



# Human Language Characteristics

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# Discreteness and Symbolic Structure

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- Discrete units:
  - Human language is composed of **discrete symbolic units**, unlike continuous animal signals.

Level	Units
Phonology	phonemes (/k/, /a/)
Morphology	morphemes (un-, -ed)
Lexicon	words
Syntax	phrases, clauses
Discourse	utterances, conversations



# Discreteness and Symbolic Structure

- **Duality of patterning:**
  - **Meaningless units** (phonemes) combine
  - to form **meaningful units** (morphemes, words)
- Example:
  - /k/ + /æ/ + /t/ → *cat*
- This property dramatically reduces memory load and enables productivity.

# Productivity and Recursion (Generativity)

## Infinite expressivity:

- Humans can generate and understand **novel sentences** they have never encountered.
- Ex. “The student who read the paper that cited the book that referenced the theory...”

This is possible due to **recursive structure**.

# Productivity and Recursion (Generativity)

- Hierarchical recursion:
  - Language is **hierarchical**, not linear.
  - Ex. “The boy saw the dog with a telescope.”
  - [S
    - [NP The boy]
    - [VP
      - [V saw]
      - [NP
        - [Det the]
        - [N dog]
        - [PP with a telescope]
  - ]]]
- Meaning depends on **structure**, not word order alone.

# Compositional Semantics

Principle of compositionality:

- The meaning of a whole is determined by:
  - meanings of parts
  - rules of combination

Formally:

$$\text{Meaning}(S) = f(\text{Meaning}(w_1), \dots, \text{Meaning}(w_n) \text{Syntax})$$

Example:

- “Dog bites man”  $\neq$  “Man bites dog”

# Compositional Semantics

- Semantic abstraction:
  - Humans manipulate:
    - concrete concepts (*chair*)
    - abstract concepts (*justice*)
    - counterfactuals (*If I had known...*)
    - hypotheticals (*Suppose gravity stopped*)

Language supports **mental simulation**.

# Context Sensitivity and Pragmatics

Meaning  $\neq$  sentence meaning:

Human language is **context-dependent**

Sentence:

“It’s cold here.”

Possible meanings:

- Statement
- Request (close window)
- Complaint





# Pragmatic inference

Humans infer **speaker intention** using:

- shared knowledge
- goals
- social norms

## **Gricean maxims**

- Quantity
- Quality
- Relevance
- Manner

Violation → implicature.

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# Grounded Meaning (Symbol Grounding)

The grounding problem:

- Words are not defined only by other words.
- “Red” is understood because it is grounded in:
  - perception
  - experience
  - action
- Human language is **multimodally grounded**:
  - Vision
  - Audition
  - Motor system
  - Emotion

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# Evidence from cognition

- Color terms linked to visual cortex
- Action verbs activate motor areas
- Emotion words recruit affective systems
- Meaning is **embodied**, not purely symbolic.

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# Learning and Acquisition Properties

- Rapid acquisition:
- Children acquire language:
  - without explicit instruction
  - from noisy input
  - within ~5 years
- This suggests:
  - strong inductive biases
  - structured learning mechanisms

# Statistical learning

## Humans track:

- phoneme transitional probabilities
- word frequency
- distributional regularities

Infants can segment words  
using statistics alone.

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# Robustness and Noise Tolerance

Human language comprehension is **error-tolerant**:

- typos
- speech disfluencies
- accents
- incomplete sentences

Example:

- “I yesterday market went”
- Still comprehensible.

This robustness comes from:

- redundancy
- prediction
- probabilistic inference

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# Predictive Processing Nature of Language

- Humans constantly **predict upcoming input**.
- Psycholinguistic measures:
  - surprisal
  - reaction time
  - eye-tracking
  - ERP (N400)  
$$\text{Surprisal}(w) = -\log P(w \mid \text{context})$$
- Higher surprisal → longer RTs.
- Language comprehension is **predictive, not reactive**.

# Social and Interactive Nature

Language is inherently:

- dialogic
- cooperative
- goal-oriented

Properties:

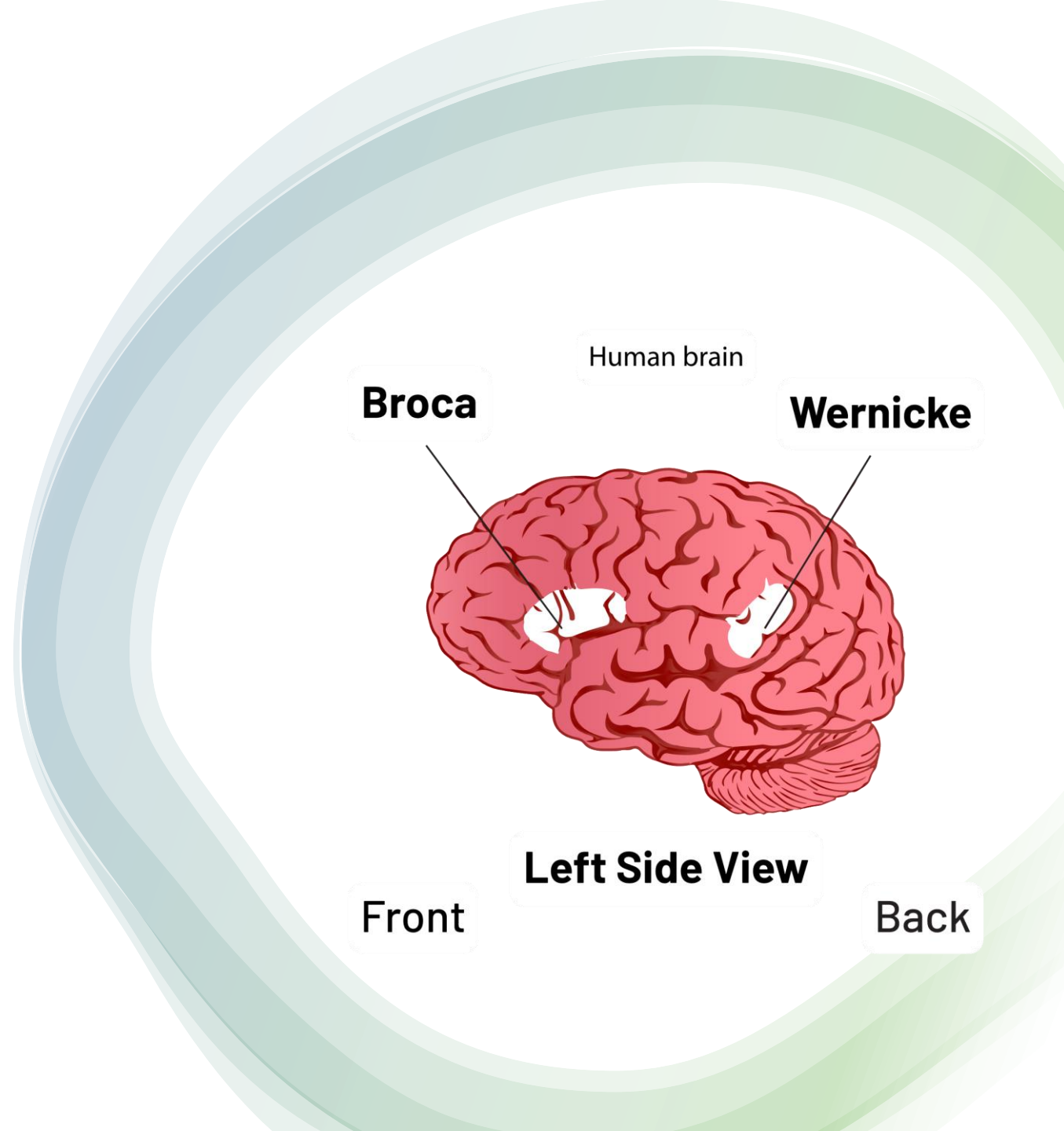
- turn-taking
- repair mechanisms
- alignment (lexical, syntactic, semantic)

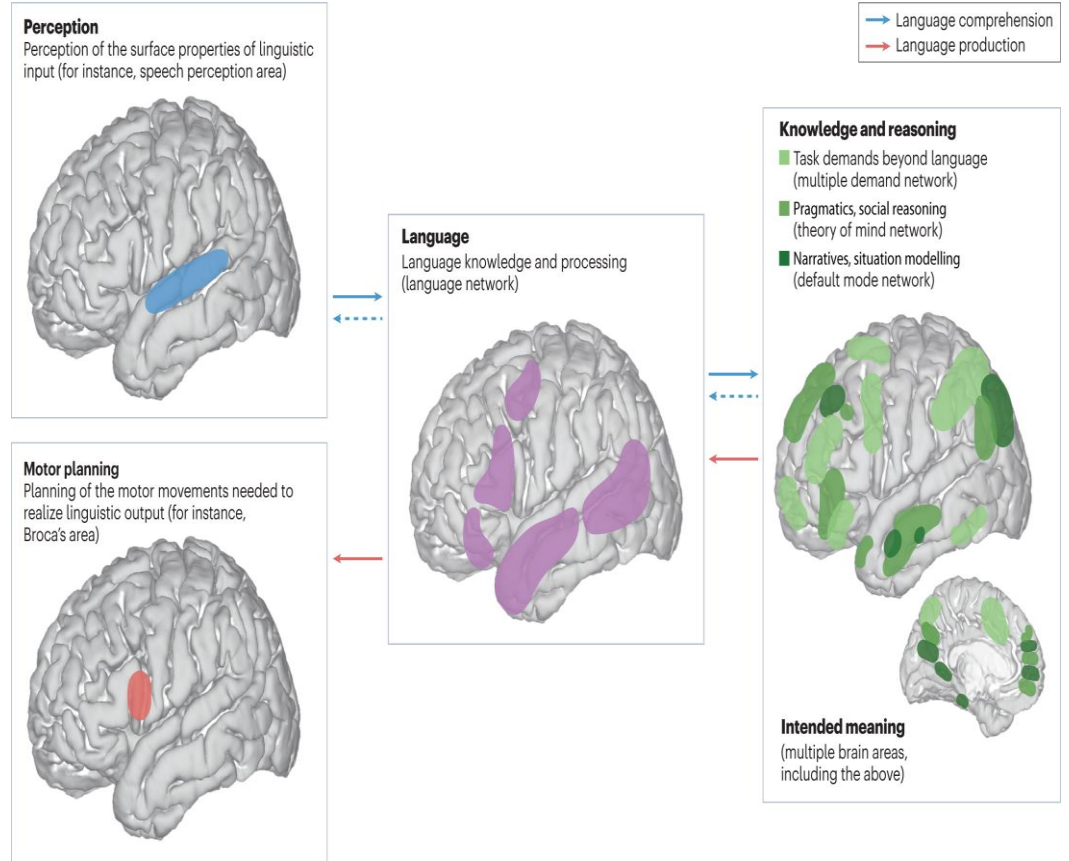
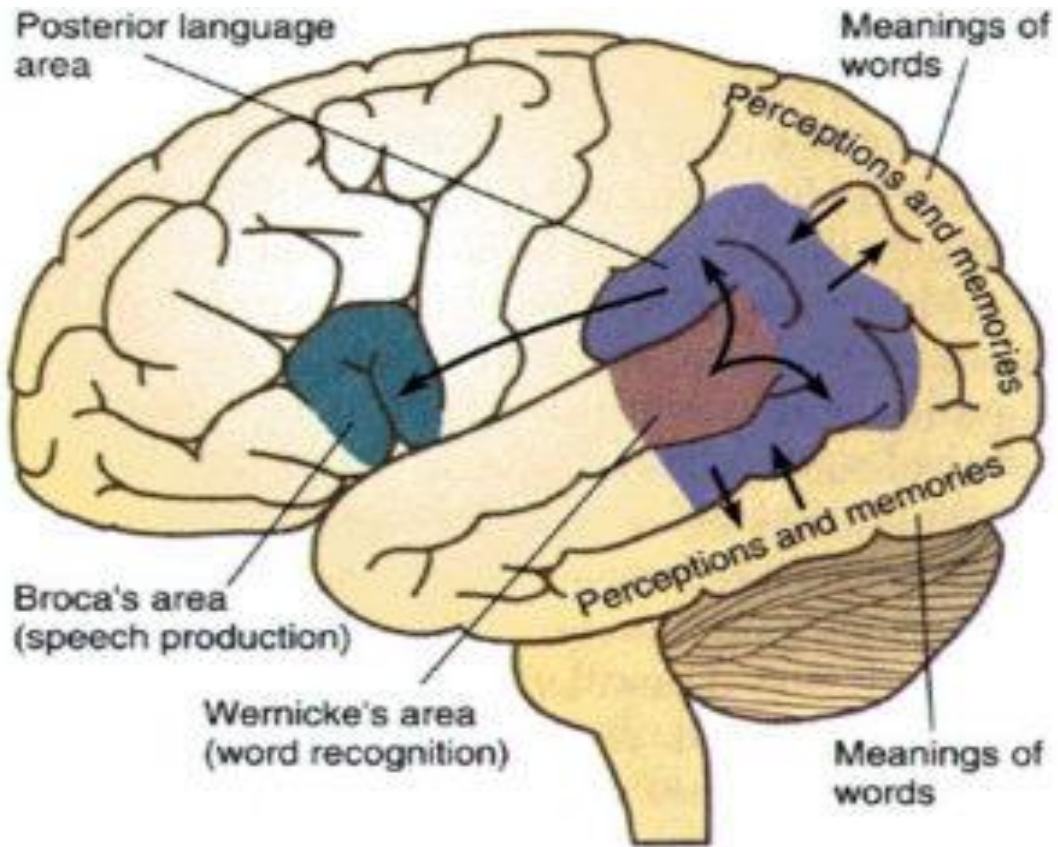
Conversation shapes grammar and usage.



# Neurological Organization

- Language relies on **distributed neural networks**, not a single module.
- Key systems:
  - Temporal cortex → lexical–semantic
  - Frontal cortex → syntax, planning
  - Motor cortex → articulation
  - Subcortical structures → timing, fluency
- Damage produces selective deficits (aphasias).





# Neural Distribution



Thank You !