

Semantics vs. Lexicon – Musings on the Evolution of Language

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Semantics vs. Lexicon

Summary

1. The Problem
2. Steps and Time Delays in Creating Speech
3. Semantic Representation in the Brain
4. भर्तृहरि Bhartṛhari and वाक्यपदीय Vākyapadīya
5. Nouns and Verbs
6. Sound and Word
7. Cognitive Grammar
8. Vocalization, Creation of Word
9. Prosody and Vowels
10. Sentence structure and Cultural imprint
11. Sound as Signature
12. Evolution of Language

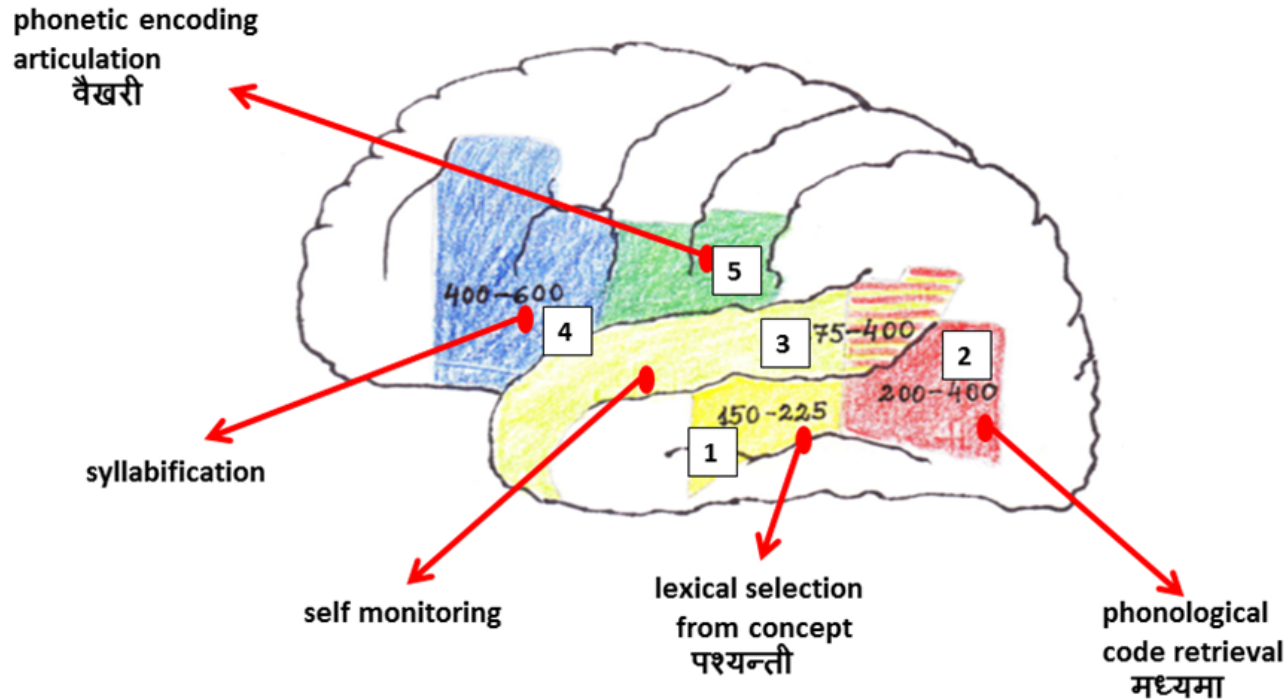
Semantics vs. Lexicon

The Problem

1. **Semantics:** the meaning of a word deciphered in hearing and context
2. **Lexicon** : the meaning of a word obtained through a dictionary
3. **Problem** :
 - a. How does the brain function?
 - b. How do sounds convert to create an alphabetic rendering?
 - c. What does thinking consist of?

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The Steps and Time Delays in Speech



	Brain Area	Activity	Time-Scale	Indian Grammatical Term
1	Middle and inferior temporal gyri	lexical selection from concept	150-225 msec	पश्यन्ती
2	Middle temporal gyrus and parieto-occipital gyrus	phonological code retrieval	200-400 msec	मध्यमा
3	Superior temporal gyrus	self monitoring	275-400 msec	
4	Middle and inferior frontal gyri	syllabification	400-600 msec	
5	Pre-and postcentral gyri	phonetic encoding and articulation	600- msec	वैखरी

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Brain Functions in Speech

1. Lexical selection from Concept

Time duration: 100-225 milliseconds

पश्यन्ती “paśyantī”

2. Phonological Code Retrieval

Time duration: 200-400 milliseconds

मध्यमा “madhyamā”

3. Self-Monitoring

Time duration: 275-400 milliseconds

No equivalent known term

4. Syllabification

Time duration: 400-600 milliseconds

No equivalent known term

5. Phonetic Encoding and Articulation

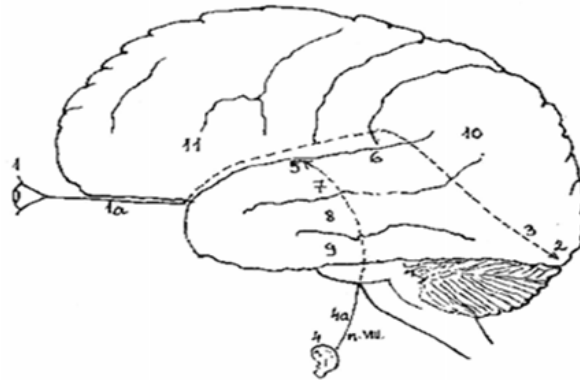
Time duration: 600 milliseconds

वैखरी “vaikharī”

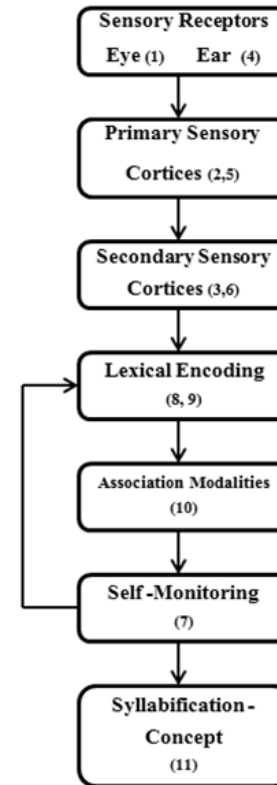
(Indefrey and Levelt, 2004)

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Semantic Representation in Brain



	Structure	Function I	Function II
1	Eye/retina	visual sensory organ	reception of color, shape, movement
1a	Visual neuronal pathway	conduct electrical messages	some processing occurs
2	Primary visual cortex	perceives information	retinotopic processing of information
3	Secondary visual cortex	combines modalities	associates modalities
4	ear/organ of Corti	auditory sensory organ	filters intensity and wavelength
4a	auditory neuronal pathway	conduct electrical messages	localizing the sound
5	Primary auditory cortex	perceives information	separation to tone
6	Wernicke's area	sensory auditory cortex	sensory perception of speech
7	Superior temporal gyrus	self-monitoring	examination through memory
8	Middle temporal gyrus	lexical encoding	lexical encoding and retrieval
9	Inferior temporal gyrus	lexical encoding	lexical encoding and retrieval
10	Parietal association cortex	combining multimodalities	association context and image
11	Middle and inferior frontal gyri	conscious processing	syllabification-concept grammar



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Multi-lingual Semantic Parsing

- **fMRI reading experiments on bilingual speakers (Buchweiz, Prat; review paper, 2013)**
- **Portuguese and English (Lexical)**
Words having same meanings pointed to the same memory location
- **Japanese (logographic) and Korean (syllabic)**
Recognition and processing of words
Letter to sound mappings
- **Sentence-level and word-level processing**

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Bhartrhari's segmentation of sound (400AD)

- We hear sequential noise – ध्वनि dhvani
- Between the pauses, we have शब्द śabda
- In śabda, we have one or more पद pada
- A pada consists of one or more वर्ण varṇa
- A group of (one or more) śabda making a meaning make a वाक्य vākya
- A vākya when heard carries a meaning independent of the component parts
- Each group of objects can create a meaning different from its component parts.

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Bhartṛhari's analysis of meaning

- Lexical meaning – अर्थ artha
Obtained from local memory
Cultural use
Aid in communication
- Semantic understanding achieved by स्फोट
Bursting forth
Obtained from the deeper memory
Time delay
Superposition of the parsed concept to the
concept in memory

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Experiments on baby cognition and speech

- **Patricia Kuhl and associates
(University of Washington, USA)**
Baby perception is as good as an adult
Baby sound comprehension is superior to adult
Baby has no nativity preference until 8 months.
Lip-reading leads to nativity preference.
- **Baby speech is limited by motor control.**
“k”, “g”, “m”, “p” and “b” are discernible.
All expressions are confined to these syllables.
New syllables are learned by lip reading.
- **Baby expressive capacity as an adult**
Vowels and prosody rendition

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Nouns and Verbs in Brain

- Experiments (1993) on aphasia patients by Antonio and Tranel (University of Iowa, USA)
Experiments used English language words.
- Nouns and Verbs are retrieved differently.
Nouns are stored as classes (clusters).
Each known object was identified with precision.
- Verbs were retrieved easier.
Verbs had a better semantic mapping.
- Inference drawn confirms स्फोट theory.
- Noun comprehension is through recall.
- Verb comprehension is through analysis.

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Example of Pirahã language in Amazon

- Effort was to teach English language to the Pirahã tribespeople by Jesuit priests.
- The experiment failed denoting that the communicated language is cultural.
- Confirms that the acquisition of new phonemes is through training and is not natural.
- Pirahã has no separate words for colors, numbers and non-parental relationship.
- The communication is through vowel rendering and prosodic delivery.
- Nativity can die with lexical drills.

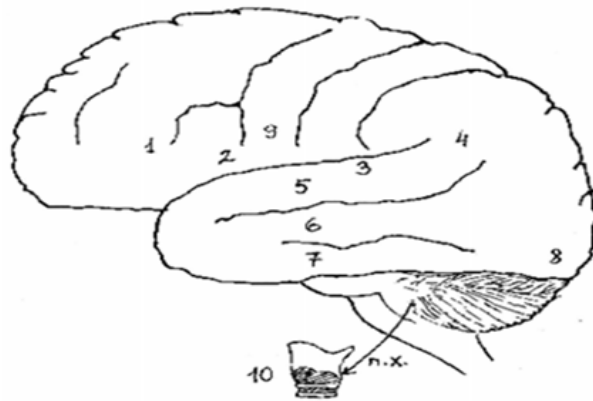
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Sound as Signature (empirical observations)

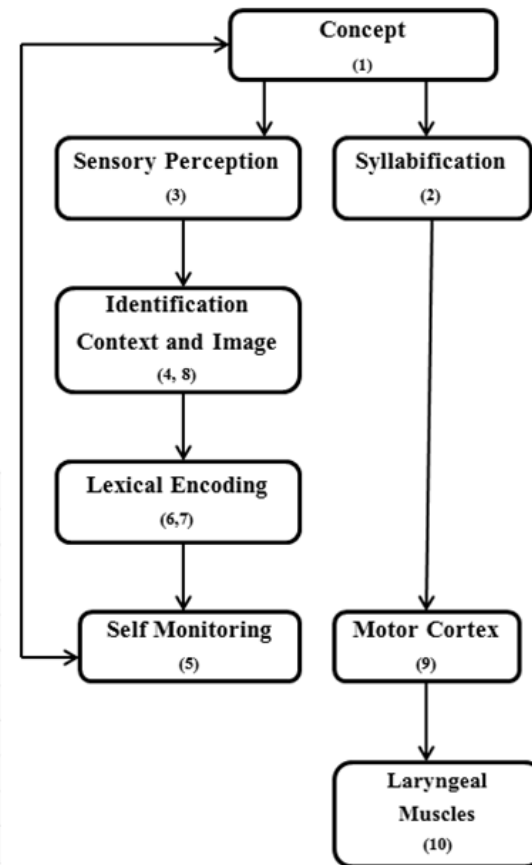
- **Cosmological significance of sound**
- **Sound perception and recognition**
- **Sound reproduction in imitation, training, repetition, identification**
- **Sound as a conveyer of environment**
- **Human voice, vocal chord, individual signature**
- **Sound as expression of feelings and emotion**
- **Rendering of words: Consonants and Vowels**
- **Economy in expression**
- **Expression vs. Communication**
- **Sound Comprehension**
- **Grammar**

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Brain Functions from Thought to Articulation



Structure	Function I	Function II
1 Prefrontal and middle frontal gyri	conscious processes	unpacking concept memory
2 Broca's area	articulation commands	syllabification
3 Wernicke's area	sensory auditory cortex	sensory perception of speech
4 Parietal association cortex	combining multimodalities	identification context and image
5 Superior temporal gyrus	self-monitoring	examination through memory
6 Middle temporal gyrus	lexical encoding	lexical encoding and retrieval
7 Inferior temporal gyrus	lexical encoding	lexical encoding and retrieval
8 Visual cortex	processing visual information	process color, shape, movement
9 Motor cortex	organizing motor responses	sending commands to muscles
10 Laryngeal muscles	muscle movements	articulation-vocalization



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Memory storage, “Cognitive Grammar” - Musings

- “Cognitive Memory”
- Deep, individual preference
- Achieved through conceptual understanding
- Accessed through recall, concentration and meditation
- Layered as background to “Lexical Memory”
- Individual filter to help develop “Cognitive Memory”
- It reciprocates बिन्दु “bindu” concept in Indian literature.
- The filter can be termed “Cognitive Grammar,” innate to each individual.

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“Cognitive Grammar” in Word Creation - Musings

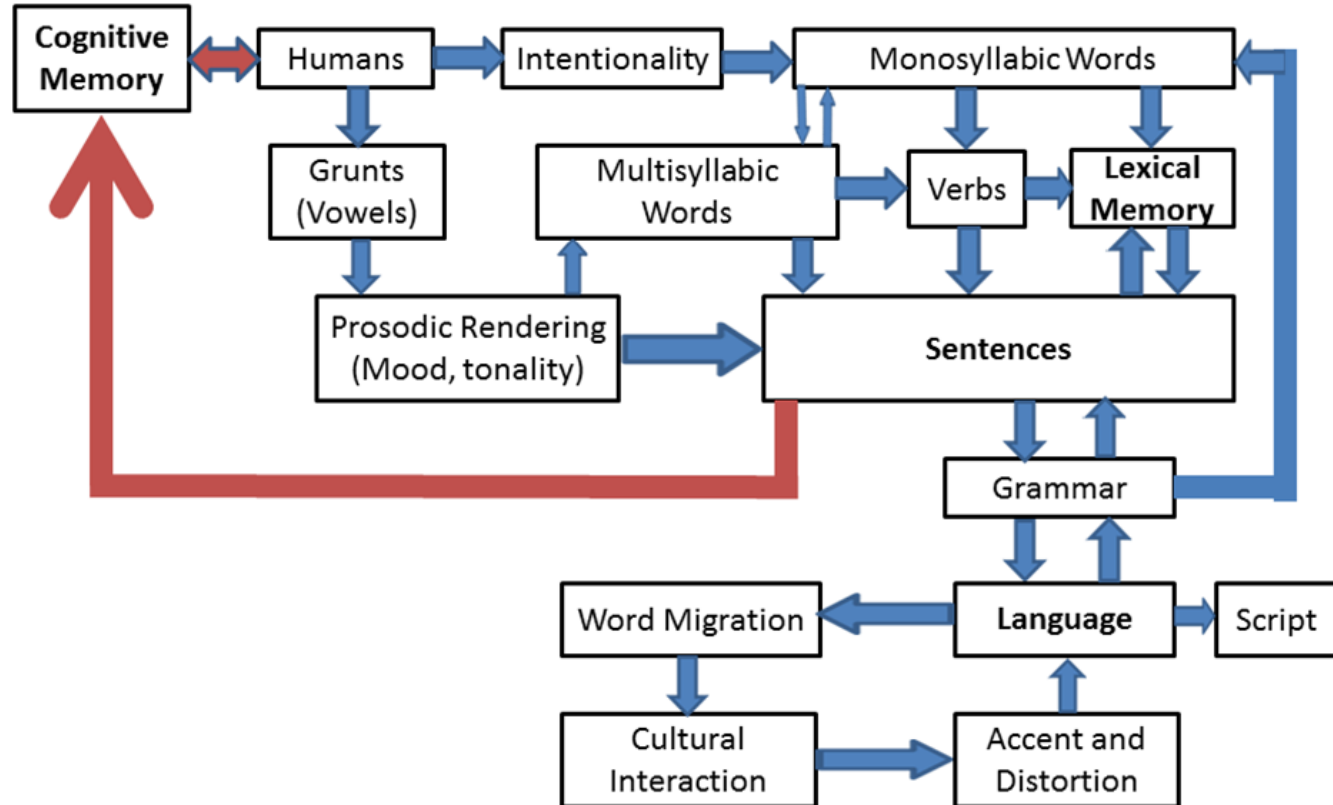
- Examples from s̄antāli language
- “o” – burning stick
- “ot” – earth
- “otā” – (verb) press down
- “ote” – (verb) listen
- “oñ” – breath
- “ok” – burn
- “oj” – work
- “oh” -- pain
- “or” – drag
- “on” – grain
- “og” – mother.

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Role of Vowels in Word Creation - Musings

- Examples from oḍiā language
- “प” “pa” - “पि” “pi” verb “to drink”
- “पिए” “pie” meaning “drinks normally”
- “पिउछि” “piuchi” meaning “is drinking”
- “पिइछि” “piichi” meaning “has drunk”
- “पिउथाए” “piuthāe” meaning “habitually drinks”
- “पिइथाए” “piithāe” meaning “habitually drunk”
- “पिआहुए” “piāhue” meaning “drinking happens”
- “पिइहुए” “piihue” meaning “facilitates in drinking”.
- Note “आ” “ā” , “इ” “i”, “उ” “u” and “ए” “e”
- More: “क” “ka” “who”, “का” “kā” “where”, “कि” “ki” “what”, “के” “ke” “who (plural)”.
- No “कु” “ku” in the set!

Evolution of Language – Conceptual Flow Chart



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Thank You!