

The Brain, Biology and Cognition

Language Development + Differences and Similarities between human and animal communication

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Language



Consider the questions:

- What is the definition of the word 'language'?
- What do we mean by 'understanding' a language?
- Could we operate without a *human* language?
- What would be different without one?
- What is the main *purpose* of language?

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What is language?



Harley (2008, p.5):

- "Language is a system of symbols and rules that enable us to communicate.
- Symbols are things that stand for other things: Words, either written or spoken, are symbols.
- The rules specify how words are ordered to form sentences."

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More than communication?



Remarkable human skill

- Used to think and record information
- Used to express, solve problems, & plan etc.
- Used creatively, to convey emotion, & form social relationships.

Evolved historically / culturally



- Information is passed down generations through language.
- Provides knowledge.

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Cognitive Neuroscience of language



Includes three premises:

1. Use of language mediated by activity in all areas of brain that participate in cognitive processes involved in the language related behaviour
 - Constituent cognitive processes involved in language are divided into:
 - Phonological analysis (sound)
 - Grammatical analysis (structure)
 - Semantic analysis (meaning)

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Cognitive Neuroscience of language



2. Areas of brain involved in language are not dedicated solely to that purpose
3. Areas of brain involved in language likely to be small, widely distributed, and specialise, as they are part of other functional systems (e.g memory)
 - Brain imaging research:
 - More widespread activity in left hemisphere during silent reading (Bavelier et al., 1997)
 - Areas of left temporal lobe that activate during object naming depend on object category (Damasio et al., 1996)

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Levels of language creation



Language is a multi-layered structured system for combining abstract elements into meaningful productions

Levels of language

- Phonemes – speech sounds
 - E.g. **a** sound in *ba*by and *ta*ble (note: sound not letter)
- Phonemic rules
 - language specific, possible phoneme combinations (e.g. stop consonants *p, b, d*)
- Words – approx. 600,000 in English language
- Sentences
 - Word order governed by rules (grammar and syntax)

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Five stages of Language production development



Stage 1 = Cooing 1-2 months

- Long drawn-out vowels or combinations of consonant-vowels
- E.g. oooooooh or gaaaaaaaah

Stage 2 = Babbling 6-10 months

- More consonant-vowel combinations and repetitions
- E.g. dadadada
- Phonemes are beginning to be constrained by language exposure

Stage 3 = First words 10-15 months

- 50 words
- A single word has many purposes e.g. juice (request, comment, lament) – holophrases

Stage 4 = Two-word utterances 18 months

- Telegraphic speech – omit grammatical words e.g. milk gone

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Five stages of Language production development



Stage 5 = Vocabulary explosion 24 months+

- Straight from 2 words to sentences!
- Sentence structure and grammar develops
 - Is inconsistent at first
 - E.g. over generalise – more than one 'cat' are 'catses', playing with past tense makes 'go' becomes 'goed'
- Grammar develops in a particular sequence
 - Words ending in -ing (notes verb)
 - Prepositions in/on
 - Plural -s
- Consistent by age 4

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Language production in infants



Average 6-year-old

- 14,000-15,000 words (Clark, 1991)

Noam Chomsky (1957/1965) - Language is innate and species specific

- Explosion of language indicates innate nature of language
- Hard wired to pick up language, grammar and syntax and do so spontaneously with little formal training
 - E.g. parents correct for **meaning** but not **grammar**
- Sequence of language learning is universal
 - E.g. Sign/invented languages

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Animal communication



Animals can communicate in simple and complex ways.

Evidence from Ethology

- study of animal behaviour in natural settings

Pioneered by Konrad Lorenz (1903-1989)

Imprinting of chicks and critical period - when chicks bond with first moving object it sees



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Honeybees (Karl Von-Frisch, 1950)



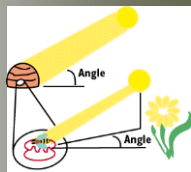
Social insects

Specialised roles - worker bee = sterile female who finds food for the community

Forage for pollen

Return to hive and 'tell' other workers the location of pollen

- Round dance = direction
- Number of waggles = distance



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Vervet Monkeys – Seyfarth et al (1980)



Social and communicative

Different alarm calls signal predators and elicits response

- Eagle call – look to sky
- Leopard call – flee to trees
- Snake call – look down



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Criteria for Language



What are the differences between these, and language used by humans?

Different in?:

- Range of events that can be communicated
- Flexibility in how message is conveyed

• But how we define language and criteria for comparing to animal communication is key.

Aitchison (1983) focused on four features he argued to be unique to humans

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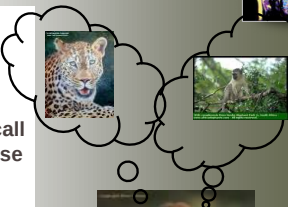
Criteria 1. Semantics



Human language – each word has at least one specific meaning

Vervet monkeys – each call elicits different response – is this semantics?

Does monkey have mental representation of meaning of the call?




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Criteria 2. Displacement



Across Time / space

For true / hypothetical situations

Step away from current true state of affairs

- We talk about what 'might' be true or time not yet reached (e.g., "where is the exam?")
- Abstract concepts represented (e.g., Love, justice, truth)

But consider the honeybee:

- Spatial displacement from bees (and perhaps time)
- But... "Bees will never dance a book on the psychology of the bees dance" (Harley, 1995 p. 10)

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Criteria 3. Structure dependence



Human language characterised by series of symbols that are abstract

Words put into units of meaning where **position** in sentence is important to meaning

E.g. "water bird" vs. "bird water"

The set of rules that govern how words are combined is **syntax** (Chomsky, 1960)

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Criteria 4. Creativity



Human language allows us to produce utterances never expressed before

- Novel utterances

Flexible and infinitely productive

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Primate language learning



Washoe the chimp (Gardner & Gardner, 1967)

- Raised like human infant
- Learned American Sign Language (ASL)
- acquired 132 signs
- Most signs were 'natural' chimp signs e.g., hurry, more

Sarah the chimp (Premack, 1971)

- Metal backed chips and magnetic board
 - nouns (chocolate, dish, Sarah),
 - verbs (give, insert),
 - concepts (same, if-then),
 - adjectives (red, yellow)



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Structure dependence



No strong evidence for primate grammar/syntax:

- E.g., Terrace et al. (1979) – Nim chimpsky
- Put 'more' before other words (e.g. chocolate, tickle) more often than chance (suggests grammar)
- But communications were mind-numbingly similar
 - More drink, more drink
 - More Nim, more Nim
 - Banana Nim banana Nim
 - Banana eat more Nim

**"Give orange me give eat orange me eat orange
give me eat orange give me you!"**

- Does this suggest meaning and syntax?

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A major difference



Quality of 'recursion' in human language

- Embedding of packets of meaning
- E.g. *The man, who had just been to town, (where the big shopping centre was) (which had just been built), stopped to look at his watch, (which he had just purchased in town), briefly.*
- Recursion adds large degree of flexibility not apparent in animal communication
 - Complexity of meaning and information

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Why are we interested?



Language closely linked to idea of ‘thought’

- Sapir-Whorf hypothesis (Whorf, 1956)
 - Language guides and defines thought and cognition

Memory may be heavily reliant on language

- E.g., Propositional representation
 - ‘The car is behind the lorry’ as way to represent information in memory
- Working memory close relation to spoken language
 - Phonological processing, stores and rehearsal

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Language



Interactive Task:
Consider a debate:

- What is/are the most important aspect(s) of *human* language definition:
 - What aspect or aspects are most essential?
 - How would it change language if not present?

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Language



How do the Hauser et al. (2002) and the Pinker and Jackendoff (2005) papers on Moodle differ?

Why did Pinker & Jackendoff find the assumptions put forward by Hauser et al. regarding which aspects of language were uniquely human as problematic.

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Summary



Human language and animal communication

Similar

- Both use symbols to represent events in the world
- Rely on sender and receiver sharing representation
- Primates can learn meaning of some arbitrary symbols for communication (as humans do)

Different

- Animals cannot communicate beyond 'here' & 'now' (abstract)
- Syntax in language more human
- Recursion is a human language sophistication
- Semantics: difficult to fully test but possibly more human

Qualitative and Quantitative differences
