

# Language

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Is language uniquely human?

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Can a non-human primate  
learn language?

Scientists were unable to teach apes human speech  
(Hayes & Hayes, 1952).

What is the problem here?

Apes can't produce human speech -- so there have  
been several attempts to teach apes (chimpanzees)  
ASL.

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The evolution of language  
learning in apes

**Washoe:** Studied by Roger Fouts,  
learned 160 signs (ASL).



Washoe

**Sarah:** Studied by David Premack.  
Learned 130 words in a plastic  
symbol-based language.

**Lana:** Studied by Duane  
Rumbaugh. Learned words in a  
keyboard-based language.



Lana

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# Nim Chimpsky

Studied by Herbert Terrace, learned approximately 125 signs.



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## Project Nim (Terrace, 1979)

Nim was studied at Columbia University for 44 months.

Nim first appeared to produce "primitive sentences."

more banana, more drink, more hug, more tickle

banana Nim eat, me eat drink more, tickle me  
Nim play

But Terrace concluded that Nim never learned a language.

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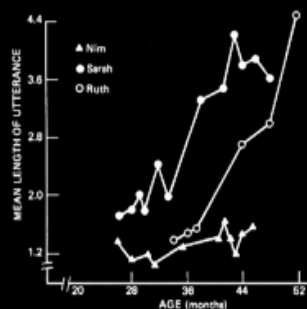
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Despite a steady increase in Nim's vocabulary, his length of utterances did not increase (average length remained between 1.1 - 1.6 signs).

Children's utterances steadily increase in length, and long utterances build upon shorter ones.

When Nim did make long utterances, they were not informative - most signs were mere repetitions.



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## Nim's longest recorded utterance:

"give orange me give eat orange me eat  
orange give me eat orange give me you"

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Only 12% of Nim's 20,000+ recorded utterances were spontaneous.

Many of his utterances were mere repetitions of what the trainer had just signed.

Terrace's conclusion: Apes (like Nim) could learn "words" -- they could learn a fairly complex manual response in the presence of some stimulus (by classical and/or operant conditioning). But they could not learn language.

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Terrace concluded that apes could learn "words" in the sense of a response triggered by some form of stimulus (by classical and/or operant conditioning).

However, they could not learn language.

## Language & Apes

Savage-Rumbaugh taught bonobos, most notably **Kanzi** and **Panbanisha**, to use language.

The chimps use a keyboard to express meanings.

Panbanisha learned a vocabulary of 3000 words by 14 and became very good at combining a series of symbols in a grammatically correct order.



Sue Savage-Rumbaugh

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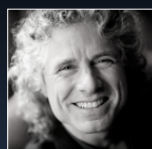
Savage-Rumbaugh's view about language in apes is heavily criticized by many prominent scientists, including Pinker and Chomsky.



Sue Savage-Rumbaugh

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"In my mind this kind of research is more analogous to the bears in the Moscow circus who are trained to ride unicycles. You can train animals to do all kinds of amazing things."

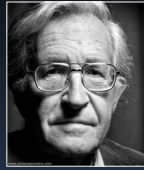


Steven Pinker

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The biggest concerns with attempts to teach apes language at this point was that scientists were merely 'training' apes to use the language, and that the apes were not using the language in a way that was upon their own accord.

"Would it be of any interest to train grad students to more or less mimic apes? We would learn nothing about apes from the fact that grad students can be trained to more or less mimic them... just as we learn nothing about humans from the facts that apes can be trained to mimic humans in some respects. "



Noam Chomsky

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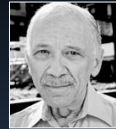
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"Kanzi is simply going through a bag of tricks in order to get things. If a child does exactly what the best chimpanzee did, the child would be thought of as disturbed. [The scientists at the Language Research Center] are studying some very complicated cognitive processes in chimpanzees. That says an awful lot about the evolution of intelligence. How do chimpanzees think without language, how do they remember without language? Those are much more important questions than trying to reproduce a few tidbits of language from a chimpanzee trying to get rewards."



Herbert Terrace

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## How does language work?

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## The Hierarchical Nature of Language

SENTENCE	The umpires talked to the players				
PHRASE	The umpires		talked to the players		
WORD	The	umpires	talked	to	the players
MORPHEME	The	umpire s	talk ed	to	the player s
PHONEME	ð	i	ʌ	mpeɪr z	tɔk t tuw ðə pleyər z

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Morpheme - simplest form of a word.

Phoneme - smallest distinguishable sounds in a language.

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# Speech Production

Variations based on voicing, place of articulation, and manner of production.

Variations in these three features allow us to produce all sounds in the English language.

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Speech is produced as a combination of the following:

variations based on:

- Voicing.

- Place of articulation.

- Manner of production.

## Voicing

Vibrations caused by opening and closing of the vocal folds.

- Voiced sounds: Z, N
- Nonvoiced sounds: F, K, S, T

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Voicing - vibrations caused by opening and closing of the vocal cords.

## Place of Articulation

Variations in location of the obstructions of airflow.

- Bilabial: B, P
- Labiodental: F, V
- Alveolar: D, T
- Interdental: TH

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Place of articulation - variations in location of the obstruction of airflow.

## Manner of Articulation

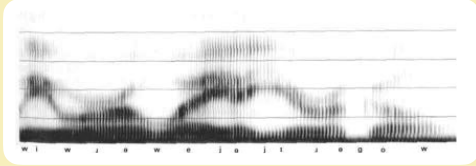
Variation in configurations of the articulators (e.g., tongues, lips).

- Nasal: M, N
- Location: L, R
- Stoppage: B, P, T

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Manner of articulation - variation in configurations of the articulators.

## Speech Comprehension



This is a spectrogram for "We were away a year ago."

See how there are no gaps between the words, even though we "hear" the gaps?

### Segmentation

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Segmentation - creating gaps in a sentence, that do not actually exist.

## Some Problems in Speech Perception

No real gaps between utterances -- requires segmentation.

Pronunciation of a given letter varies from one context to another. E.g., the "s" in soup is pronounced very differently than in "speech."

While pronouncing a letter/word, people shape their mouth differently depending on the upcoming letters/words -- **Coarticulation**.

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Coarticulation - the shaping of one's mouth differently depending on the upcoming letters/words.

Speech recognition difficulties: requires segmentation, pronunciation varies on context, and coarticulation.

## Coarticulation

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## What helps speech perception?

- Context, knowledge.
- Prosody: The rise and fall of intonation and the pattern of pauses.
- There is a limited set of high frequency words that we use all the time (Miller, 1951).
- Lip reading.
  - But what if what you see and what you hear differ?  
Do you rely on what you see or what you hear then?

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Speech perception is aided by:

- Context, knowledge.

- Prosody - the rise and fall of intonation and the pattern of pauses.

- Lip reading.

# The McGurk Effect

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An accidental discovery, now one of the most robust and widely discussed findings in psycholinguistics.

McGurk & MacDonald were interested in whether auditory or visual modalities are differentially dominant during childrens' perceptual development.

Subjects viewed a video of a person producing speech, but the sound and the lip movement do not match.

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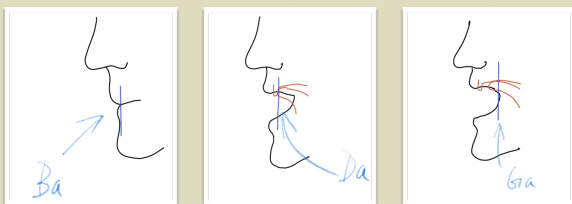
## McGurk & MacDonald (1976)

- Auditory: [ba ba]
- Visual: [ga ga]
- The surprising finding: Adults experience [da da].
- The brain combines the visual and auditory signals when comprehending speech.

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The McGurk Effect - oddly enough, when the auditory perception does not match the visual perception (of one making such sounds), the brain combines the visual and auditory signals when comprehending speech.

## The McGurk Effect



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Speech perception is multisensory.

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## More on Speech Perception

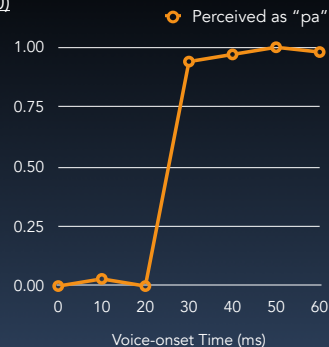
- What is the difference between the pronunciation of B and P?
- Voice onset time (VOT)
- P is voiced with a 60 ms VOT.
- B is voiced with a 0 ms VOT (no delay).
- What if we vary the VOT between 0-60 ms?

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## Categorical Perception of Speech

Lisker & Abramson (1970)

Speech is perceived in a categorical, instead of a continuous, manner. People cannot hear any difference between a "ba" sound pronounced with a 0 VOT and one pronounced with a 20 VOT.



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## Sentence Comprehension

How do we comprehend sentences?

**Parsing** - the process by which people analyze words and phrases to make inferences of the sentence's grammatical structure and meaning.

What happens when the sentence contains ambiguity in its meaning?

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Parsing - the process by which people analyze words and phrases to make inferences of the sentence's grammatical structure and meaning.



# Sentence Comprehension

**Serial parsing** — When encountering ambiguity, the reader makes one interpretation and continues to parse the sentence using that interpretation until disambiguating information is given.

**Parallel parsing** — the reader generates multiple interpretations and stores them until disambiguating information is given, at which point only the correct interpretation is maintained.

How can we tell? **Garden path sentences.**

Time flies like an arrow. Fruit flies like a banana.

The old man the ships.

The secretary applauded for his efforts was soon promoted.

Because he ran the second mile went quickly.

Put the apple on the towel into the box.

The horse raced past the barn fell.

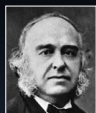
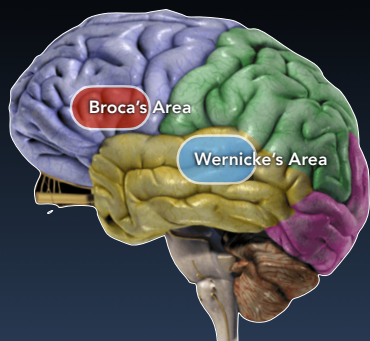
## Garden Path Sentences

Garden path sentences show that people parse a sentence as they hear/read it, try to figure out the role that each word plays as it is encountered.

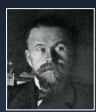
Parsing adheres to the rule of **minimal attachment** — that readers proceed through a sentence looking for the simplest possible syntactical structure.

E.g., "The old man the ships." — The old man: agent vs. The old man: agent + action.

## The Biological Basis of Language



Paul Broca



Carl Wernicke

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Serial parsing - when encountering something that is unclear, the reader makes one interpretation and continues parsing the sentence.

Parallel parsing - the reader generates multiple interpretations and stores them until disambiguating information is given, at which the reader then continues with the correct interpretation.

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Garden Path Sentences - sentences with an ambiguous part that leads the reader to initially assume a certain interpretation of a sentence, to only realize later in the sentence that the original interpretation was wrong.

minimal attachment - readers proceed through a sentence looking for the simplest syntactical structure.

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Language is mainly handled in Broca's Area and Wernicke's Area.

Broca's Area - left frontal lobe. Speech production.

Wernicke's Area - left temporal lobe. Speech comprehension.

## Broca's Aphasia

Damage to **Broca's area** causes Broca's aphasia (aka nonfluent aphasia). Patients with this condition are unable to produce grammatically complex sentences.

The sentences usually contain only content words.

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Broca's Aphasia - the inability to produce grammatically complex sentences.

Occurs when the Broca's Area becomes damaged.

Sentences usually contain only content words.

## Broca's Aphasia

Relatively preserved comprehension of single words.

Grossly impaired sentence structure and syntax comprehension (e.g., Peter was bit by the wolf vs. the Peter chases John).

Often demonstrate motor deficit on the right side of the body.

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People with Broca's Aphasia generally preserve comprehension of single words. However, their sentence structure and syntax comprehension is grossly impaired.

Often demonstrate motor deficit on right side of body.

## Wernicke's Aphasia

Damage to **Wernicke's area** causes impairment in comprehension (Wernicke's aphasia/fluent aphasia). These patients can create grammatically correct, but mostly meaningless, sentences (word salad).

Very limited comprehension ability.

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Wernicke's Aphasia - causes impairment in one's ability to comprehend language. Patients can form grammatically correct, but mostly meaningless sentences.

## Wernicke's Aphasia

No impairment in motor functioning.

Not fully aware of deficit.

Often create new words.

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Unlike Broca's Aphasia, Wernicke's Aphasia has no impairment in motor functioning. However, patients are not fully aware of their deficit, and often create new words.