

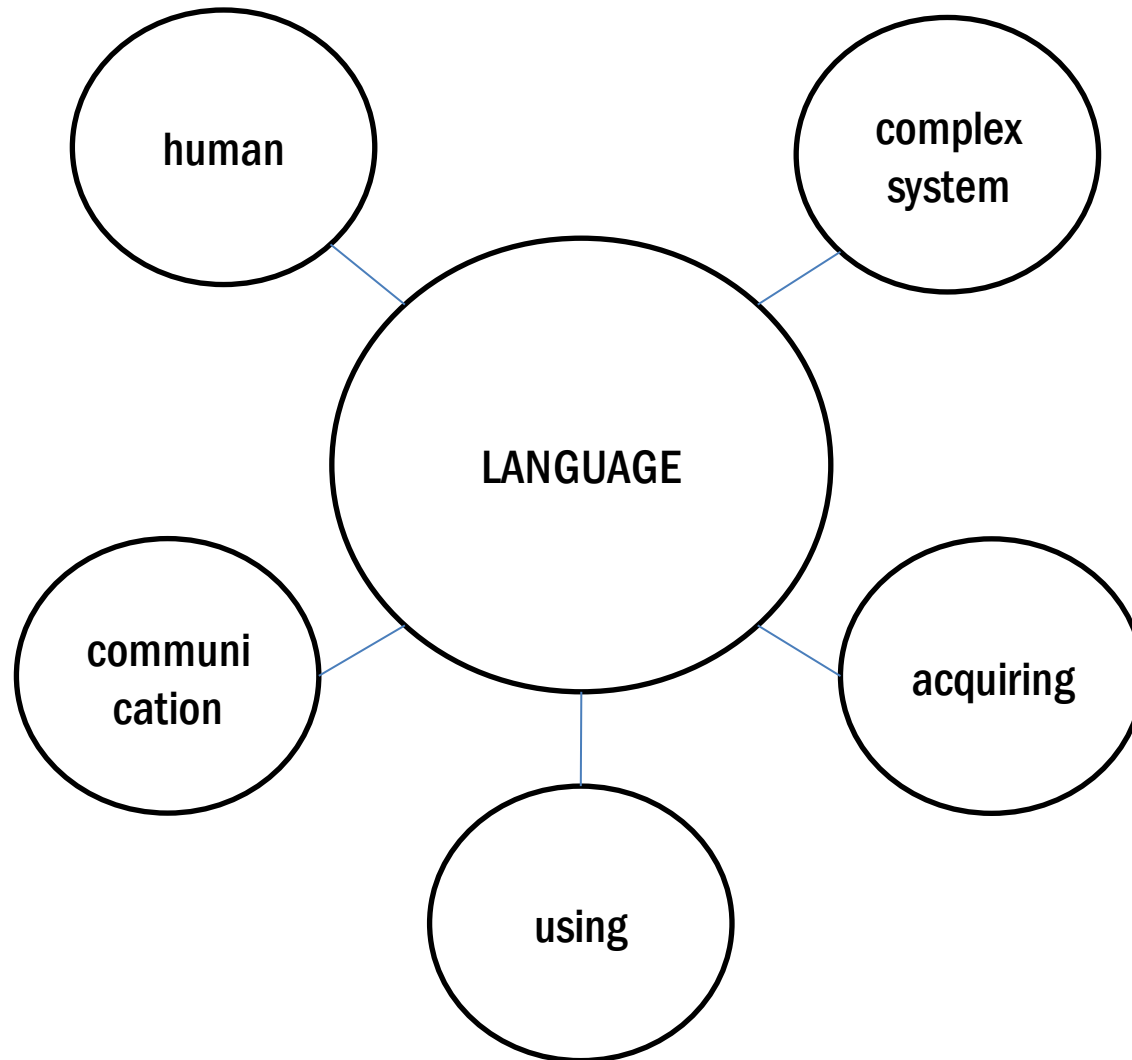
Fundamentos de Neurociencia Cognitiva

*Language / concepts in
Language*

Precursory remarks

- **Some more specific properties of language**
- **Levels of language representation**
 - **Phonemes, syllables, morphemes, words, syntax, discourse**

What is language?



What is language?

- **Complex system**
 - Many words
 - Constraints on order and appearance of words
 - Meaningful
 - Productive

- **More specific properties**

Properties of language

- Dutch language

Video Dutch

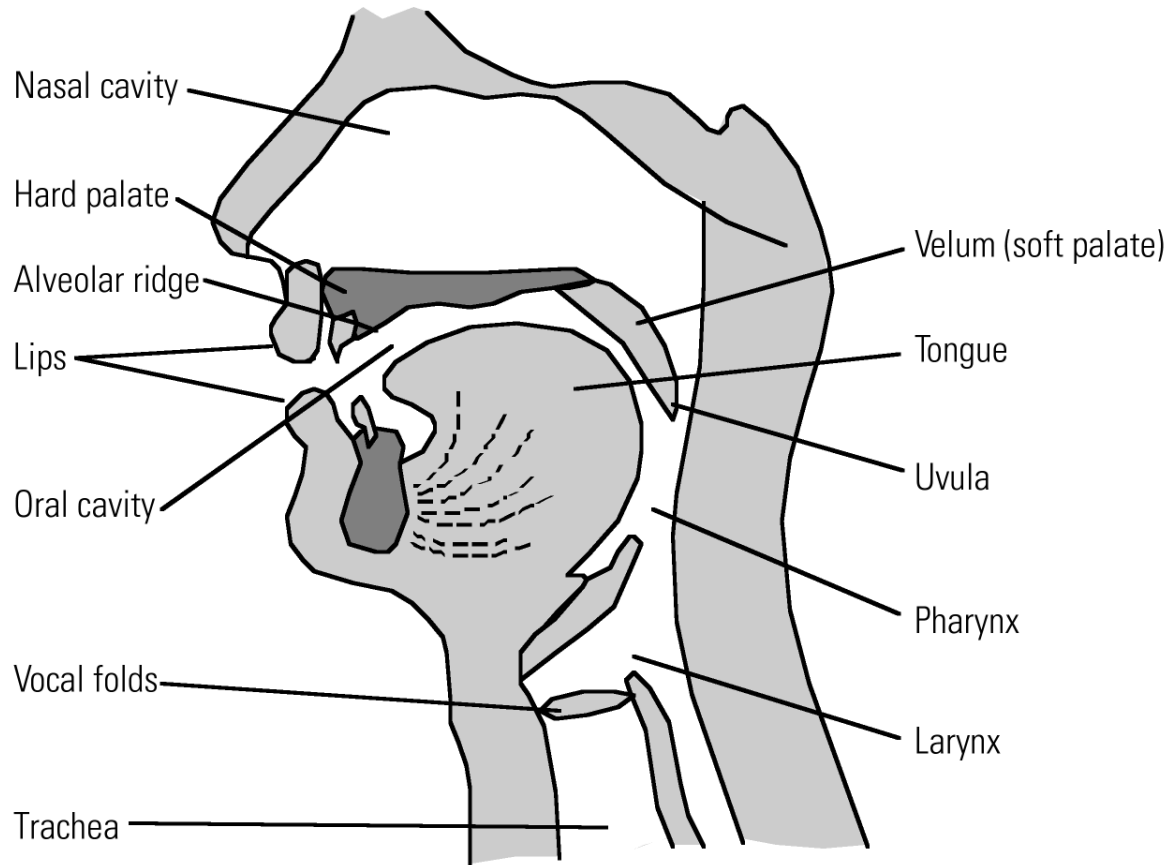
Properties of language

- "Dr Spock gave him the antigravitational module"
 1. Phonemes /a/ ,/n/ ,/t/ ,/i/ ,/g/ , etc
 2. Syllables, an.ti.gra.vi.ta.ti.o.nal.
 3. Morphemes, [anti][gravi][tational]
 4. Words [antigravitational]
 5. Phrases {the antigravitational module}
 6. Discourse

Phonology

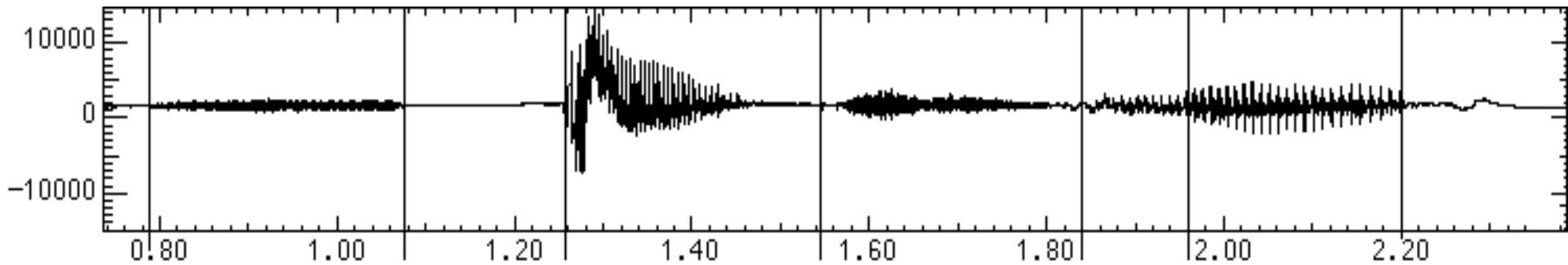
- **Phones = acoustically different speech sounds**
- **Phonemes = speech sounds that cause difference in meaning (dot vs pot)**
- **Allophones = variations of the same phoneme (pil vs p^hil)**

How are the sounds made?



Properties of speech

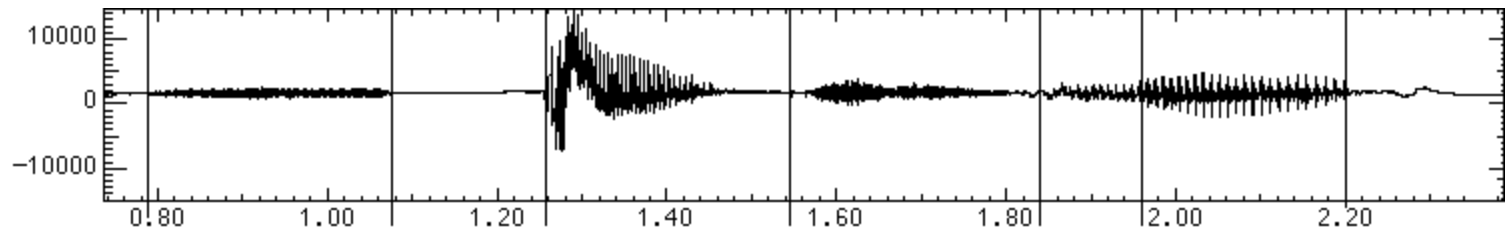
- How do we visualize speech?
 - Pressure waves
 - Spectrograms



Properties of speech

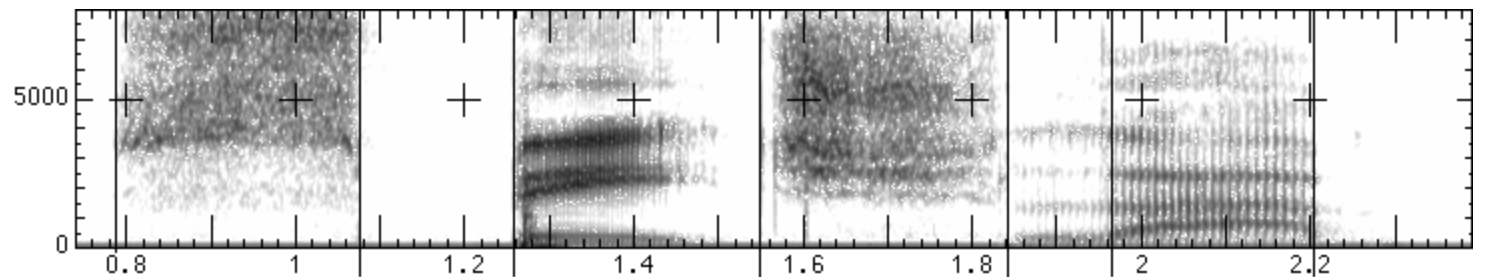
“S P EE CH L A B”

Pressure Wave



Spectrogram

Frequency

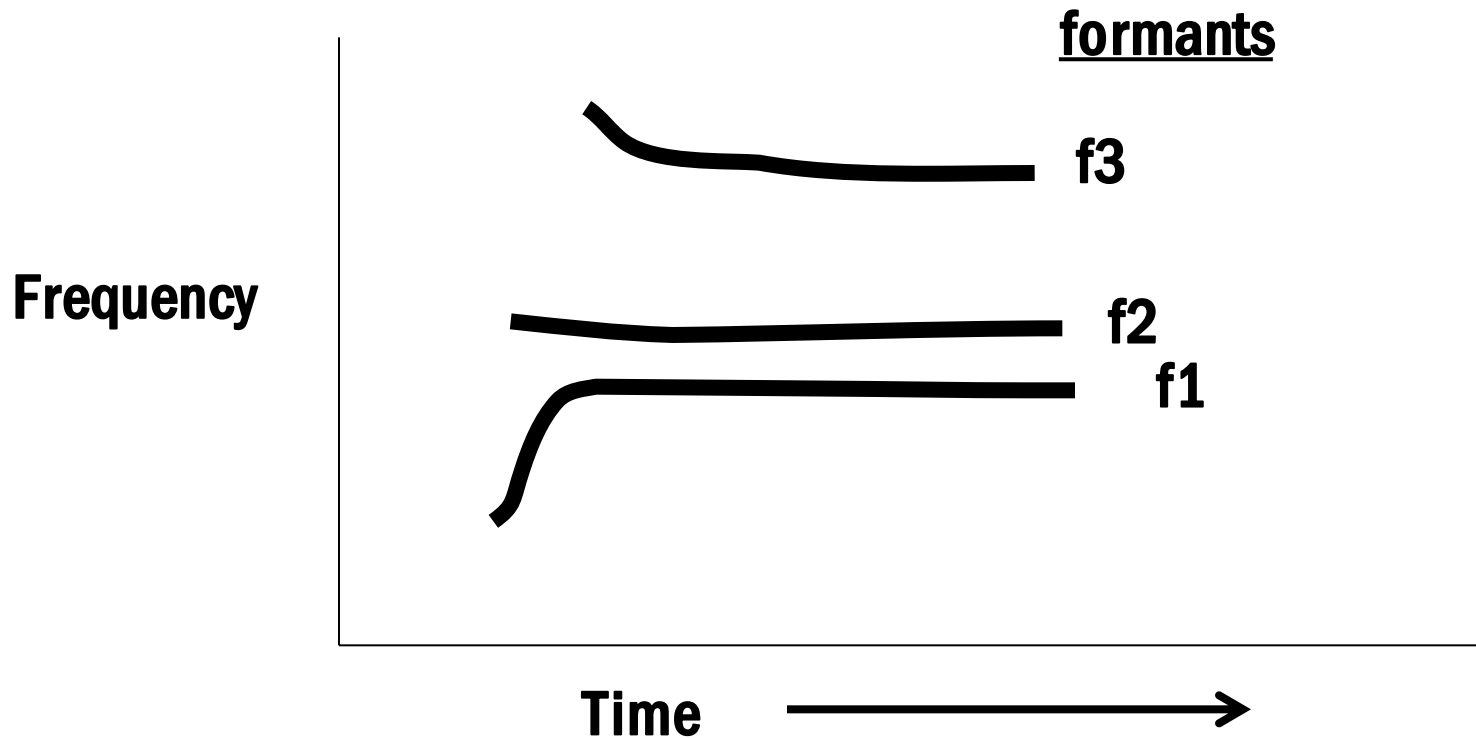


Time

Properties of speech

- Formants

Spectrogram



Phonemes of the world

- English has 40 phonemes
- Polynesian has 11, Khoisan has 141 (“bushman”)
- In total there are thousands of phonemes
- Some are found in many languages (e.g., /m/, /n/, /t/, /d/, /k/, /g/, /s/, /z/)
- Easy to produce, easy to distinguish

Articulatory features

- **Consonants versus vowels**
- **Consonants are produced by restricting vocal tract**
 - **Place of articulation (dental, velar)**
 - **Manner of articulation (stop vs nasal vs fricative)**
 - **Voicing (voiced, unvoiced)**
- **/b/ : voiced, labial, stop**
- **/p/ : unvoiced, labial, stop**

Phonology - International Phonetic Alphabet

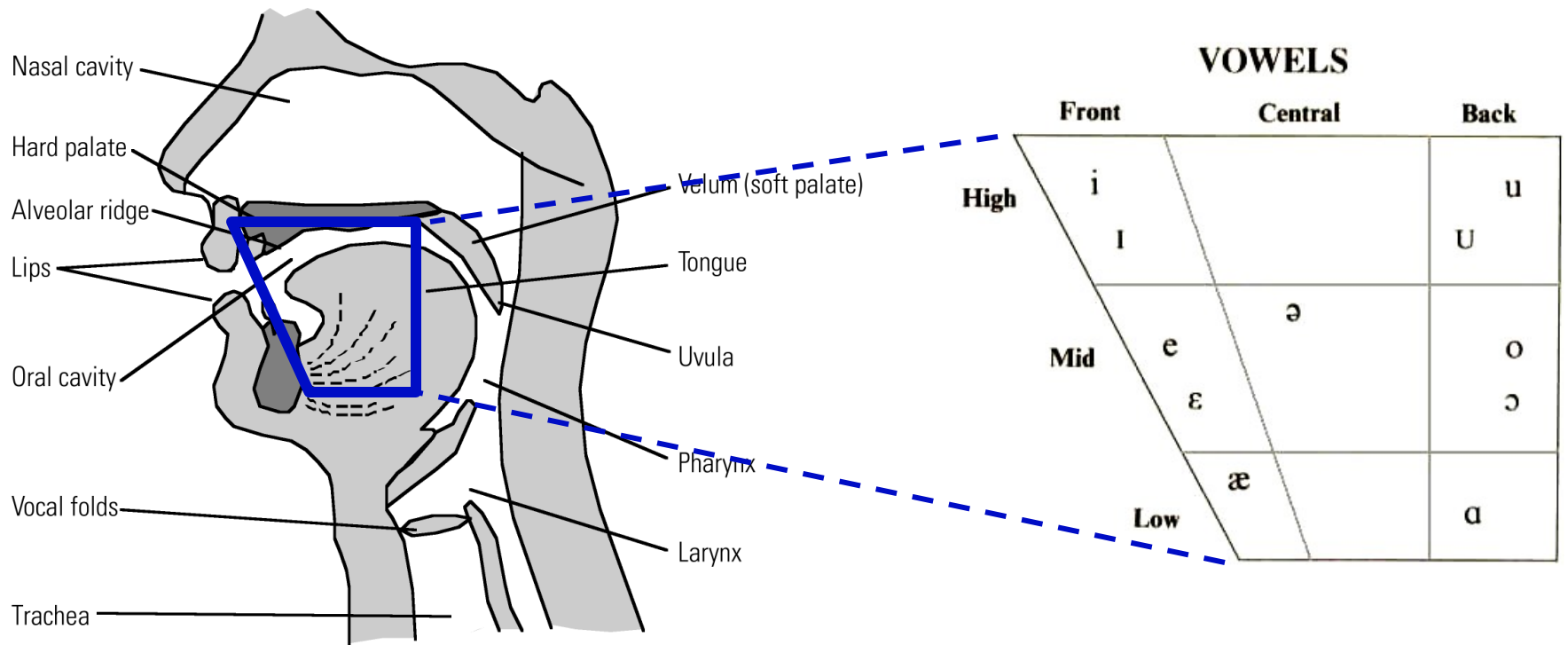
Consonants

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k ɡ	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			ɾ					ʀ		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Articulatory features

- **Vowels**
- **Unrestricted vocal tract**
 - Part of tongue (front vs back)
 - Beet vs boot
 - Position of tongue (high vs middle vs low)
 - beet vs bat

Vowels Spread Throughout Mouth



Syllables

- **An-ti-gra-vi-ta-ti-o-nal**
- **More natural unit than phoneme**
- **Language differences – Spanish versus Dutch**
- **Used in word recognition (in some languages)**

Morphology

- **[anti][gravitational]**
- **Smallest unit with meaning**
- **Describes word structure**
- **Big differences between languages**

Morphology

- **Two types of morphology**
 - **Inflectional and derivational**

Morphology

- **Inflectional**
 - Number +s for plural (Spanish: mesa – mesas)
 - Gender (not regular in Spanish)
 - Verbal (very complex! In Spanish)
 - Case (not in Spanish, but German)

Morphology

- **Derivational**
 - +ness from A to N (happiness)
 - +er from V to N (work – worker)

 - Also in Spanish
 - Very common in many languages

Morphology

- **Inflectional means word does not change word class**
 - CAT is a noun, CATS is also a noun
- **Derivational means word changes word class**
 - HAPPY is an adjective, HAPPINESS is a noun

Words

- **[antigravitational]**
- **Units that have a clear meaning**
- **Write separately**
- **Stored in your memory**

Words

- **What do you store? How to say, write, and what word means.**
- **Words or morphemes? Or both?**

mesa

s

mesas

Words

- **There are two types of words**
 - **Closed class and open class words**
 - **Function words and content words**

Words

- **"Dr Spock gave him the antigravitational module"**
- **Open class, content words**
 - **Dr. Spock, gave, antigravitational, module**
- **Closed class, function words**
 - **Him, the**

Words

- **Open class, content words**
 - Words that carry the meaning of the sentence
 - Nouns, verbs, adjectives, adverbs
- **Closed class, function words**
 - Words that have little meaning, and more syntactic function
 - Determiners, conjunctions, prepositions

Syntax

- What orders are allowed in language, what are the rules
- El coche verde vs *El verde coche
- Rule of spanish syntax: Adjectives appear after nouns (post-nominally)
- Language differences

Syntax

- **What are the rules?**
- **Adjective after noun? -> un gran hombre?**

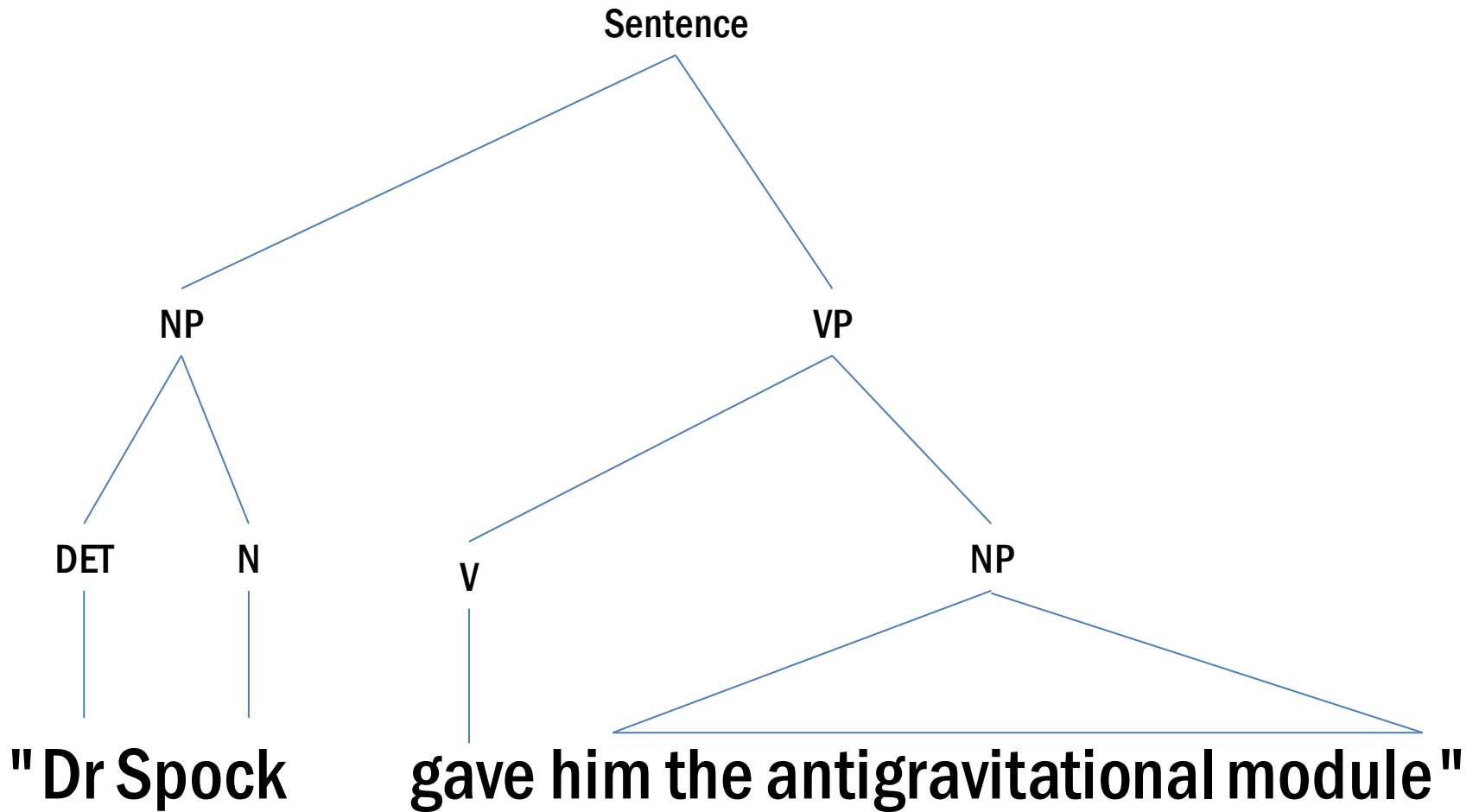
Syntax

- Generalizations in language
- The rule is not: "verde" goes after "coche"
- The rule is general: adjective goes after noun

Syntax

- Determiners (el, la, este, etc) go *before* the noun
- El coche verde vs *coche verde el
- Spanish NP → det + noun + adj

Syntax



Discourse

- **Highest level in descriptive analysis of language**
- **Comprehension / production of multiple phrases**
- **Intergration of phrases with existing knowledge**

Discourse

- Luis fue a la fiesta de cumpleaños de Pedro.
 - Pedro abrió sus regalos.
 - Luis comió la tarta y se fue.
-
- Luis fue a la fiesta de cumpleaños de Pedro.
 - Pedro estudió la carrera de farmacia.
 - Luis pesa 80 kilos.
-
- María oyó al heladero llegar.
 - Recordó su monedero.
 - Entró en la casa.

Properties of Language

- So now we know what properties language has
- How do we acquire, understand and produce language?

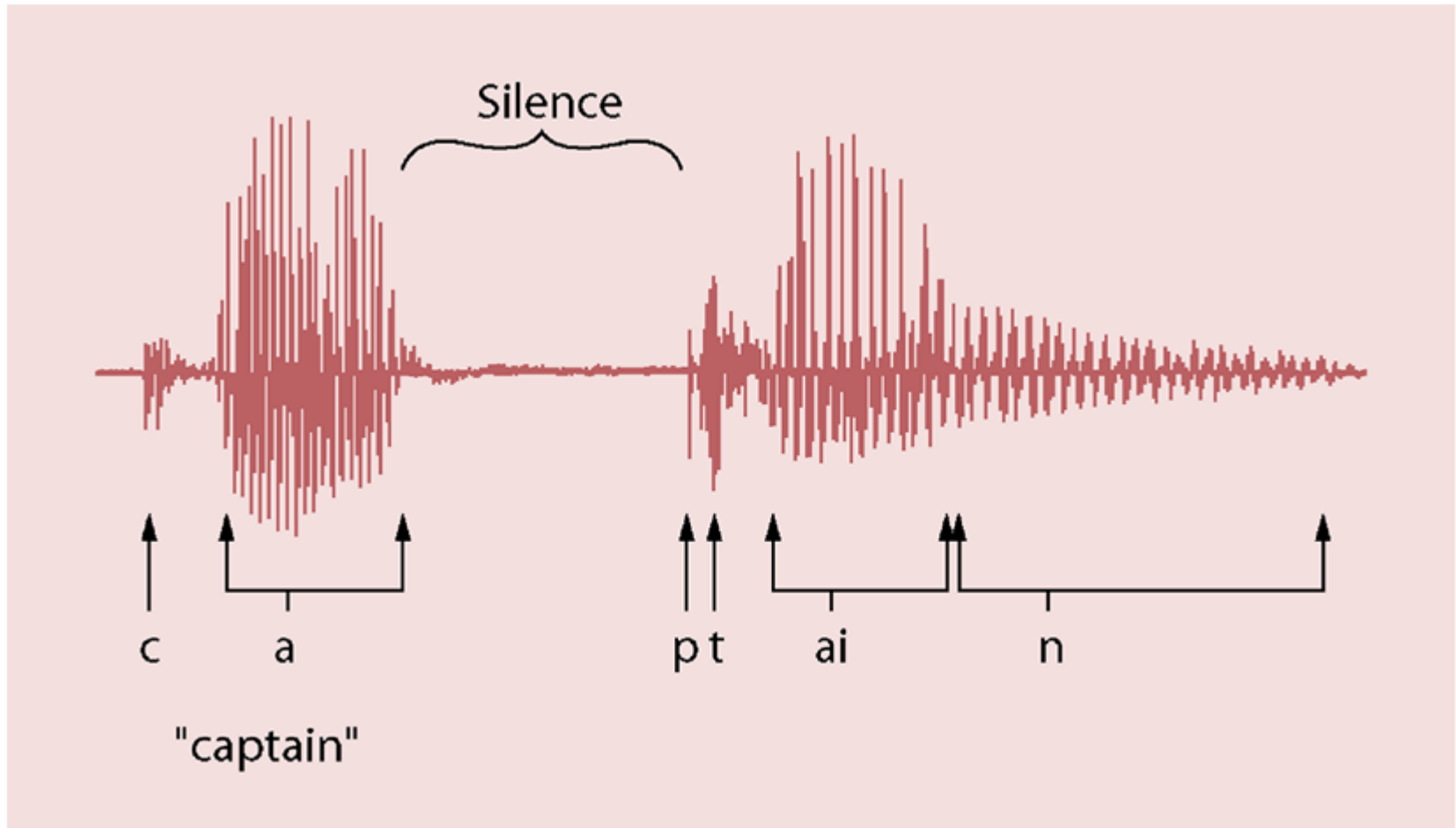
How do we understand it?

- **Spoken speech sounds**
- **Fast: 15 sounds/sec, 30/s in fast speech**
- **Parallel transmission: sounds blend into each other**
 - Each chunk of speech contains evidence of multiple phonemes

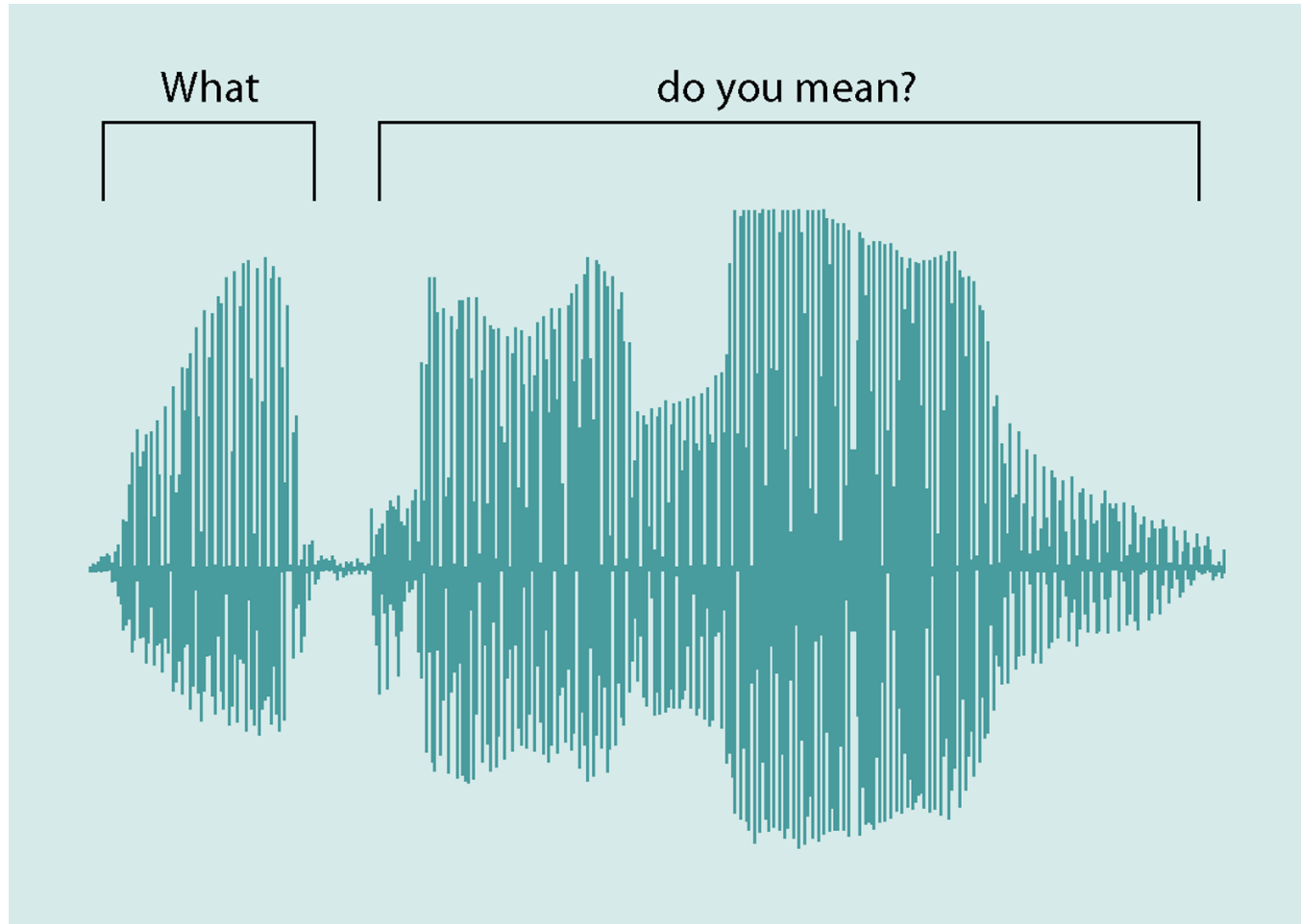
How we understand it?

- **Prosody**
 - Same word can be pronounced differently
 - “is that a car???” versus “look a car”
- **Emotional state**
 - Smiling
 - Frowning
 - stressed
- **Different speakers**
 - Female voices, male voices, etc

Perception of continuous speech



Perception of continuous speech

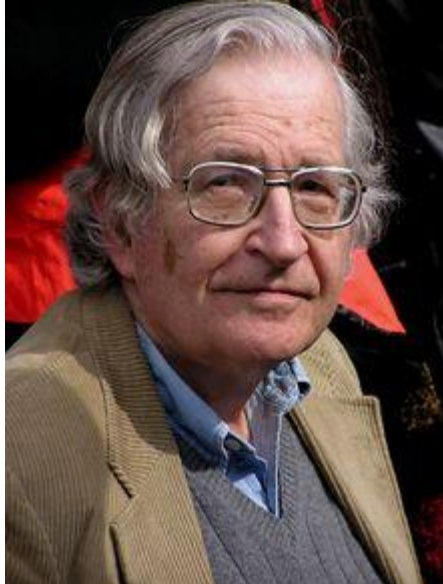


Perception of continuous speech

- **How do we segment speech?**
 - Use probabilities
 - Use stress rules (greenhouse versus green house)
 - Use context (top down influence)

Language views

- **Two different views on language**
 - **Structuralism (Chomsky)**
 - **Functionalism (Piaget)**



Language views

- **Structuralism (Chomsky)**
 - Focus on structure of language
 - Language is an isolated module
 - Language is innately specified
 - Language is separate from other cognitive functions (IQ)
 - Language is learned by a special device

Language views

- **Functionalism (Piaget)**
 - Focus on function of language
 - Language development along with rest of cognitive system
 - Language is a social phenomenon
 - There is no special language acquisition device

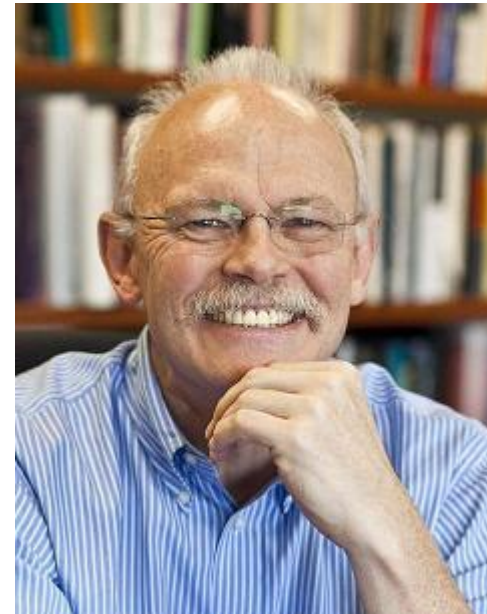
Language views

- **Structuralism (Chomsky)**
 - In line with "sudden mutation" of language evolution

- **Functionalism (Piaget)**
 - In line with "gradual evolution"

Language views

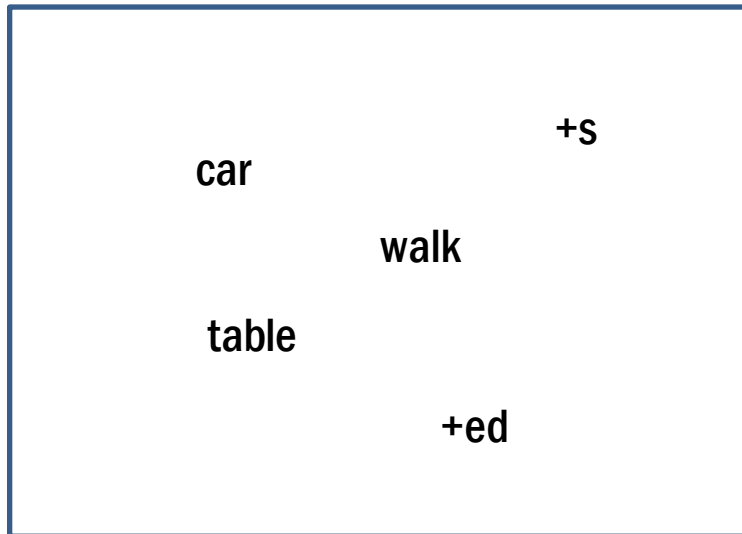
- **Words and Rules (Steven Pinker)**
- **Connectionism (James McClelland)**



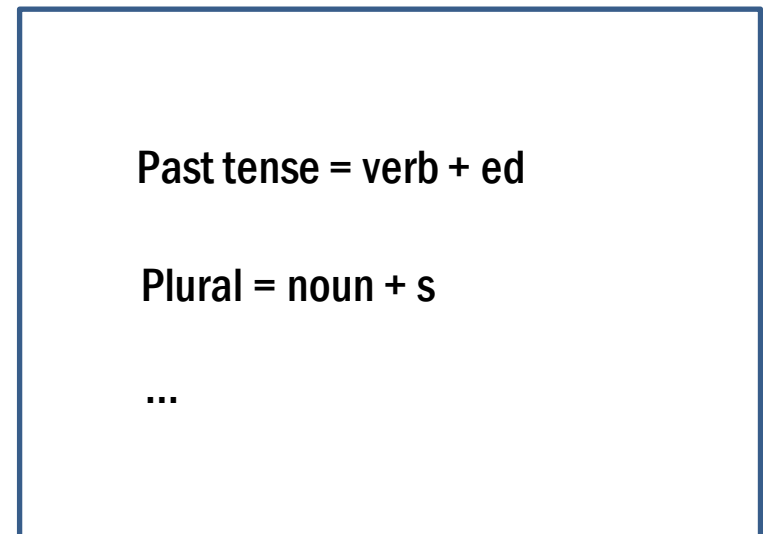
Language views

- **Words and Rules**

words



rules

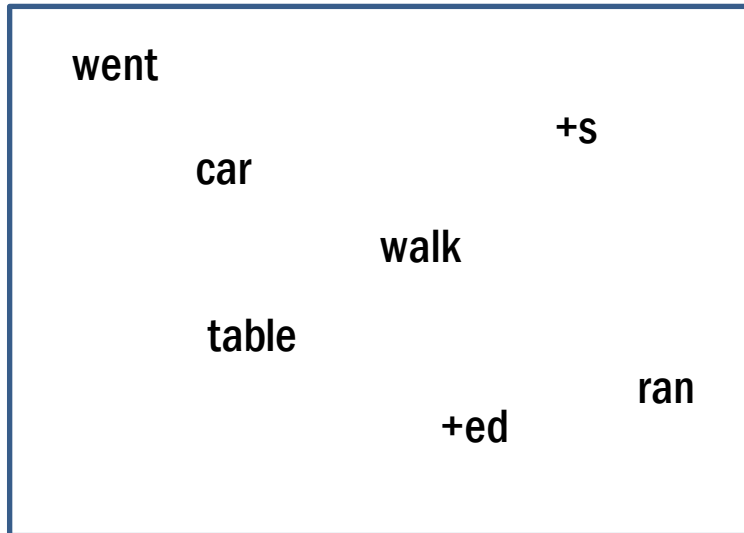


"car", "cars", "walked", etc

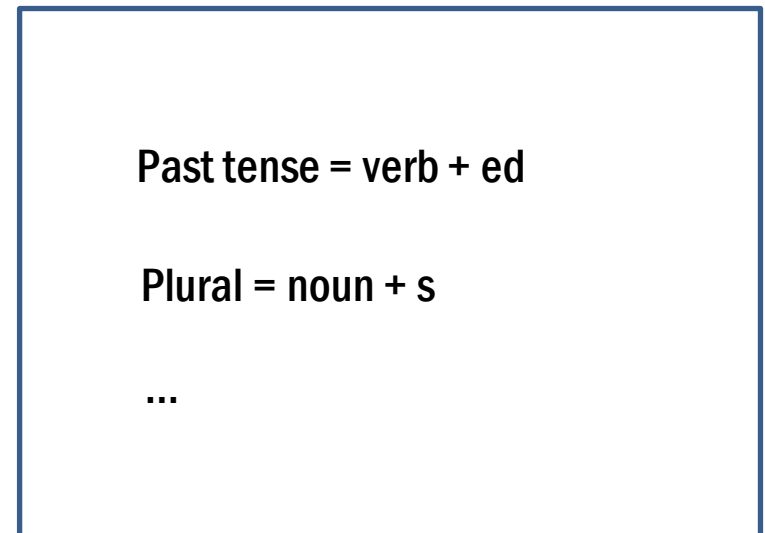
Language views

- **Words and rules problem**
 - What about irregular past tense?
 - Go = goed? No, went!

words

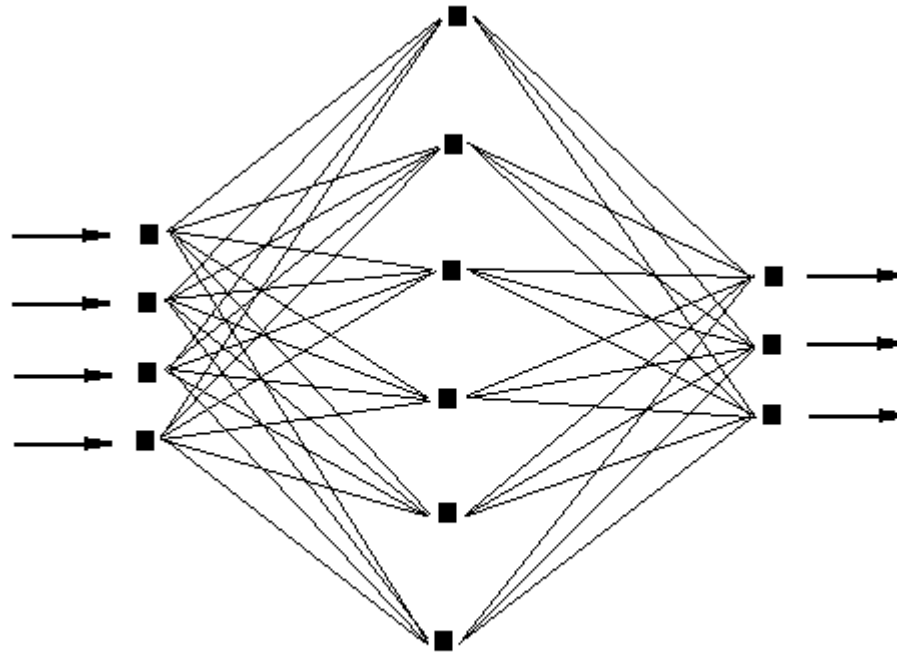


rules



Language views

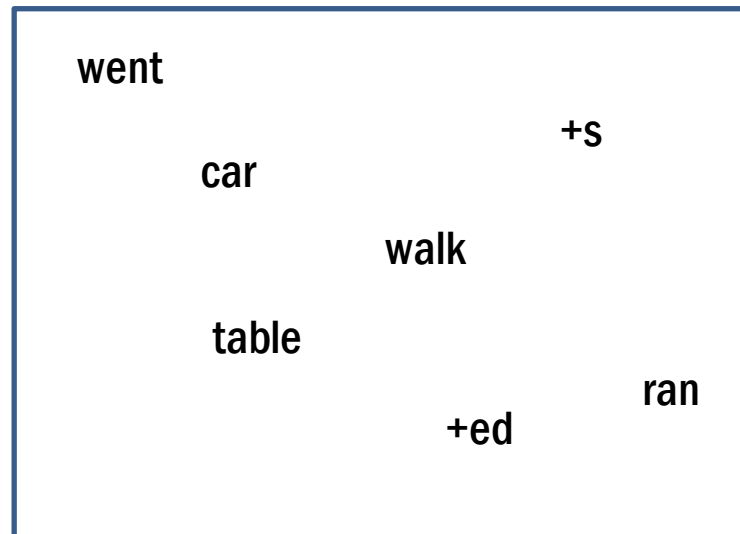
- **Connectionism (neural networks)**



Language views

- **Connectionism**
 - There are no rules

words



Language views

- **Word and rules**
 - Words separate from rules
 - Rules "innate"
 - Structuralism of Chomsky

- **Connectionism**
 - Only words, no rules
 - Basic learning mechanisms that learn language
 - Functionalism of Piaget

Central issues in language processing

- **What specific questions are important in language research?**
 - **Top down versus bottom up processing**
 - **Automatic versus controlled processing**

Top down versus bottom-up

- **Bottom up = information from the environment or information at earlier levels drives processing at later levels**
- **Top down = processing at earlier levels is influenced by processes at later levels**

Top down versus bottom-up

TAE CAT

REB

SROT

FISH

DEBT

Automatic versus controlled processes

- **Automatic processes = a task is automatic when task difficulty does not impact performance**
- **Controlled processes = are influenced by task difficulty**

VERDE

- **Word reading = automatic**
- **Color retrieval = controlled**

Automatic versus controlled

AZUL

- Automatic process is faster than controlled

Summary

- **Specific properties of language**
 - **Phonemes, syllables, morphemes, words, syntax, discourse**
 - **Understanding speech is complex and involves top-down influences**
 - **Different language views are still relevant in today's research questions**