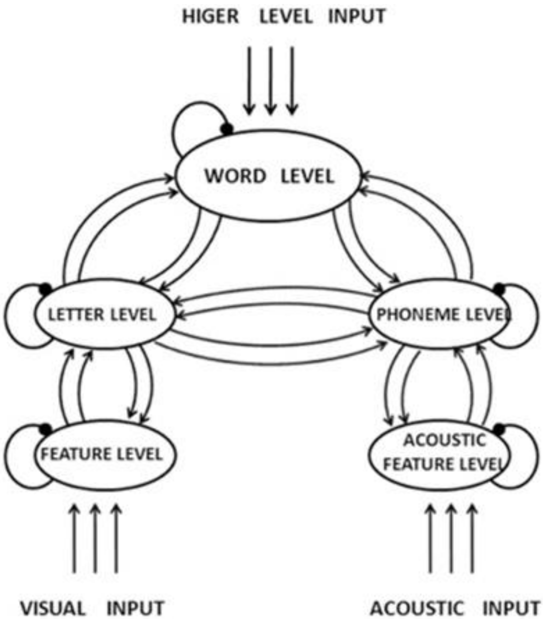

Figure 6.2 The TRACE model of lexical access
(McClelland & Rumelhart, 1981, pp. 378,380)

A. Structure of TRACE

TRACE contains multiple processing levels:

a. Feature level

Basic visual or acoustic features

b. Phoneme/Letter level

Intermediate linguistic units

c. Word level

Lexical representations

B. How the model works

Input activates feature units

Feature units activate phoneme/letter units

Phoneme/letter units activate word units

Activation flows both upward and downward

C. This means:

Bottom up processing occurs from sensory input

Top down feedback occurs from word level to lower levels

Units at the same level inhibit competitors (lateral inhibition)

D. Main characteristics

Cascaded activation (activation starts immediately, no need to wait for full input)

Interactive processing

Top down and bottom up integration

Competition between candidates

E. Strengths

a. Explains recognition under degraded input

b. Explains the word superiority effect

c. Allows simultaneous processing across levels

d. Better than serial models in explaining ambiguity

F. Limitations
   a. Computationally complex
   b. Sometimes overestimates feedback effects
   c. Not all lexical access appears fully interactive in real cognition

Revised Cohort Model

The revised version of Cohort improves weaknesses of the original model.

New improvements

Word activation is graded, not all or none

Includes frequency effects

Direct connection between acoustic phonetic features and word level representations

Better explanation for ambiguous auditory input

A. Strengths

   More flexible than original Cohort

   Better explains spoken word competition

   Includes probabilistic activation

B. Limitations
   a. Still relies strongly on onset based activation
   b. Less powerful than fully distributed connectionist models

➢ Third Generation Models: Distributed Features and Distributed Cohort

Third generation models explain lexical access using connectionist and distributed cognitive systems. Unlike earlier models, lexical information is not stored as isolated units but as patterns of activation across networks of interconnected units.

Distributed Feature Models

Distributed feature models propose that word meaning and lexical representation emerge from patterns of activation distributed across multiple features.
A word is not represented in one single location, but through many semantic, phonological, and contextual features working together.

A. Example:
   Word: **dog**
   Activated distributed features may include:
   a. animal
   b. living
   c. moves
   d. barks
   e. pet

   Recognition happens when the activation pattern matches the stored distributed representation.

B. Main characteristics
   a. Distributed representation
   b. Parallel activation
   c. Feature based lexical coding
   d. Neural network style processing

C. Strengths
   a. Explains semantic similarity effects
   b. Handles partial and noisy input
   c. More biologically plausible

D. Limitations
   a. Difficult to isolate individual lexical units
   b. Computationally abstract

The Architecture of the Mind-Language

Simple Recurrent Network (Elman)

One important distributed feature model is Elman's Simple Recurrent Network (SRN).

A. Structure

SRN contains:

a. Input units
b. Hidden units
c. Output units
d. Context units

Context units store information from previous input, allowing the system to process language sequentially.

B. How the model works

Current input enters network
Hidden units process activation
Previous context influences current processing
Output emerges as distributed activation pattern

C. Main characteristics

Uses context memory
Dynamic activation over time
Learns lexical patterns through exposure
Sensitive to sequence information

D. Strengths

a. Explains contextual lexical processing
b. Models prediction in language processing
c. Simulates human like sequential comprehension

Distributed Cohort Model

The distributed cohort model combines ideas from:
Cohort theory
Connectionist processing
Distributed activation networks

The parallel distributed processing enterprise continued to grow and develop with the invention of newer and more advanced mathematical models of lexical access. For example, Jeff Elman's simple recurrent network (SRN) model assumed that words were represented as a pattern of neural activity across a multi-layered network.

The model further subdivided individual word representations (e.g., book), by producing slightly different patterns of activation when the word appeared in different contexts. This solves one of the sticky problems faced by the "dictionary entry" and feature-based theories of semantics. Namely, how do you have enough entries in the dictionary to take care of all of the slightly different shades of meaning that you can assign to a particular word in different contexts? The SRN model solves this problem by letting context influence the pattern of activity that occurs in the network, so the representation of the word ball (the activity in the hidden units) will be slightly different in a baseball context and a playground context

A. How the model works

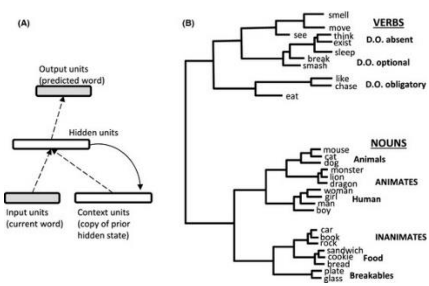

Figure 6.3 Top: The architecture of the network. Bottom: The semantic space that emerged after the model was trained.

Initial auditory input activates multiple lexical candidates
Candidates are represented as distributed patterns
Activation changes continuously as more input arrives
Context and feature similarity influence lexical competition

B. Main characteristics
Parallel lexical competition
Graded activation
Feature based lexical representation
Context sensitive processing

C. Strengths
Integrates spoken word competition with distributed processing
Better explains lexical ambiguity
More flexible than original cohort models

D. Limitations
Complex computational structure
Less directly observable experimentally

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Sentence Processing and Syntactic Parsing in Psycholinguistics

An Marsanda Rahayu, Gadis Kamilah Cahyadi, Khesya Almira Gianinna, Zahra Maulidia

This course covers sentence processing and syntactic analysis (syntactic parsing) in psycholinguistics. Students learn how humans comprehend sequences of words and organise them into meaningful phrases, clauses and sentences. The material covers syntactic parsing, sentence ambiguity, and processing theories such as two-stage parsing models, Garden Path Theory and constraint-based models. In addition, parsing strategies such as late closure and minimal attachment are discussed, as well as the role of context, meaning and prior knowledge in supporting language comprehension. Through this course, students are expected to be able to analyse the processes of sentence comprehension and language-processing phenomena in everyday communication.

➢ Introduction to Sentence Processing

Sentence processing is one of the important topics in psycholinguistics. It studies how people understand sentences during reading and listening. Humans can process language quickly even when sentences are long or complicated. This ability involves cognitive processes that connect grammar, meaning, and memory.

The Architecture of the Mind-Language

When listeners hear a sentence, they process words one by one. At the same time, they organize these words into meaningful structures. For example, in the sentence:
"The teacher explained the lesson clearly."

The listener identifies "the teacher" as the subject and "explained" as the verb. Then, the listener connects the remaining words to complete the meaning of the sentence.

Sentence processing does not always occur smoothly. Sometimes sentences contain ambiguity, meaning that a sentence can have more than one interpretation. In such situations, comprehenders must decide which interpretation is correct based on grammar, context, or meaning.

Psycholinguists study sentence processing to understand how the human brain organizes linguistic information. Research in this area helps explain reading comprehension, language acquisition, and communication difficulties.

➢ Syntactic Parsing

Syntactic parsing is the process of analyzing grammatical structures during sentence comprehension. Parsing helps comprehenders determine how words are grouped into phrases and clauses.

For example, consider the sentence:
"The boy saw the girl with binoculars."

This sentence has two possible interpretations:

a. The boy used binoculars to see the girl.
b. The girl had binoculars.

The ambiguity happens because the phrase "with binoculars" can attach to different parts of the sentence.

During parsing, the brain builds a mental structure of the sentence. This process is important because sentence meaning depends on grammatical organization. Readers and listeners continuously revise their interpretations when they receive new information.

Psycholinguists often use phrase structure trees to explain parsing. Phrase structure trees visually represent how words combine into phrases such as noun phrases (NP) and verb phrases (VP). These structures help explain how humans process syntax during comprehension.

Parsing is usually automatic and rapid. However, difficult sentence structures may slow comprehension and increase processing effort.

➢ Ambiguous Sentences

Ambiguous sentences are sentences that have more than one interpretation. Ambiguity is common in language because words and structures can often be interpreted differently.

There are two major types of ambiguity:

A. Global Ambiguity

   Global ambiguity occurs when a sentence remains ambiguous even after the sentence is completed.

   Example:

   "The chicken is ready to eat."

   This sentence may mean:

   a. The chicken is prepared for someone to eat.
   b. The chicken is ready to eat food.

   The sentence stays ambiguous because both meanings are grammatically possible.

B. Temporary Ambiguity

Temporary ambiguity occurs when the beginning of a sentence creates confusion, but later information clarifies the meaning.

Example:

"While Anna dressed the baby played in the crib."

At first, readers may think Anna dressed the baby. However, later they realize that "the baby" is actually the subject of the second clause. This causes readers to reanalyze the sentence structure.

Temporary ambiguity often creates processing difficulty because comprehenders initially choose an incorrect interpretation.

Psycholinguists use ambiguous sentences to study how people process syntax and meaning in real time.

➢ Garden Path Theory

Garden path theory explains how readers and listeners sometimes follow an incorrect interpretation during sentence processing. According to this theory, people initially choose the simplest grammatical structure. When later information contradicts that interpretation, they must revise their understanding.

According to Garden Path Theory, sentence processing happens step-by-step and in real-time using three distinct, sequential stages:

a. Stage 1: The Lexical Processor immediately identifies the grammatical categories (like nouns, verbs, and conjunctions) of words as they come in, stripping away the specific meanings to create a structural sequence.

b. Stage 2: The Syntactic Parser uses that sequence of categories to build a grammatical tree structure on a word-by-word basis, without needing to know the actual words yet.
   A famous example is:
   “The horse raced past the barn fell.”
   At first, readers interpret “raced” as the main verb. However, later they realize that “raced past the barn” functions as a reduced relative clause. This creates confusion because the initial interpretation was incorrect.
c. Stage 3: The Thematic Interpreter inserts the real words into the parser's tree structure and applies rules to assign semantic roles (such as who is doing the action) based on tree placement.

The Feedback Loop: Listeners monitor meaning constantly rather than waiting for the end of a sentence. If the thematic interpreter builds a meaning that makes sense and aligns with the listener's background knowledge, processing finishes. However, if the meaning is illogical or confusing (a "garden path" error), the interpreter signals the syntactic parser to go back and attempt to build an alternative structural path.

Garden path sentences demonstrate how parsing strategies influence comprehension. Two important parsing principles in garden path theory are:

a. Minimal Attachment
   Minimal attachment means that comprehenders prefer the simplest grammatical structure possible.
   Example:
   “The man kept the dog in the house.”

Readers initially attach "in the house" to the verb phrase because it creates a simpler structure.

b. Late Closure

Late closure means that readers tend to attach new words to the current phrase rather than starting a new structure.

Example:

"Tom said that Bill had taken the cleaning out yesterday."

Readers first connect "yesterday" to the closest clause because it follows the principle of late closure.

Garden path theory suggests that syntax plays a major role during the early stages of sentence comprehension.

➢ Two-Stage Models

Two-stage models explain sentence comprehension as a process that occurs in separate stages.

a. First Stage: Initial Parsing

In the first stage, comprehenders analyze sentence structure mainly based on syntax. Semantic and contextual information are not strongly considered yet. The parser quickly chooses one grammatical interpretation using principles such as minimal attachment and late closure.

b. Second Stage: Reanalysis

If the initial interpretation is incorrect, comprehenders move to the second stage and revise the structure using semantic and contextual information.

For example:

"The old man the boats."

Readers may initially misunderstand “old” as an adjective. Later, they realize that “man” functions as a verb, requiring syntactic reanalysis.

Two-stage models emphasize the importance of syntax in sentence comprehension. These models argue that parsing decisions occur before semantic interpretation becomes fully involved.

Although influential, two-stage models have also been criticized because they may underestimate the role of context and meaning during comprehension.

➢ Constraint-Based Models

In contrast to the sequential, step-by-step approach of the Garden Path theory (where syntax is built first and checked for meaning later), Constraint-Based Models argue that your brain is the ultimate multitasker when it comes to understanding sentences.

Instead of waiting in line, multiple streams of information act as "constraints" (clues or boundaries) that work together simultaneously and in real-time to help you figure out what a sentence means.

Here is how those five sources of information collaborate at the exact same moment:

The 5 Simultaneous Forces

a. Syntax (Grammar rules): Your brain tracks structural patterns (like subject-verb-object) to know how words traditionally fit together mechanically.

b. Semantics (Word meaning): The actual meaning of the words is processed instantly. For example, if a sentence starts with "*The animate chef cooked...*" versus "*The inanimate apple cooked...*", your brain immediately uses the meaning of "chef" or "apple" to predict what role they will play in the rest of the sentence.

c. Context (The surroundings): The current environment or preceding sentences instantly eliminate wrong interpretations. If you are looking at a table with two apples and someone says, "*Pick up the apple on the...*", your brain immediately knows the next words will describe the location to clarify *which* apple, ignoring other grammatical possibilities.

d. Frequency of Language Use: Your brain calculates statistical probabilities based on your past experiences. If a word can be used as both a noun and a verb (like *train*), your brain will automatically lean toward the version you encounter most frequently in daily life.

e. World Knowledge (Common sense): General knowledge about how the physical world works is applied instantly. You know that keys open doors, gravity drops things, and ice is cold. If a sentence structure implies something physically impossible, constraint-based models argue your brain rejects that structure *immediately*, rather than building it and fixing it later.

Think of the Garden Path model as an assembly line where a sentence goes through a grammar machine first, then a meaning machine. The Constraint-Based model is more like a jury deliberation, where grammar, word meanings, context, past habits, and common sense all sit at the table at the exact same time, rapidly voting until they instantly agree on the most logical interpretation of the sentence.

➢ Context and Semantic Effects in Parsing

Context and semantic interpretation strongly influence sentence comprehension. Readers and listeners often rely on background knowledge and situational context to interpret ambiguous structures.

For example, the sentence:

"The spy saw the cop with the binoculars."

can be interpreted differently depending on context. If the story discusses surveillance equipment, readers may assume the spy used binoculars. If the story discusses a police officer carrying equipment, readers may interpret the cop as having binoculars.

Semantic plausibility also affects parsing decisions. People tend to prefer interpretations that make sense in real-world situations.

Another important factor is subcategory frequency effects. Some verbs appear more frequently in certain sentence structures, influencing how comprehenders interpret sentences.

For example, verbs like "admit" are often followed by clauses, while verbs like "visit" are commonly followed by noun phrases. Readers unconsciously use this information during parsing.

Contextual and semantic effects demonstrate that sentence comprehension is not based only on grammar. Meaning, experience, and language exposure also play important roles.

➢ Conclusion

Sentence processing is an important area of psycho-linguistics because it explains how humans understand language during communication. Through syntactic parsing, readers and listeners organize words into meaningful structures. However, sentence comprehension can become difficult when ambiguity occurs.

Theories such as garden path theory and two-stage models explain how people initially rely on syntax when interpreting sentences. Meanwhile, constraint-based models argue that syntax, semantics, and context work together simultaneously during comprehension.

Understanding sentence processing helps students analyze language comprehension more critically. It also provides insight into how grammar, meaning, and cognition interact in human communication

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Book Chapter

Infant Speech Perception and Phonological Development

Marsha Fathia Jasmine, Afifa Zahara Sugandi, Taufiqul Hakim

This course examines infants' perception of speech and phonological development in psycholinguistics. Students learn how infants begin to recognise, distinguish and understand the sounds of language from an early age, and how these abilities develop into a phonological system through the process of language acquisition. The course material also highlights the links between sound perception, brain development and language acquisition, including how infants gradually master the sounds of the language they hear. Through this course, students are expected to gain an understanding of phonological development and speech perception in infants, as well as their relationship to human language acquisition.

➢ Infant Perception and Categorization of Phonemes

Language acquisition actually starts far earlier than the moment children begin producing recognizable words. Even during the first months of infancy, babies are already surrounded by streams of spoken language and continuously processing the sounds they hear from parents and people around them. One of the earliest abilities they begin developing is the recognition of phonemes, which are understood as the smallest sound units capable of distinguishing meaning within a language. In English, for instance, the phonemes /b/ and /p/ create different lexical meanings, as seen in pairs such as bat and pat.

At the same time, infants are not only learning isolated sounds. They are also trying to figure out how those sounds connect to larger linguistic structures. While still unable to speak fluently, they must identify which sound patterns belong to words, understand how words are separated in continuous speech, and later recognize how words combine into grammatical sentences. What makes this process especially fascinating is that children manage to accomplish all of these things naturally, without explicit teaching or formal instruction (Traxler, 2012, p. 329).

Phonemes as the Building Blocks of Language

Phonemes are generally understood as the smallest sound elements that contribute to meaning distinctions within a language. These sound units become the foundation from which words are formed and recognized. Still, spoken language in everyday communication is far from uniform. The way people pronounce words can vary significantly depending on factors such as speaking speed, pitch, regional accent, emotional state, and even the physical structure of the speaker's vocal tract (Traxler, 2012). Because of this variation, speech rarely appears in an identical acoustic form across different speakers.

A simple example can be seen in the pronunciation of the word "baby". When spoken by different individuals, the acoustic signal may change noticeably, yet listeners are still able to identify all versions as the same lexical item. This happens because the human perceptual system does not interpret every sound difference as meaningful. Instead, listeners mentally group a range of similar acoustic patterns into stable phonological categories. In psycholinguistics, this process is referred to as categorical perception. Through categorical perception, people are able to process spoken language efficiently despite the enormous variability that naturally exists in speech production.

Categorical perception describes the tendency of listeners to treat acoustically different sounds as belonging to a single phonemic category when those differences are not linguistically meaningful. In everyday speech processing, adults generally overlook small variations in pronunciation as long as the sounds are still recognized as the same phoneme. This ability allows listeners to understand spoken language efficiently despite constant acoustic variability between speakers and contexts.

An important study conducted by Peter D. Eimas and his colleagues showed that this perceptual ability appears surprisingly early in human development. Their research found that infants who were only around one month old already demonstrated signs of categorical speech perception. In the experiment, infants were exposed to the syllable /ba/ produced with varying degrees of *voice onset time* or VOT, which refers to the interval between the release of a consonant sound and the beginning of vocal cord vibration (Eimas et al., 1971). Interestingly, when the altered sounds still remained within the /ba/ category, the infants responded as though they were hearing the same sound repeatedly. The reaction changed once the sound crossed the phonemic boundary and began resembling /pa/. At that point, the infants detected the contrast immediately, something reflected in increased sucking responses during the experiment.

These findings suggest that infants perceive speech sounds categorically in ways similar to adults, even before they begin speaking.

Is Speech Perception Innate or Learned?

One of the long-standing debates in psycholinguistics concerns whether speech perception is something humans are born with or something acquired mainly through experience. Some researchers have argued that the human brain contains biologically specialized mechanisms dedicated to processing speech sounds. From this perspective, the ability to distinguish phonemes is not learned entirely from the environment because humans are already genetically prepared for language perception from birth (Liberman et al., 1967; Eimas et al., 1971). This idea became influential partly because infants demonstrate surprisingly advanced sensitivity to speech contrasts very early in life, long before they are capable of producing language themselves.

Still, later research complicated the picture quite a bit. Several studies found that certain animals, including chinchillas and Japanese quail, were also able to categorize speech sounds in ways that resembled human perception. Findings like these weakened the argument that categorical perception belongs exclusively to human speech processing. Researchers additionally discovered that humans categorize some non speech sounds categorically as well, not only linguistic ones (Kluender & Kiefte, 2006). Experiments involving synthetic sounds modeled after musical instruments produced similar results. Both adults and infants were able to group sounds into categories such as “bowed” and “plucked,” despite the fact that the stimuli were not speech based at all (Cutting & Rosner, 1974; Jusczyk et al., 1977). Because of findings like these, many researchers began considering the possibility that categorical perception might come from broader auditory processing abilities rather than from a language specific system alone.

Even with those challenges, researchers did not completely abandon the idea of innate language capacities. Infants consistently show strong attention toward speech from the earliest stages of life, and they often prefer language related sounds over other auditory stimuli (Jusczyk & Bertoncini, 1988). This pattern suggests that although language knowledge itself develops gradually through exposure, infants may still arrive in the world biologically prepared to attend to speech. Jusczyk later proposed the idea of an innately guided learning process, where biology provides the initial orientation toward language, while detailed phonological knowledge emerges through interaction with linguistic input and experience over time.

Broad Phonological Sensitivity in Infancy

Research in infant speech perception has shown that babies begin life with remarkably broad phonological sensitivity. During the early stages of development, infants are able to discriminate many speech contrasts, including sounds that do not belong to the language spoken around them. Studies by Werker and Tees demonstrated that young infants can distinguish phonemic differences from unfamiliar languages, even when they have never previously been exposed to those sound systems (Werker & Tees, 1983). This suggests that infants are not initially restricted to the phonological categories of a single language but instead possess a flexible perceptual system capable of responding to a wide range of human speech sounds.

A well known example involves the contrast between /r/ and /l/. In English, these sounds function as separate phonemes and can distinguish meaning, while in Japanese they are not treated as distinct categories in the same way. As a result, many adult Japanese speakers experience difficulty perceiving the contrast clearly. Interestingly, infants at an early age are still able to hear the difference regardless of whether they are raised in English speaking or Japanese speaking environments (Traxler, 2012, p. 332). Similar patterns appear with aspiration contrasts as well. Even infants who grow up hearing languages without aspirated consonants can initially detect the difference between aspirated and non aspirated sounds. This early flexibility is often interpreted as evidence that human infants begin with the potential to acquire virtually any natural language.

The process is somewhat comparable to a music streaming application that initially treats all genres equally but gradually adapts to the listener's preferences over time. Infant phonological development works in a similar direction. Continuous exposure to certain speech patterns strengthens sensitivity to frequently heard sound categories, while distinctions that are not relevant in the surrounding language environment slowly weaken. By the end of the first year, infants become increasingly specialized in processing contrasts that are important for their native language and less responsive to non native distinctions (Kuhl et al., 2006). What begins as a highly flexible perceptual system gradually narrows into language specific phonological expertise.

Phoneme Prototypes and the Perceptual Magnet Effect

One influential explanation of early phonological learning comes from the work of Patricia K. Kuhl, who argued that infants gradually build what are known as *phoneme prototypes*. These prototypes function like mental reference points formed from the speech sounds infants hear repeatedly in their environment. Since pronunciation naturally varies across speakers because of differences in accent, pitch, speaking style, and vocal anatomy, infants cannot rely on identical acoustic input every time they hear a sound. Instead, they begin organizing similar pronunciations into broader phonemic categories and treat the most typical version as a kind of perceptual center (Kuhl et al., 1992).

Kuhl referred to this process as the *perceptual magnet effect*. The idea is that once a prototype becomes established, nearby sound variations are mentally drawn toward that central category, making the differences between them less noticeable to the listener. A good example can be seen in vowel perception. Both Swedish and English contain vowel sounds resembling “ee,” but the exact acoustic qualities are not perfectly identical between the two languages. Infants raised in Swedish speaking environments gradually become more sensitive to Swedish vowel prototypes, whereas English learning infants become more attuned to the English versions of those sounds (Traxler, 2012, p. 333). In other words, repeated language exposure slowly reshapes perception so that infants process speech according to the sound patterns most relevant in their own linguistic environment.

➢ Solving the Segmentation Problem

One of the biggest challenges in early language acquisition is the segmentation problem. In natural speech, people do not usually pause between every word when speaking. Instead, spoken language sounds continuous and connected. For example, a sentence like "I want to eat ice cream" may sound more like "Iwannaeaticecream" in fast conversation. Adults can understand the boundaries between words easily because they already know the language. However, infants do not yet have vocabulary knowledge, so they must somehow discover where one word ends and another begins. This difficulty is known as the segmentation problem in psycholinguistics (Weiss, et. al 2009).

Researchers believe that infants solve this problem by using several cognitive and perceptual strategies. One important strategy is called statistical learning. Statistical learning refers to the ability to detect patterns and regularities in the speech stream. Instead of hearing speech as random sounds, infants unconsciously calculate which syllables frequently occur together. When certain syllables repeatedly appear together, infants begin to assume that those syllables belong to the same word (Saffran, et. al 1996).

An influential study by Jenny Saffran, Richard Aslin, and Elissa Newport demonstrated this ability in 8-month-old infants. In their experiment, infants listened to an artificial language made of nonsense syllables spoken continuously without pauses. Even though there were no clear word boundaries, the infants successfully identified groups of syllables that statistically belonged together. The researchers concluded that infants were able to segment words by tracking transitional probabilities between syllables. Transitional probability refers to the likelihood that one syllable will follow another. If two syllables often appear together, infants treat them as part of the same word (Safran, et. al. 1996).

For example, in the phrase "pretty baby," the syllable "pre" is highly likely to be followed by "tty," while "tty" is less strongly connected to "ba" because "ba" may belong to another word. As a result, infants begin to detect that "pretty" and "baby" are separate units. This process happens automatically and does not require formal teaching (Marimon, et. al. 2025).

Besides statistical learning, infants also use stress patterns to segment speech. In English, many words begin with a stressed syllable, such as "BAby," "MOther," and "TAble." Infants gradually learn that stressed syllables often signal the beginning of words. Jusczyk and colleagues found that infants around 7 to 8 months old already show sensitivity to these stress patterns in English speech. This helps them divide continuous speech into smaller meaningful units (Estes, et. al. 2007).

Another useful cue is phonotactic knowledge. Phonotactics refers to the rules about which sound combinations are possible in a language. Infants slowly learn that some sound combinations commonly occur within words, while others usually occur across word boundaries. For instance, certain consonant clusters may sound natural inside English words, whereas other combinations rarely appear together. By learning these regularities, infants become more skilled at identifying possible word boundaries (Brent & Cartwright. 1996).

Researchers also discovered that familiar words help infants segment speech more effectively. When infants repeatedly hear familiar words such as “mommy,” “milk,” or their own name, these known words become anchors in the speech stream. Once infants recognize one familiar word, they can use it to identify neighboring words more easily. This process gradually supports vocabulary growth and more advanced language comprehension (Estes, et. al. 2013). In addition, speech segmentation is closely connected to vocabulary acquisition. Before children can learn the meaning of words, they must first separate those words from continuous speech. Studies show that infants who successfully segment words are better able to connect those words with meanings later. In other words, segmentation becomes an important foundation for language learning and communication development.

The segmentation problem demonstrates that infants are active learners rather than passive listeners. Even before they can speak fluently, babies continuously analyze sounds, identify patterns, and organize linguistic information in their minds. Through exposure to speech and interaction with their environment, infants gradually transform continuous streams of sound into meaningful language structures. This ability shows how remarkable early human language acquisition truly is (Saffran et. al. 1996)

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Book Chapter

Language Development in Infancy and Early Childhood

Ananda Sasi Kirana, Maely Aisyah Rezqy Lubis, Sintiya Ridiyanti

This course examines the development of language in infants and young children from a psycholinguistic perspective. Students learn how children begin to acquire language skills from birth, starting with recognizing sounds and intonation, understanding words, forming grammatical structures, and eventually using language to communicate. The course material also emphasizes the role of children's interactions with adults through infant-directed speech, as well as infants' ability to recognize language patterns through statistical learning and speech segmentation. In addition, the course covers theories of language acquisition—behaviourism, nativism, cognitive theory and interactionism—which explain the roles of innate factors, the environment, cognitive processes and social interaction in children's language development. Through this course, students are expected to gain an understanding of the processes and factors that influence language development in infancy and early childhood.

Language development in infancy and early childhood is one of the most extraordinary feats of human cognition. It doesn't happen all at once; rather, it is a beautifully orchestrated process where a child learns the sounds, rules, meanings, and social nuances of their culture's language.

The Architecture of the Mind-Language

Here is a detailed breakdown of the components, the driving forces, and the milestones of how children learn to communicate.

➢ The Core Components of Language

To master a language, a child must simultaneously piece together five distinct systems:

a. Phonological Development (Sounds): This is learning the distinct sounds (phonemes) of a language and how they can be combined. A baby must learn to distinguish between sounds like /b/ and /p/ and figure out how to physically coordinate their mouth, tongue, and vocal cords to reproduce them.

b. Vocabulary Development (Words): Also known as lexical acquisition. Children rapidly transition from understanding zero words to recognizing names, objects, and actions. This kicks into overdrive around 18 months with the "vocabulary spurt," where they might learn multiple new words a day.

c. Grammar Development (Structure): This involves syntax (how words are ordered to make sentences) and morphology (how word parts change meaning, like adding "-ed" for past tense or "-s" for plurals). Children move from single words to two-word phrases ("*More milk*"), eventually mastering complex sentence structures.

d. Semantic Development (Meaning): This is the process of mapping words to their actual concepts. It requires cognitive sorting. For example, a toddler might initially use overextension (calling every four-legged animal a "doggy") or underextension (thinking the word "cat" *only* applies to their specific pet cat, not other cats) until their semantic boundaries refine.

e. Pragmatic Development (Social Rules): This is learning *how* to use language appropriately in social contexts. It includes understanding conversational turn-taking, staying on topic, adjusting your tone depending on who you are talking to (e.g., speaking differently to a baby vs. a teacher), and understanding politeness.

➢ Influencing Factors: What Drives Development?

Language does not develop in a vacuum; it is shaped by an intricate interplay of nature and nurture:

a. Biological Factors: Human brains are biologically hardwired for language. Areas like Broca's area (speech production) and Wernicke's area (speech comprehension) provide the neural architecture. Genetics also play a huge role in the pacing of auditory processing and motor control.

b. Family Environment: The home is a child's primary language lab. The quality, richness, and emotional warmth of the language spoken at home directly impact verbal intelligence and vocabulary size.

c. Social Interaction: Language is fundamentally social. Children do not learn language effectively just by listening to a television or a tablet; they learn through interactive loops—when a caregiver responds to their babbles, smiles, and gestures, creating a responsive feedback system.

d. Language Exposure: The *quantity* and *variety* of words a child hears matter immensely. Children who are frequently spoken to, read to, and engaged in storytelling develop stronger language skills and adapt to school settings faster.

e. The Child's Cognitive Development: Language and thinking grow together. As a child's memory, attention span, and ability to categorize objects improve, their capacity to learn complex language structures increases. For example, a child cannot easily use words like "yesterday" or "tomorrow" until they cognitively grasp the abstract concept of time.

➢ The Stages of Child Language Development

While every child develops at their own pace, the structural milestones generally unfold in a predictable sequence:

Table 2. The Stages of Child Language Development

Age Range	Stage	What It Looks Like
0 – 4 Months	Vegetative & Cooing	Crying to signal needs, followed by vowel-like sounds ("*ooo*", "*aaa*") when content.
4 – 6 Months	Vocal Play	Testing vocal limits by squealing, growling, making friction sounds, and blowing bubbles.
6 – 12 Months	Babbling	Canonical babbling ("*ba-ba-ba*") shifts to variegated babbling ("*ba-da-ma*"). By 10 months, their babbles begin to mimic the rhythm and

		intonation of their native language.
12 – 18 Months	Holophrastic (One-Word)	Using a single word to represent a whole sentence. "*Juice!*" could mean "*I want juice*" or "*I spilled my juice.*"
18 – 24 Months	Two-Word (Telegraphic)	The vocabulary spurt begins. They combine words using basic syntax, stripping out filler words. ("*Daddy go,*" "*Big doggy*").
2 – 3 Years	Early Multi-Word	Sentences grow to 3-4 words. They begin using grammatical morphemes (plurals, prepositions) but often overregularize grammar rules ("*I goed to the park*" instead of "*went*").
3 – 5+ Years	Complex Language	Sentences become grammatically correct and complex. Vocabulary expands to thousands of words, and they can carry out full conversations, tell structured stories, and use language to negotiate or joke.

Pre-linguistic Stage

This stage lasts from birth until around 12 months of age. At this stage, infants are not yet able to produce meaningful words, but have begun to communicate through:

a. Crying
b. Body movements
c. Facial expressions
d. Cooing
e. Babbling

One Word Stage

This stage typically occurs around 12-18 months of age. Children begin to use single words to convey an idea or desire.

Examples:

a. "Mama"
b. "Milk"
c. "Play"
d. "Ball"

Characteristics:

a. A single word represents a complete sentence
b. Children begin to understand the relationship between words and meaning
c. Vocabulary begins to expand

Examples:

a. The word "milk" can mean:
b. "I want milk"
c. "That's my milk"

Advantages:

a. Demonstrates the early development of symbolic language skills
b. Children begin to communicate actively

Limitations:

a. Meaning is often ambiguous
b. Depends on context

Two-Word Stage

At around 18-24 months of age, children begin to combine two simple words

Examples:

a. "Want milk"

b. "Mama go"

c. "Little brother sleep"

Characteristics:

a. Begins to understand relationships between words

b. Sentences are still simple

c. Does not yet use complete grammar

Strengths:

a. Shows early syntactic development

b. Communication becomes clearer

Limitations:

a. Sentence structure is still limited

b. Many grammatical elements have not yet emerged

Simple Sentences Stage

After the age of two, children begin to produce longer and more complex sentences.

Examples:

a. "I want to play outside."

b. "Mom is cooking."

c. "My older sibling is going to school."

Characteristics:

a. Vocabulary develops rapidly

b. Begins to understand basic grammar

c. Able to express feelings and desires

Advantages:

a. More effective communication

b. Children begin to understand language rules

Limitations:
a. Still frequently makes grammatical mistakes
b. Pronunciation is not yet perfect

Infant Directed Speech

Infant-directed speech is a specific style of speech that adults use when talking to babies or young children.

Characteristics:
a. Higher pitch
b. Slower speaking pace
c. Word repetition
d. Simple sentences
e. Clearer pronunciation

Examples:
a. "Hello, beautiful baby!"
b. "Would you like some milk?"
c. "Look at the ball!"

Functions:
a. Helps infants recognize language sounds
b. Attracts the infant's attention
c. Facilitates language comprehension
d. Supports vocabulary development

Advantages:
a. Supports the language acquisition process
b. Enhances social interaction between infants and caregivers

Limitations:
c. Not all cultures use the same speaking style
d. It is not the sole factor in language development

➢ Statistical Learning and Speech Segmentation

Statistical Learning

Statistical learning is an infant's ability to recognize sound patterns that frequently occur in language.

How it works:

a. Infants hear language sounds continuously.
b. They recognize sound patterns that frequently occur together.
c. They begin to understand that these patterns represent specific words.

Characteristics:

a. Occurs unconsciously
b. Based on pattern repetition
c. Aids in word recognition

Advantages:

a. Helps infants learn language naturally
b. Supports vocabulary development

Limitations:

a. Depends on the amount of language exposure
b. Insufficient without social interaction

Speech Segmentation

Speech segmentation is the ability to separate words from a continuous stream of speech.

Example:

Sentence:

"Iwanttogotoschool"

Segmented into:

"I want to go to school."

The Architecture of the Mind-Language

How it works:

a. Babies use sound patterns
b. Use intonation
c. Use word repetition
d. Use the context of communication

Characteristics:

a. Helps identify words
b. Related to listening skills

Advantages:

a. Helps with vocabulary acquisition
b. Helps with language comprehension

Limitations:

a. Difficult if the language input is unclear
b. Affected by the quality of interaction

➢ Interim Summary

Language development in infancy and early childhood is a complex process involving biological, cognitive, and social factors. Children acquire language gradually through interaction with their environment and continuous exposure to language.

Infants are not merely passive listeners but active learners capable of recognizing sound patterns, understanding words, and developing communication skills from an early age. Social interaction, particularly with parents and caregivers, plays a crucial role in supporting children's language development.

➢ The Eight Group

The concept of the "Eight Group" provides a comprehensive framework for tracking how infants and toddlers transform from passive listeners into active, socially skilled communicators. While the previous breakdown focused on the structural components of language (like grammar and semantics), these eight aspects look at the cognitive and behavioral milestones a child achieves during early childhood.

Here is a closer look at what each of these eight aspects means in practice:

A. Perception of Language Sounds
   a. What it is: The ability to hear, distinguish, and map the specific acoustic sounds of a native language.
   b. How it develops: Babies are born as "citizens of the world," capable of distinguishing between the sounds of *any* human language. By around 6 to 12 months, their brains prune away unused sounds and specialize exclusively in the language they hear daily (e.g., learning to tell the difference between English /b/ and /p/, or getting used to tonal differences in Mandarin).

B. Word Recognition
   a. What it is: Segmenting the continuous stream of spoken speech into individual, recognizable words.
   b. How it develops: When adults speak, sentences sound like an uninterrupted wall of sound ("*Lookatthebaby*"). Through statistical learning, infants track which sounds constantly cluster together. They realize "*baby*" is a standalone unit separate from "*look at the*", allowing them to recognize familiar words even before they know what they mean.

C. Vocabulary Development
   a. What it is: Building a personal mental dictionary (the lexicon), matching spoken words to real-world objects, actions, and people.
   b. How it develops: This begins slowly around 10–12 months with first words (like "*Mama*" or "*ball*"). Between 18 and 24 months, children undergo a "vocabulary explosion," where their expressive vocabulary expands from a few dozen words to hundreds, driven by rapid neural mapping.

D. Comprehension of Meaning
   a. What it is: Receptive language—understanding what sentences and combinations of words actually mean when spoken by others.
   b. How it develops: A child’s ability to *understand* language always outpaces their ability to *speak* it. Long before a toddler can say, "*Put the toy in the box,*" they can understand the intent behind the command, process the spatial relationship ("in"), and execute the action.

E. Language Production
   a. What it is: Expressive language—the physical and neurological ability to vocalize sounds, syllables, words, and sentences to express thoughts.
   b. How it develops: This is a physical and structural journey that progresses through distinct milestones: crying → cooing → canonical babbling ("*ba-ba*") → single words → telegraphic speech ("*more juice*") → complex full sentences.

F. Social Interaction
   a. What it is: Using language as a collaborative tool to connect with other human beings.

   b. How it develops: Language is fundamentally born out of social necessity. Early interaction includes "serve-and-return" behaviors, like a baby babbling and a parent responding. It also relies heavily on joint attention—when a child points at a dog, looks at their parent to ensure they see it too, and waits for the parent to say, "*Yes, that's a dog!*"

G. Language Memory
   a. What it is: The cognitive storage systems (working memory and long-term memory) required to retain word meanings, grammatical rules, and conversational context.
   b. How it develops: To understand a sentence, a child has to hold the beginning of the sentence in their working memory until the speaker reaches the end. As memory capacity expands, children transition from remembering short, immediate commands to recalling past events and telling multi-layered stories.

H. Pragmatic Skills
   a. What it is: The unwritten social rules of communication—knowing *how* to use language appropriately depending on the context.
   b. How it develops: Pragmatics turn a child into a functional conversational partner. It involves mastering the physics of a conversation: waiting for your turn to speak, making eye contact, understanding when a speaker is being playful versus serious, and adjusting vocal volume based on whether you are in a library or on a playground.

The Architecture of the Mind-Language

The Big Picture: These eight aspects do not develop in isolation. For example, a child uses sound perception and word recognition to build their vocabulary, stores those words using language memory, processes their comprehension, executes language production, and applies pragmatic skills—all during a single, brief social interaction on the playground.

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Book Chapter

Word Learning and the Acquisition of Grammatical Knowledge

Keyne Cahaya Syaktanani, Marchella Legie Yanti, Riska Rahmadani

This module examines vocabulary and grammar acquisition in children's language development. Students will learn how children recognise and understand new words, link word forms to their meanings, and use them in everyday communication. The material also highlights the gradual process by which children master grammar, ranging from word formation and sentence construction to the use of linguistic structures. The study examines the cognitive, environmental and social interaction factors that support language acquisition. Consequently, students are expected to understand how children develop their vocabulary and grammatical knowledge as integral parts of language acquisition.

➢ Learning Word Meaning

Children are remarkably efficient word learners. They achieve this without any explicit training or feedback.The process begins once infants can separate speech into individual words, and from there they need to associate those words with the concepts they represent. A commonly assumed way children learn words is through the point-and-say method, where a speaker points to something and names it. However, pointing and speaking alone do not give enough information for a child to figure out the intended meaning. Imagine arriving in a foreign country: a rabbit runs by, and your local guide says "gavagai." You might guess it means "rabbit," but the guide could just as easily be referring to something furry, long-eared, a mammal, or even just expressing surprise. Nothing in the environment rules out any of these interpretations (Bloom, 2000).

The difficulty gets worse when we consider words that are not object names at all. Words like milk and plastic refer to substances, thought refers to a process, and early social words like hi and bye-bye have no corresponding object to point at. On top of that, if point-and-say were the main mechanism for learning words, blind children would be seriously disadvantaged. Yet research shows that blind children learn words at roughly the same rate as sighted children. Verbs present an even greater challenge. People rarely label an action while they are performing it. Action verbs like chase and flee are especially tricky, because every chasing event is simultaneously a fleeing event. If a speaker points to a scene where a duck is chasing a rabbit and says "blicket," the child has no way of knowing whether blicket means chase or flee. The meaning depends entirely on the speaker's perspective, not on what the child observes (Harley, 2014).

To solve this poverty of the stimulus problem, one proposal is that children are born with innate grammatical categories such as noun and verb, which they then fill in with words from their native language. This is called the genetically guided learning hypothesis. It helps rule out many wrong interpretations of a new word, but does not fully solve the problem on its own. Another view holds that children simply have a strong general ability to pick up and remember information conveyed through language, rather than a dedicated word-learning system. Research supports this: both children and adults show better recall for arbitrary information when it is delivered linguistically compared to other means. Rather than starting with the broadest or most specific interpretation of a new word, infants appear to have a built-in tendency to treat new labels as names for basic-level categories. When people name objects, they tend to use labels that are neither too broad nor too specific, such as dog rather than poodle or mammal. Children and adults alike also tend to assume that a new word refers to a whole object rather than its parts, color, or other features. So when someone says "gavagai" while pointing at a rabbit, both a child and an adult are likely to treat it as a label for the whole animal, applying to other similar things (Bloom, 2000).

Children do sometimes make errors when learning new words. They tend to extend new terms based on physical similarity, especially shape. Some children overextend words, using bunny to refer to all small furry animals including cats and dogs. Others underextend them, applying a word only to a very narrow set of cases. One child was described as only calling the cars visible through his front window "car" and giving other cars different names. While these errors are relatively rare, they confirm that pairing sounds with meanings is genuinely difficult. To refine word meanings over time, children use the mutual exclusivity assumption and the principle of contrast. Mutual exclusivity is the assumption that no two words in a language have exactly the same meaning. If a child already knows the name for something, she will reject a second label as referring to the same thing. In lab experiments, when children see a familiar object like a spoon alongside an unfamiliar one like a whisk, and hear a novel word such as "bring me the fendle," they reliably pick the unfamiliar object. They seem to reason: I already know that one is called spoon, so fendle must be the name of the new one(Clark, 2009).

The principle of contrast works alongside mutual exclusivity to help children understand that different labels for the same object, such as dog, mammal, and animal, are not interchangeable. Each label reflects the speaker's particular perspective and what they want to emphasize. Without this principle, children might assume all applicable labels mean the same thing, or that every new word is simply a synonym for one they already know.

Learning word meanings also requires understanding that speakers intend to refer to concepts when they talk, which is known as referential intent. This is part of theory of mind, the ability to recognize that other people have their own thoughts they want to communicate. Some children, including those with autism, have difficulties with theory of mind and sometimes assign meanings to sounds incorrectly. In contrast, children with Williams syndrome, who have significant intellectual deficits but a relatively intact theory of mind, assign word meanings much like typical children do.

Children also pay attention to where a speaker is looking to figure out what is being labeled, and they consider how reliable a speaker is. They are more likely to trust an adult than a child when learning names for new objects, and they pay closer attention to speakers who have been accurate in the past (Bloom, 2000). One more important point is the noun bias. Because children's perception naturally divides the world into distinct objects, it makes sense that they would learn object names (nouns) before relational words like verbs. Large cross-linguistic studies show that nouns make up a greater share of toddlers' early vocabularies across many languages. Some studies suggest that in languages where verbs are more prominent in speech to babies, infants pick up verbs a bit faster. But overall, noun bias appears to be a fairly consistent feature of early word learning, which suggests that conceptual development may lead vocabulary development (Gentner, 1982).

➢ Syntactic Bootstrapping

The previous section covered several strategies children use to learn noun meanings. But what about verbs? Young children may find it harder to learn verb meanings than noun meanings, because verbs express more complex ideas. While nouns can refer to concrete, directly observable things, understanding a verb requires grasping the speaker's perspective on an event. Consider a scene where a duck chases a rabbit. A speaker focusing on the duck might say "The duck blickets the rabbit," making blicket mean chase. A speaker focusing on the rabbit might say "The rabbit blickets the duck," making blicket mean flee. The point-and-say method simply cannot explain how children tell these apart, because the physical scene alone does not reveal the speaker's perspective (Fromkin, Rodman, & Hyams, 2018).

The Architecture of the Mind-Language

Children can begin to work around this problem by paying attention to syntactic cues in the sentences they hear. This is the core of the syntactic bootstrapping hypothesis. The grammatical structure of an utterance can support meaning inferences in several important ways . First, syntax can help children figure out whether a new word is a noun or a verb. When children look at a picture of someone cutting cloth with an unfamiliar tool and hear "In this picture, you can see sibbing," they infer that sibbing is a verb. If they hear "Can you see a sib or some sib?" they infer it is a noun. The type of article also provides extra clues. When the new word follows a, children infer it is a count noun and select the tool in the picture. When it follows some, they treat it as a mass noun and point to the cloth instead (Gentner, 1982).

Children also use verb syntax to figure out what verbs mean. They pay particular attention to the subcategorization frame, meaning how many participants a verb takes in a sentence. Consider: (1) "She blicked!" and (2) "She blicked her!" Even without knowing what blocked means, you can tell from sentence (1) that only one person is involved (intransitive), while sentence (2) involves two people (transitive). That difference in structure already hints at the meaning. An experiment by Yuan and Fisher tested this directly. Children listened to either a transitive or intransitive sentence with a new verb, then watched two videos, one showing a solo action and one showing a two-person interaction. Children who heard the intransitive version pointed to the solo video when asked to "Find blicking!" Those who heard the transitive version pointed to the two-person video. This shows that children genuinely use transitivity to interpret new verbs (Yuan &

Fisher, 2009). Of course, syntax alone cannot pin down an exact meaning. Children combine grammatical cues with what they observe in the environment and what they think the speaker is trying to communicate.

But how do children learn to use syntactic cues in the first place? Cynthia Fisher and colleagues propose that when children observe an event, they build an organized mental picture of it, noting who is doing the action (the agent), who is being acted upon (the patient), and what the action itself is. When they hear someone describe that event, say "She's blocking her," they map the subject (She) to the agent, the object (her) to the patient, and the verb to the action. Fisher calls this process alignment. In her words, children arrive at a structure-sensitive interpretation of a sentence by structurally aligning a representation of the sentence with a structured conceptual representation of the relevant scene. For alignment to work, children need some prior knowledge of nouns. Without knowing the difference between She and her, the mapping would not be possible. But since infants start recognizing nouns fairly early, noun knowledge can serve as a foundation for building syntactic understanding. Once children learn that causal agents tend to come before the verb and patients after it, they can use that pattern to interpret new sentences involving different actors and actions (Grossberg, 2023).

➢ Acquisition of Morphological and Syntactic Knowledge

Acquisition of Morphological and Syntactic Knowledge explains how children naturally acquire the ability to understand word form and sentence structures from an early age. Children do not immediately grasp grammar perfectly, but this ability develops gradually through daily interaction and exposure to the language (Chomsky, 1965; Pinker, 1994a; Wexler, 1998).

In the area of morphology, children learn how a word can change form to convey a specific meaning. For example in English, verbs can change according to tense, such as "play" becoming "played" or nouns can change to plural forms, such as "cat" becoming "cats." Children often make mistakes as they begin to understand these rules. For instance, a child might say "goed" Instead of "went." Such mistakes actually indicate that the child is trying to apply the grammar rule they have learned by adding "-ed" for the past tense. Therefore, such errors are actually a sign of language development (Pinker, 1994a).

Meanwhile, syntactic knowledge relates to a child's ability to understand word order in sentences. Children learn that language follows certain patterns. For example, in English, the subject is typically followed by the verb and then the object. At first, children use simple sentences like "me want milk" which later develop into "I want milk." This shows that children are beginning to understand grammatical rules and the correct use of pronouns. In psycholinguistics, this process is important because it demonstrates that children do not merely imitate adult speech but also construct their own grammatical system in their minds (Chomsky, 1965; Wexler, 1998).

➢ Acquisition of Word Category Knowledge

This explains how children learn to recognize word categories such as nouns, verbs, adjectives, and the others. Children understand word categories through the context of the sentence "The dog is running," children gradually come to understand that "dog" is a noun because it refers to an object or animal, while "running" is a verb because it indicates an action. Knowledge of word categories helps children understand the meaning of sentences and makes it easier for them to learn more complex grammar (Pinker, 1996; Clark, 2009). This material is also related to the discussion in the module on syntactic bootstrapping.

This theory explains that children use clues form sentence structure to understand the meaning of new words, especially verbs. For example, when a child hears the sentence "She blicked her," the child can infer that the word "blicked" is an action involving two people because there is a subject and an object in the sentence. Thus, syntactic structure helps children understand the meaning of words even if they have never heard and understand the meaning of words even if they have never heard before (Yuan & Fisher, 2009). .

Additionally, the module explains that children tend to learn nouns faster than verbs, a phenomenon known as the "noun bias." This occurs because objects are easier to recognize directly than actions or relationships between objects. Consequently, a child's early vocabulary is typically dominated by nouns before they grasp verbs or more complex sentence structure.

➢ Acquisition of Morphological Knowledge

Morphological knowledge is the understanding of how words are formed and modified to convey grammatical meaning. Morphology plays an essential role in language because it allows speakers to express functions such as tense, plurality, possession, and other grammatical features. In English, word forms often change according to grammatical context, for example, 'walk' changes to 'walked' to show past tense, while cat becomes cats to indicate plural form. Children develop this understanding gradually through regular exposure to language in daily communication (Fromkin, Rodman, & Hyams, 2018).

Morphology is made up of free morphemes and bound morphemes. Free morphemes are words that can stand alone and still have meaning, such as book, play, and child. Meanwhile, bound morphemes cannot stand alone because they must be added to another word, such as -ed, -s, and un-. Morphological knowledge is also divided into inflectional morphology and derivational morphology. Inflectional morphology changes the form of a word to show grammatical information without changing the word class. For example, play becomes played to show past tense. On the other hand, derivational morphology changes the meaning or the word class. For example, 'happy' changes into 'happiness,' where the adjective becomes a noun.

One important area in morphological acquisition is how children learn past tense forms in English. English verbs are divided into regular verbs and irregular verbs. Regular verbs form the past tense by adding the suffix -ed, such as walked, jumped, and kicked. In contrast, irregular verbs do not follow a fixed pattern, for example 'go' changes to 'went' and 'think' changes to 'thought.' Since irregular verbs do not follow clear rules, children usually find them more difficult to learn.

According to the Words-and-Rules Theory by Steven Pinker, children learn morphology through two processes: memorizing irregular word forms and learning grammatical rules for regular forms. In the early stage of language development, children usually remember irregular verbs from the language they hear around them. After that, they begin to understand the rule that past tense is formed by adding -ed. Once they learn this rule, children sometimes use it for all verbs, including irregular verbs, which results in forms like 'goed,' 'thinked,' and 'bringed.' This process is called overregularization (Pinker, 1999).

The development of past tense acquisition usually follows a U-shaped learning pattern. In the first page, children can use the correct irregular form because they memorize it, such as 'went.' In the second stage, after learning the regular past tense rule, they often apply it to all verbs and produce forms like 'goed.' In the final stage, children learn the correct irregular form again and return to using 'went.' This process shows that children do not simply copy adult speech, but actively build their own grammatical understanding.

Another theory related to morphological acquisition is the Probabilistic Learning Theory. This theory stated that children learn grammatical patterns from the language input they hear repeatedly in everyday communication. Through frequent exposure, children notice similarities between words and slowly develop their understanding of grammar. Supporters of this theory created connectionist models to imitate the way the human brain processes language patterns. These models explain how children identify sound similarities, predict grammatical forms, and gradually develop morphological knowledge through experience (Tomasello, 2003).

Language input has an important role in children's morphological development. Repetition, interaction with parents or caregivers, and daily communication help children understand how words are formed and changed grammatically. Through continued exposure to language in their environment, children gradually develop morphological knowledge and improve their understanding of grammar (Owens, 2016).

➢ Acquisition of Phrase Structure Knowledge

Phrase structure knowledge is the ability to understand how words are arranged into phrases and sentences based on grammatical rules. In learning language, children need to understand how words are combined to create meaningful expressions and how grammatical relationships work in communication. Phrase structure helps speakers explain who does an action, what action happens, and who receives the action, because of this, phrase structure knowledge is an important part of children's syntactic development (Clark, 2009).

Phrase structure consists of several grammatical components, especially noun phrases and verb phrases. A noun phrase is focused on a noun and can include adjective, possessives, or quantifiers, such as my shoe, big house, and some apples. Meanwhile, a verb phrase is centered on a verb and descries action or events, such as eat bananas, drink milk, and paly football. Through regular exposure to language, children slowly learn how these phrases are combined to form complete sentences.

One important theory related to phrase structure acquisition is the nativist Theory proposed by Noam Chomsky. This theory explains that children are born with an inborn ability to understand grammar, called Universal Grammar. According to his theory, children already have basic grammatical principles in their minds, while language exposure helps them identify the grammatical patterns used in their first language (Chomsky, 1965).

Different languages have different grammatical patterns or parameters. For example, English requires the subject to appear clearly in a sentence, such as 'He ate bananas.' However, some languages like Italian allow the subject to be omitted. Languages that allow missing subjects are known as pro-drop languages. Children learn these language patterns gradually form the language they hear around them.

The Nativist Theory is also supported by the Continuity Hypothesis, which explains that children's grammar is basically similar to adult grammar from the early stages of language acquisition. Early expressions such as Mommy fix, mama dress, and more milk show that children already understand basic phrase structure. However, children still produce sentences that are not fully correct according to adult grammar, such as 'i want hold it,' instead of 'i want to hold it.' These mistakes show that grammatical development continues gradually as children grow and gain more language experience.

Another explanation of phrase structure acquisition is the Usage-Based Theory developed by Michael Tomasello. This theory explains that children lear phrase structure through language use, interaction, and repeated exposure to sentence patterns. Children learn by hearing similar expressions many times and then recognizing patterns from them. For example, children may hear phrases like want milk, want candy, and want juice, and later understand the pattern want + noun. This process is called verb-based learning (Tomasello, 2003).

Children are also seen as conservative learners because they usually use sentence structures they have heard before and avoid unfamiliar patterns. Because of this, children's early speech is often repetitive and based on familiar expressions. The frequency and quality of language input have a strong influence on the development of phrase structure knowledge. Through daily interaction and communication, children gradually improve their understanding of phrase structure and grammar.

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