

Brain and Language

1.2 Language in the Brain

History of Linguistics

- Behaviourism: language is a learned behaviour, explained by general-purpose learning mechanisms
- Noam Chomsky challenged behaviourist explanations of language
- He proposed a cognitive theory of language based on a modular specialised subsystem endowed with a genetically-determined set of rules about language production: a "universal grammar"
- Evolution of language: sudden, single mutation (Chomsky), or gradual adaptation by natural selection (Pinker)

Verbal Behaviour

- Skinner's approach focused on the circumstances in which language was used; for example, asking for water was functionally a different response from labeling something as water, responding to someone asking for water, etc, which Chomsky criticised as ignoring important questions
- A child does not, as an English speaker in the presence of a house, utter "house" repeatedly in the presence of reinforcing elders
- Language as such seems to be learned without, in a sense, being explicitly taught or taught in detail, and behaviorism doesn't offer an account of how this could be so
- In human language behaviour, "stimulus" is not well defined as in more restricted domains of animal behaviour. Name of person may be recalled in absence of the person. "I have often used the words Eisenhower and Moscow (without ever having been) stimulated by the corresponding objects." So also the terms "response", "reinforcement", "conditioning"
- Language use is a creative activity - no bound on grammatically well-formed sentences one might produce or hear. Almost every sentence uttered is a new combination of words

Language Areas in the Brain

- Broca's Aphasia: difficulty producing language, pauses between words, difficulty reading
- Wernicke's Aphasia: fluent but nonsensical speech, correct grammar but no semantic content
- Conduction Aphasia: difficulty repeating words, traditionally thought to be caused by damage to arcuate fasciculus fibres linking Broca's and Wernicke's areas
- Aphasia seems to affect sign language in basically the same way, though some brain regions in slightly different areas
- Language is generally lateralised to the left hemisphere

Imaging Techniques

- CT: shows different regions of brain structure
- MRI: shows different proton densities in different tissues
- DTI: technique for visualising connections (fibre tracts) in the brain

- PET: measures the uptake of radioactive isotopes
- fMRI: measures changes in cerebral blood flow
- EEG: measures local electric potentials over regions of the head
- MEG: measures local magnetic fields

Components of Language

- Phonetics: the sound of human speech, how they are produced by the vocal tract and the mouth, how they are transmitted through physical media, and how they are perceived by the ear
- Phonology: the way sounds function within a language and how phonemes are used within and across languages
- Morphology: how words are decomposed into morphemes, the smallest meaningful component, and the rules governing this
- Syntax: the rules governing how words are combined into sentences in different languages
- Semantics: how meaning is encoded into sounds, words, and sentences. Incorporates the study of human language as a formal language
- Pragmatics: the manner in which linguistic and non-linguistic context contributes to and alters meaning
- Sociolinguistics: how social norms, values, cultural context and expectations shape the way language is used and is perceived

1.3 Language Acquisition

Important Questions

- How is this tacit language knowledge acquired by children?
- How can we characterize the differences between adult and child language knowledge?
- How is this knowledge represented in the brain and is it different between adults and children?

Characteristics of Language Acquisition

- Universality: No matter in which society a child is born, under normal circumstances, every child acquires a human language
- Rapidity: Once children start to produce their first words and phrases, children go through development stages in a fairly quick fashion
- Uniformity: Children around the world go through very similar stages of language development
- Unique to humans
- Effortlessness: You put the child in the right situation and they will acquire language. They don't need to try in any sense. It's more like growth of height than book learning. Explicit instruction by parents is not needed at all (e.g. children of immigrant parents). Furthermore, no language is so difficult that only some native children manage to learn it
- Convergence: every child growing up in the same linguistic community learns the same language; otherwise mutual understanding would not be possible. This is all the more remarkable given that they all received different input

Stages of Language Acquisition

- Birth to 6 months: cooing (vowels only)
- 6 months to 10 months: babbling (includes consonants)
- 10 months to 1.5 years: one-word
- 1.5 years to 2.5 years: two-words, sensitivity to plurals
- 2.5 years to 3.0 years: multi-word stage
- 3 years on: the emergence of grammar

Research Methods

- CHILDES database of spontaneous child speech production
- Language elicitation studies (e.g. WUGs)
- Truth-value judgement tasks
- Eyetracking
- Brain imaging, often EEG or MEG
- Non-nutritive sucking
- Conditioned headturn
- Habituation and preferential looking (e.g. can they distinguish two sounds)

Usage-based Theories of Language Acquisition

- Children listen to and imitate the language they hear around them
- Predicts that frequent speech input patterns would be acquired earlier
- Predicts that usage patterns should be fairly formulaic, with only limited word substitution

Poverty of the Stimulus

- Continuity assumption
- Dual process approach to language acquisition (or words and rules approach): linguistic periphery aspects (like words and language parameters) are learned by ordinary learning mechanisms, while linguistic core elements cannot be so learned
- Cognitive-functional linguistics: linguistic symbols themselves are meaningful, and it is the use of them in different contexts and combinations that is vital to meaning and communication. Grammar is secondary (hence against a 'formal languages' approach to linguistics)
- Examples of this are the highly ritualised specific phrases like 'hang in there' and 'I wouldn't put it past him'
- "A plausible way to think of mature linguistic competence, then, is as a structured inventory of constructions, some of which are similar to many others and so reside in a more core-like center, and others of which connect to very few other constructions and so reside more toward the periphery"
- "If linguistic constructions are meaningful linguistic symbols in their own right, then children can use function or meaning to assist in their acquisition, just as they do in their acquisition of smaller linguistic constructions such as individual words"

Chomsky on The Architecture of Language

- To say that somebody knows a language is simply to say that their language faculty is in a particular state corresponding to that language

- 'principles and parameters approach': much of what we traditionally call grammar (things like relative clauses), is not fundamental to language, but an artefact of a deeper, fairly small set of basic principles (and variations in parameters)
- Problems with Universal grammar:
 - How can the child link their abstract universal grammar to the particularities of the particular language they are learning?
 - How can we understand the changing nature of children's language across development if universal grammar is always the same?
 - "A grammar is a set of rules (often tacit, intuitive) which characterises all and only the sentences of the that we as speakers are able to produce and understand"

Theories of Language Acquisition

- Trial and Error: this notion cannot explain the fairly universal pace and sequences that most children go through in acquiring language. Nor can this explain how all children in the same linguistic community end up speaking the same language. Children also make far fewer errors than we would expect by trial and error, and what errors they do make are not random, but tend to follow predictable patterns
- Corrective Feedback: the idea that children learn language as they are corrected by their parents is mostly wrong. First, children make relatively few mistakes in learning language, far fewer than would be necessary for this type of learning. Second, research has shown that most parents do not systematically correct their children's language mistakes, nor is there evidence for differential parental reinforcement of grammatical versus ungrammatical utterances. Third, children are regularly observed to be either unable or unwilling to correct their grammar even in response to repeated parental attempts
- Imitation: partly true, but cannot be the whole story because children make characteristic errors that they never hear from adults, for example overgeneralizations ('goed', 'sheeps'), and -Wh errors ('what do you think what the pigs eat?')
- Motherese: adults do talk differently to children, using shorter sentences, mumbling less, and using exaggerated intonation. However, experiences where parents are randomly assigned to use or not to use motherese show no real difference in language acquisition. Furthermore, simplifying linguistic input actually makes it more difficult, rather than less, to disambiguate between different possible grammars and meanings

2.1 Phonology and Morphology

Difference between Phonology and Phonetics

- "When we turn to the characteristics of the English sound system that make it specifically English, and different from French or Welsh or Quechua, we move into the domain of phonology, which is the language-specific selection and organisation of sounds to signal meanings"
- "Phonetics supplies an embarrassment of riches, providing much more information than speakers seem to use or need: all those speakers, and every utterance different! Phonology, on the other hand, involves a reduction to the essential information, to what speakers and hearers think they are saying and hearing"

- "It's not just that I say tomahto and you say tomayto; it's that I say tomahto and tomahto and tomahto, and the three utterances are subtly different, but we both think I said the same thing three times"
- " 'I know of no physiological reason why a Yankee should talk through his nose, unless he got in the habit of shutting his mouth to keep out the cold fogs and drizzling north-easters of Massachusetts Bay'"

The Parsing Problem

- Speech is dynamic, continuous, transient, variable and ambiguous
- How can we even tell where one word ends and another begins? No obvious patterns in raw soundwaves
- Transitional probabilities - use probability of transition from one sound or word to another to make estimates of relative likelihoods of what the person is saying
- Adjacent transitional probabilities in continuous speech help parse speech; probability: 'pre'-'ty' > 'ty' -'bay'

Infant Research Methods

- Non-nutritive sucking
- Conditioned head turn
- Habituation and preferential looking
- Orienting reflex

Articulatory Phonetics

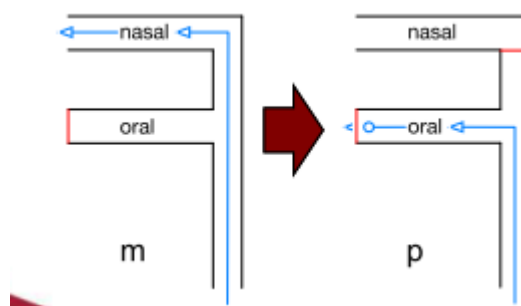
- Phonetics is the study of how the sounds of speech are produced and perceived
- This involves detailed study of how speech sounds are produced using the articulators: the jaw, vocal folds, lips, and tongue

Production of Speech

- Stage 1: exhalation of compressed air from the lungs; provides power for speech; pressure regulation controls volume of speech
- Stage 2: air is pushed through vocal tract to produce sound, with the larynx vibrating in particular ways so as to produce greater or lesser voicing
- Stage 3: movement of tongue, lips, teeth, and mouth is used to alter the nature of the sounds to produce specific vowels and consonants

Epenthetic Stops

- In many languages, an epenthetic stop can occur within nasal-fricative clusters and other sound clusters that involve rapid sequential closing of the nasal cavity and opening of the oral cavity
- In the transition period, airflow is disrupted, this producing a 'stop'
- An example of this is the 'p' in 'warmth', or the 't' in 'fence'



Voicing

- A voiced sound is one in which the vocal cords vibrate, and a voiceless sound is one in which they do not
- Voiced sounds require moderate airflow – not too fast or too slow
- Voiceless sounds can be produced with a wider range of airspeeds (it is harder to maintain a z than a long s)

Assimilation

- Two sounds close together in a word becoming closer together in terms of pronunciation, making life easier for the speaker by reducing vocal tract gymnastics
- Voicing assimilation: voiced (e.g. [d]) or voiceless (e.g. [t]) sounds may cause adjacent sounds to match in voicing
- Coarticulation: two adjacent consonant sounds constrain/modify one another in a particular way

2.2 Syntax

What is Syntax?

- When we talk about rules, we do intend nothing like the rules you can find in grammar books. They are prescriptive rules formalized in accordance with stylistic principles or conventions
- We are interested in the mental rules represented inside the mind of a (potentially illiterate) speaker, who can immediately distinguish (1) the boy swims from (2) the swims boy

Recursion

- The ability of language to generate a potentially limitless number of utterances is the result of the possibility of recursion
- All known languages have the ability to use recursion
- Example: 'Bill is sure that [Mary knows that [Joe thinks that [the boy swims]]]'

Principles and Parameters

- This is a framework within generative linguistics in which the syntax of a natural language is described in accordance with general principles (i.e. abstract rules or grammars) and specific parameters (i.e. markers, switches) that for particular languages are either turned on or off
- For example, the position of heads in phrases is determined by a parameter. Whether a language is head-initial or head-final is regarded as a parameter which is either on or off for particular languages (i.e. English is head-initial, whereas Japanese is head-final)
- The thought is that the immense diversity of human language masks an underlying sameness, in a similar way in which the enormous diversity of chemistry masks the fact that all compounds are comprised of only a few dozen elements
- Thus, it is argued that the principles and parameters approach to human language may provide equivalent explanatory power and insight in linguistics as the periodic table did for chemistry

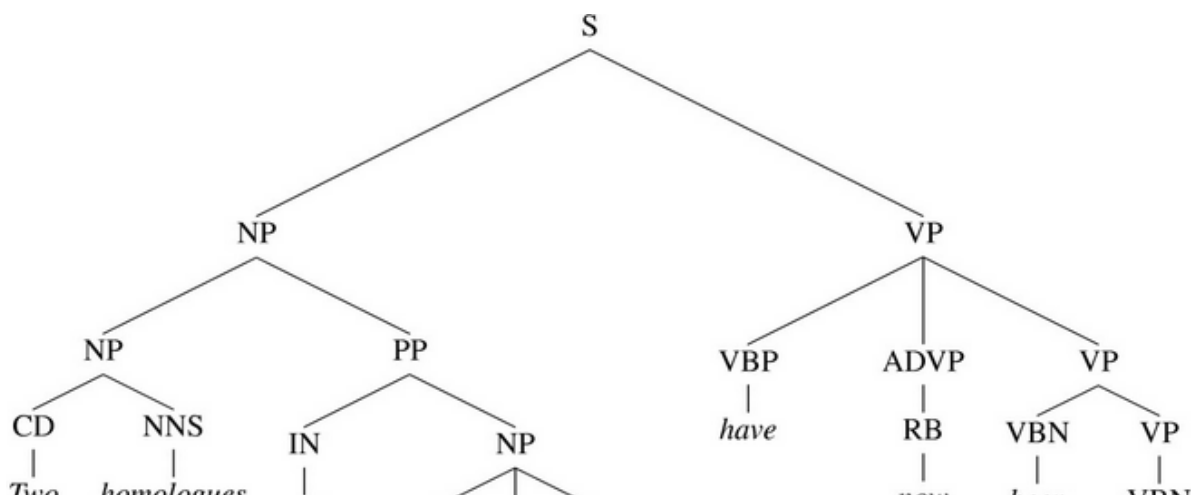
- Also has the ability to explain convergent development of similar language phenomena in different parts of the world
- Within this framework, the goal of linguistics is to identify all of the principles and parameters that are universal to human language (called Universal Grammar)
- Kayne and Rizzi have argued that the 'Principles and Parameters' approach is capable of explaining the reasons for particular patterns of change in the Romance languages as they diverged from Latin (for example, the parameter 'does a sentence require an object')
- Parameters help children to learn language because it constrains their search space - they don't need to learn the principles, just the values of the parameters

i-Language and e-language

- I-Language is human cognitive ability. When we talk about Language, we are talking about a set of rules that governs all the languages of the world
- I-Language is taken to be the object of study in linguistic theory; it is the mentally represented linguistic knowledge that a native speaker of a language has, and is therefore a mental object — from this perspective, most of theoretical linguistics is a branch of psychology
- E-Language encompasses all other notions of what a language is, for example that it is a body of knowledge or behavioural habits shared by a community. Thus, E-Language is not itself a coherent concept

Syntactic Trees

- A sentence is not an unorganized string of words. Part of Speech labels are organized into bigger units, called constituents
- The single words are grouped together to form bigger sub-units (P stands for Phrase)
- Many linguistic phenomena can be explained through structural relations based on the internal organization of the sentence in hierarchically organized constituents
- Consider for example these two sentences:
 - (1)The dad i of John shaves himself i
 - (2)The dad *i of John shaves him *i
- In (1) the pronoun himself cannot refer to John, while in (2) him can instead refer to John. We can explain this by reference to the different structural roles of the words in the two sentences
- An important aspect of phrase structure rules is that they view sentence structure from the top down. The category on the left of the arrow is a greater constituent and the immediate constituents to the right of the arrow are lesser constituents. Constituents are successively broken down into their parts as one moves down a list of phrase structure rules for a given sentence



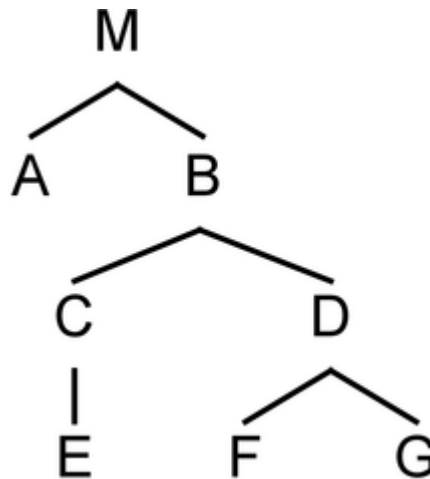
Constituency Tests

- There are several tests that can be used to reveal the internal organization of the sentences into smaller constituents
- Replacement: replace the test constituent with the appropriate pro-form (e.g. pronoun). Substitution normally involves using a definite pro-form like it, he, there, here, etc. in place of a phrase or a clause. If such a change yields a grammatical sentence where the general structure has not been altered, then the test sequence is a constituent
- Example:
 - I don't know the man who is sleeping in the car.
 - *I don't know him who is sleeping in the car. (ungrammatical)
 - I don't know him.
 - The ungrammaticality of the first version and the grammaticality of the second one demonstrates that the whole sequence, the man who is sleeping in the car, and not just the man is a constituent functioning as a unit.
- Fragments: refers to the ability of a sequence of words to stand alone as a reply to a question
- Displacement (clefting): add 'it was/is' and see if the result is grammatical, e.g. 'She bought a pair of gloves with silk embroidery' can be converted to 'It was a pair of gloves with silk embroidery that she bought'
- Topicalisation: move the test sentence to the front of the sentence as a topic, such as, 'he is going to attend another course to improve his English' becomes 'to improve his English, he is going to attend another course'

Domination and C-Command

- Node N1 dominates node N2 if N1 is above N2 in the tree (it is a parent, grandparent, etc.) and one can trace a path from N1 to N2 moving only downwards in the tree (never upwards)
- In syntax, c-command (constituent command) is a relationship between the nodes of parse trees. Loosely speaking, a node C-commands all 'sibling nodes and their children'
- Based upon this definition of dominance, node A c-commands node B if and only if:
 - A does not dominate B,
 - B does not dominate A, and
 - The first branching node that dominates A also dominates B
- If node A c-commands node B, and B also c-commands A, it can be said that node A symmetrically c-commands its sister node B
- In this example:
- M does not c-command any node because it dominates all other nodes.

- A c-commands B, C, D, E, F, and G.
- B c-commands A.
- C c-commands D, F, and G.
- D c-commands C and E.
- E c-commands D, F, and G.
- F c-commands G.
- G c-commands F.



Generative Grammar

- Generative grammar is a broad methodological approach or research paradigm, not a specific proposal or model
- A generative grammar of a language attempts to give a set of rules that will correctly predict which combinations of words will form grammatical sentences
- There are a number of competing versions of generative grammar currently practiced within linguistics. Chomsky's current theory is known as the Minimalist program. Other prominent theories include or have included dependency grammar, head-driven phrase structure grammar, lexical functional grammar, categorial grammar, relational grammar, link grammar, and tree-adjoining grammar
- The rules of a generative grammar typically function as an algorithm to predict grammaticality as a discrete (yes-or-no) result
- Three pillars of generative tradition:
 - Generative grammars of formal languages are models of the grammars of natural languages
 - Natural languages are realised in human minds as cognitive systems
 - These idealised models are distinct from the directly observable human linguistic behaviour they attempt to explain (competence/performance distinction)

Transformational Grammar

- A type of grammar which describes a language in terms of transformations applied to an underlying logical deep structure in order to generate the surface structure of sentences which can actually occur
- Following the publication of Noam Chomsky's book *Syntactic Structures* in 1957, transformational grammar (also known as transformational-generative grammar) dominated the field of linguistics for the next three decades

Minimalist Program

- In linguistics, the minimalist program (MP) is a major line of inquiry that has been developing inside generative grammar since the early 1990s, starting with a 1993 paper by Noam Chomsky

- MP works on the assumption that universal grammar constitutes a perfect design in the sense that it contains only what is necessary to meet our conceptual and physical (phonological) needs
- The MP aims to get to know how much of the principles and parameters model can be taken as a result of this hypothetical optimal and computationally efficient design of the human language faculty
- The MP aims at the further development of ideas involving economy of derivation and economy of representation, which had started to become significant in the early 1990s
- Economy of derivation is a principle stating that movements (i.e. transformations) only occur in order to match interpretable features with uninterpretable features. An example of an interpretable feature is the plural inflection on regular English nouns, e.g. *dogs*. The word *dogs* can only be used to refer to several dogs, not a single dog, and so this inflection contributes to meaning, making it *interpretable*. This information is only interpretable once a relationship is formed between the subject and the verb, so movement of the subject is required
- Economy of representation is the principle that grammatical structures must exist for a purpose, i.e. the structure of a sentence should be no larger or more complex than required to satisfy constraints on grammaticality, which are equivalent to constraints on the mapping between the conceptual/intensional and sensori-motor interfaces in the optimal system that minimalism seeks to explore

Subject-Auxiliary inversion

- In order to mark a question, the subject and the auxiliary are inverted: the auxiliary moves from its base position to a sentence-initial position
- From studies we know that no children produce yes/no questions by moving the leftmost auxiliary
- Furthermore, children never hypothesize transformational rules based merely on linear order of the words in a sentence
- That is, there are particular patterns to the syntactic rules that children apply when learning language

2.3 Semantics and Pragmatics

Semantics

- Semantic competence is the dual product of an understanding of word meanings, and possession of the necessary algorithm about how to combine these meanings in accordance with the syntactic structure of a particular utterance
- Although it is clear that syntax must be relevant to semantics, and that semantic understanding must be built out of finite
- Generative semantics: an attempt to build up the semantic meaning of complex words from a combination of much simpler concepts. For example kill = 'cause become not alive'
- Flimp: a word that could not exist according to McCawley
- An important component of knowing what a phrase 'means' is knowing what objects or properties 'out there' in 'the world' the phrase refers to. This is the property of 'aboutness'

- This sort of knowledge cannot merely be the produce of memorising correspondances, as there are far too many possibilities, and far too many variations in the manner in which they can presented
- This isn't even strictly an issue of visualising the matter - there are many situations we can understand but not easily draw a picture of, for instance 'Joan ate a tomato sandwich yesterday but not today'
- Semantic theories of informational significance are often called referential theories

Syntactic bootstrapping

- A theory that proposes that verbs, presented in their syntactic frames, provide a source of information about their meaning
- When children are presented with a sentence that includes an unfamiliar verb, they look to extralinguistic context clues to help them in determining what the definition of that verb is
- According to Gleitman's definition of syntactic bootstrapping coined in 1990, verbs are learned with a delay because the linguistic information that supports their acquisition is not available during the early stages of language acquisition

Focus particles in child language

- Younger children have trouble with focus particles, such as in the phrase 'only the little pig has a silver medal', which tends to be interpreted as 'the little pig only has the silver medal'
- This indicates that children have not yet attained adult-level understanding of this level of grammar
- We find that they begin to give adult-like responses around the age of 6 or 7

Difference between Semantics and Pragmatics

- Pragmatics refers to the "situated uses of language"
- There are some differences between the Anglo-American notion of pragmatics, which is a component view according to which pragmatics is just another step above semantics in the heirarchy of linguistic analysis, and the continental tradition, which holds that pragmatics is something more holistic and all-encompassing (the perspective view)

Semantic Universals

- Generally difficult to find any sementic universals, though there are some exceptions
- "We do not know of any langauges that lack a word that is more or less synonymous with and"
- "No langauge we know of expresses the comparative notion as a single morpheme and the absulte in a more complex way"
- "Agent, cause, change, goal, and source have been among the thematic roles proposed to link verb meanings with their arguments cross-culturally"
- "In language after language the words and constructions used to speak about space and saptial relations are recylced to speak of more abstract domains, for example possession"

Typology of Noun Phrases

- Anaphors: get their meaning from local context (e.g. the composers admire each other)
- Pronouns: get their meaning from a previous phrase (e.g. he walked over to the door)
- Names: meaning is self-contained to the word

Linguistic Underdeterminacy

- The substantial gap that exists between the meaning of a sentence and the messages actually conveyed by the uttering of that sentence

Some Basic Concepts

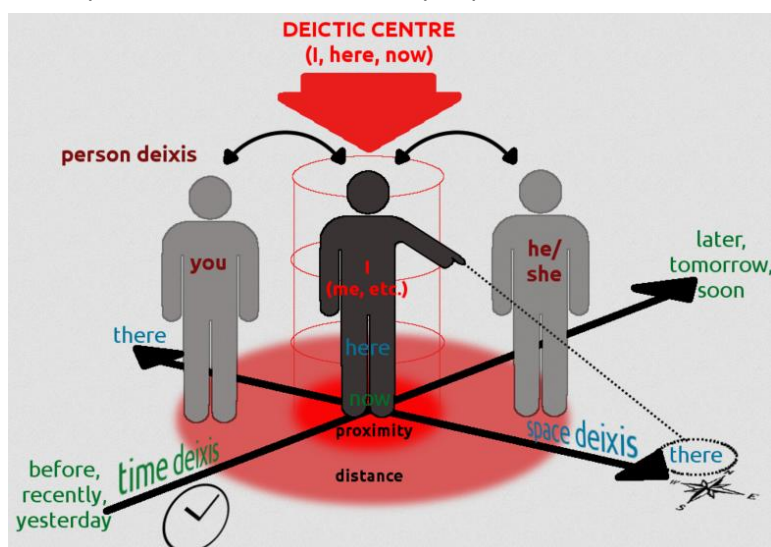
- Sentence: a well-formed string of words obeying the syntax of that language
- Utterance: a particular piece of language used by a particular person on a particular occasion. A single sentence can be instantiated in many specific utterances
- Proposition: an abstract notion which makes a true or false statement about some state of affairs. Many different sentences (as well as questions) can convey the same proposition

Types of Context

- The 'context' that pragmatics engages with can be split into two different general categories:
- Linguistic Context: The words and sentences which precede a particular word or sentence.
 - Example: 'John kicked himself', versus 'John shook Mark's hand, then punched him'
- Situational Context: All other non-linguistic factors, which provide a significant contribution to the linguistic meaning
 - Example: Sentence 'How cold is the water?'
 - Context: Speaker on the shore, hearer in the water
 - – What is the water temperature like?
 - Context: Speaker and hearer both in the water
 - – The water is really cold, isn't it?
- Linguistic context can also be used to disambiguate words which have different meanings, but have the same sound and/or spelling
 - Example: 'the boat ran into the bank' versus 'the thief ran into the bank'
- Common ground: background assumptions and knowledge shared by speaker and listener necessary for communication to take place. It comprises the collection of "mutual knowledge, mutual beliefs, and mutual assumptions" that is essential for communication between two people. Successful grounding in communication requires parties "to coordinate both the content and process"

Deixis

- Words and phrases that cannot be fully understood without additional contextual information. Words are deictic if their semantic meaning is fixed but their denotational meaning varies depending on time and/or place
- The terms deixis and indexicality are frequently used almost interchangeably, and both deal with essentially the same idea: contextually dependent references



Conversational Maxims

- Rules of conversation which participants adhere to unless they are being deliberately uncooperative
- H.P. Grice identified 4 different maxims of conversation:
 - Quantity: Say neither more nor less than the discourse requires
 - Quality: Do not lie; do not make unsupported claims
 - Relevance: Be relevant
 - Manner: Be brief and orderly; avoid ambiguity and obscurity
- Inferences
 - Inferences are elements of sentence meaning which are additional to its literal content
 - Implicatures are 'implied meanings', which are derived from a sentence's literal meaning, combined with the presumption that other speakers are obeying the conversational maxims
 - Presupposition Projection: The meaning of the presupposition (but not the assertion) remains unchanged (projects through) a number of different linguistic contexts
 - Example: 'John stopped smoking', 'John hasn't stopped smoking', 'has John stopped smoking?' all presuppose that John used to smoke

Speech acts

- Locutionary act: The actual performance of the utterance.
E.g. Saying "Can you pass the salt"
- Illocutionary act: The underlying purpose behind the speech act. I.e. Requesting someone to pass the salt
- Perlocutionary act: The effect of the speech act. E.g. The speaker persuaded the hearer to pass the salt

3.1 Developmental Language Disorders

Language Difficulties in Autism

- Autism was once thought to be a severe form of language impairment
- The diagnosis was progressively shifted away from focusing on language, and the most recent DSM-V has removed all references to language deficits for the autism diagnosis

Specific Language Impairment

- Specific language impairment (SLI) is diagnosed when a child's language does not develop normally and the difficulties cannot be accounted for by generally slow development, physical abnormality of the speech apparatus, acquired brain damage or hearing loss
- Children with SLI begin to talk later than typically developing (TD) children, and have a lower mean length of utterance (MLU) than TD children of the same age
- Difficulties in phonology: receptive; difficulty understanding words, reduced vocabulary and expressive; word finding difficulties

- Difficulties in morphology: Receptive; difficulty understanding grammatical word endings and expressive; omission of grammatical word endings
- Difficulties in syntax: Receptive; difficulty understanding directions and questions and expressive; difficulty using correct word order, omission or substitution of articles, pronouns
- The proportion of individuals within a population that have SLI is approximately 8%

Autism and SLI

- Some children with autism have similar language profiles to those with SLI, but many with autism spectrum disorders have little or no language deficit
- Furthermore, children with autism show different error patterns to those with SLI
- It is clear from twins studies that there is an overlapping genetic basis of autism and SLI

Weak Central Coherence

- The weak central coherence theory (WCC) suggests that a specific perceptual-cognitive style, loosely described as a limited ability to understand context or to "see the big picture", underlies the central disturbance in autism and related autism spectrum disorders
- The weak central coherence theory attempts to explain how some people diagnosed with autism can show remarkable ability in subjects like mathematics and engineering, yet have trouble with language skills and tend to live in an isolated social world
- "Children with autism show a reduced advantage for remembering meaningful compared to meaningless sentences"
- "Reading skill is acquired quickly, but the children read monotonously and a story... is experienced in unrelated portions rather than its coherent totality"
- "It may be difficult for autistic children to integrate semantic information derived from single words with their knowledge of the world, derived from previous experience"

Neural Correlates of Language Difficulties

- Research on the neural correlates of language impairment in autism is in its infancy
- Reduced left temporal lobe response to speech-like sounds in children and adults with autism
- Reversed lateralization of brain response to speech in infants later diagnosed with autism
- Reversed structural asymmetry of Broca's area and Wernicke's area in ASD
- Reversed lateralization of Broca's area volume is related to language impairment rather than autism
- Language difficulties in autism are related to reduced integrity of the arcuate fasciculus
- We know almost nothing about the neural basis of language impairment in the most severely affected people with autism

William's Syndrome

- Perhaps the most noted, albeit relatively little systematically investigated aspect of the WS behavioral profile is "sociability", a hallmark feature described as involving indiscriminate friendliness, enhanced empathy, and loquaciousness and socially engaging language
- "Moreover, the noted gregariousness is often extended toward people who are judged by most other people as unapproachable"
- "Despite an overall level of intellectual functioning within the mild to moderate mental retardation range, individuals with WS appear to have relative proficiency in linguistic skills"

- "Overall, notwithstanding the disagreements regarding the degree of impairment of the morphosyntactic aspects of language, which are beyond the scope of this article, it appears that linguistic skills are relative strengths in the WS cognitive profile, standing out in stark contrast to their overall intellectual disability and profound impairments in nonverbal, visuospatial cognitive functioning"
- "Using the same ERP paradigm and stimuli as in Fishman et al., we predicted that, in individuals with WS, a larger N400 effect, as an electrophysiological index of language processing, would be positively correlated with the extent of their hypersociability"
- "In support of this hypothesis, the results revealed a significant and sizeable correlation between a brain index of language processing, as measured by the N400 component of the ERPs, and approachability ratings in individuals with WS, but not in TD (typically developing) controls"
- "The mechanism through which language and sociability may be linked is a subject of an ongoing debate. Given that current theories postulate that, in SLI, these domains are linked via theory of mind mechanisms, future investigations in WS should employ measures compatible with theory of mind"

3.2 Disorders of Speech Production

What is Aphasia?

- A disturbance of the comprehension and formulation of language caused by dysfunction in specific brain regions
- Deficits are usually found in speaking, reading, writing, repetition of words, and comprehension
- Different people have different degrees of difficulty with different combinations of tasks
- Common specific impairments are anomia (inability to produce a particular word), agrammatism (inability to produce syntactically correct utterances), and difficulty in planning and coordinating muscle movements related to speech (apraxia of speech)

Causes of Aphasia

- Stroke: cerebro-vascular accident, cerebral haemorrhage
- Traumatic brain injury, brain tumours (and surgery to remove tumours)
- Brain infections: encephalitis, meningitis
- Temporarily during some migraines.
- Progressive brain diseases (dementias, e.g. Alzheimer's disease)

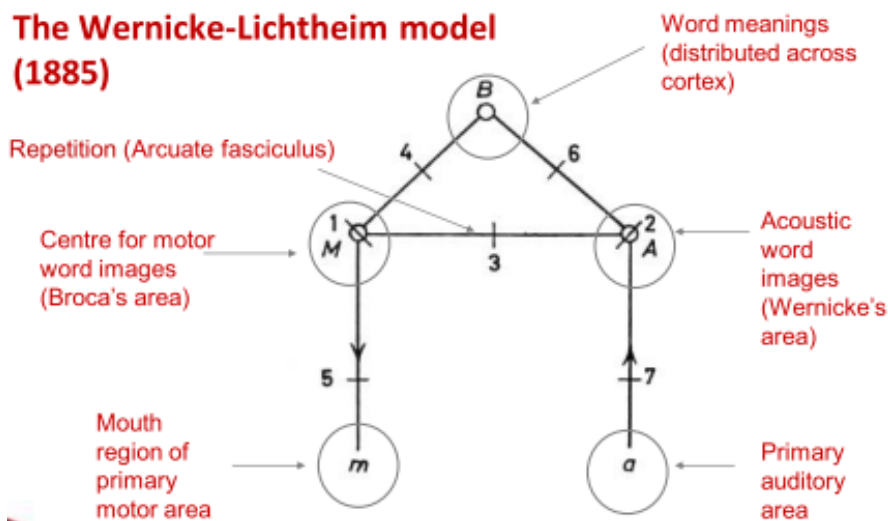
Types of Aphasia

- Fluent/non-fluent: non-fluent aphasics have hesitant speech patterns, with many breaks and pauses. Speech is slow and lacks in melody and articulatory dexterity. Fluent aphasics are able to produce regular flow and melodies of speech, though not necessarily with meaningful content
- Anomic aphasia: difficulty naming objects and accessing words for common things
- Semantic paraphasia: a speaker incorrectly produces a word related to the target word (table for chair)

- Phonemic paraphasia: a speaker has difficulty producing the correct sounds for words (e.g. says pat instead of cat)
- Agrammatism: disorders in the use of syntax, omitting words like articles, conjunctions, prepositions
- Repetition impairments: difficulty repeating the speech of others (useful for diagnostic purposes)
- Many clinicians today prefer not to use specific aphasia diagnostics, but rather simply explain the specific pattern of deficits exhibited by a particular patient

Wernicke-Lichtheim Model of Aphasia

- Originally developed in the late 19th century as a method of synthesising neuropsychological findings of Broca, Wernicke, and other researchers
- Now generally considered to be linguistically and anatomically underspecified
- Dronkers (1996): of 22 patients with lesions in Broca's area, only 10 had Broca's aphasia; all patients with Broca's aphasia had damaged insulae
- Penfield & Roberts (1959): surgical excision of classic language areas do not have permanent effects; stimulation of regions outside these areas produced speech disturbance.
- Also, very few 'pure' cases exist. Almost all aphasic patients have some deficits across all the different categories
- This points toward the fact that brain processing of language is complex and highly distributed in its representation



Recovery from Aphasia

- Perilesional restitution: using areas around the damaged area (neuroplasticity)
- Transfer of functions to homologous right hemisphere regions
- Compensatory mechanisms whereby the individual employs an alternative strategy and neural network

Sensorimotor Integration

- Speaking is an extremely complex motor act
- It requires precise co-ordination of between 70 and 100 muscles that span the respiratory, laryngeal, and vocal tracts

- Speech is extremely rapid: more than fifteen sounds per second can be produced by an adult in conversation
- Feedback from the ears and the vocal tract is essential in maintaining accuracy
- Disruption to any of the stages in this processing feedback stream can lead to various forms of speech difficulties

Stuttering

- A speech disorder in which the flow of speech is disrupted by involuntary repetitions and prolongations of sounds, syllables, words or phrases as well as involuntary silent pauses or blocks in which the person who stutters is unable to produce sounds
- Contrary to what was long thought, stuttering is generally not a problem with the physical production of speech sounds by the tongue or larynx - it is a problem in the brain
- "Previous functional brain imaging studies have shown that stuttering is associated with abnormally low function of left hemispheric speech areas compared with analogous areas of the right hemisphere. An interesting clinical finding, which is often used by neuroimagers to investigate stuttering, is that fluency can be induced through a variety of techniques such as chorus reading. During induced fluency, the activity of left hemispheric speech areas is increased to levels comparable with normal controls"
- "The low function of the left hemisphere may be related to abnormally high inhibition by dopamine. Stuttering shares many similarities with Tourette's syndrome, a disorder of known dopamine abnormality. Both disorders have their onset in childhood, follow a waxing and waning course, present with tics, and respond, at least partially, to treatment with dopamine antagonists"

4.1 Bilingualism

Why we Study Bilingualism?

- Bilingualism is the norm in many parts of the world
- To see if adults have the same linguistic capacity as children
- SLA research may have practical benefits for the language classroom, such as improved teaching methods
- To see if the bilingual brain is different from the monolingual brain (e.g. cognitive benefits)

Important Clarifications

- Learning vs. Acquisition: learning refers to formal, explicit learning of rules, whereas acquisition is merely the development of a grammatical and lexical system. Second languages are often merely acquired rather than learned explicitly, specially by children
- Competence vs. Performance: competence refers to a person's underlying, ultimately unobservable linguistic knowledge, whereas performance refers to the use of language in a particular situation. Linguists are generally more interested in competence than performance
- Receptive vs. productive: the difference here is between those who understand a language – either spoken or written – but cannot produce it themselves, and those who can do both. A receptive competence only has been referred to as semibilingualism

- Additive vs. subtractive: Additive bilingualism generally occurs where both languages continue to be useful and valued; a classic example is found in the bilingualism of aristocracies in systems in which it was considered natural and proper that every educated person know more than one variety. Subtractive bilingualism, on the other hand, often implies a society in which one language is valued more than the other, where one dominates the other, where one is on the ascendant and the other is waning
- "Generally speaking, earlier definitions tended to restrict bilingualism to equal mastery of two languages, while later ones have allowed much greater variation in competence. Most modern treatments acknowledge that any meaningful discussion must be attempted within a specific context, and for specific purposes"
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Adult Second Language Acquisition

- Unlike children, adults do not learn an L2 with an empty slate; they come with a fully developed cognitive system, an existing language (L1), prior experience with explicit learning
- Many adults learn formally, in a classroom, and at first, adults learn more quickly than children. However, many adults do not have an "immersion" experience
- In the long run however, children are better L2 learners than adults. Adults can almost never learn an L2 without an accent
- Outcomes of adult SLA are highly variable; adults don't show the rapidity, universality and uniformity that is characteristic of L1 acquisition.
- "In the process of becoming bilingual, native aptitude, age and intelligence are less important than a supportive context of necessity... given sufficient motivation and opportunity, all normally intelligent people can learn another language; those who claim they are no good at foreign languages are usually lacking in one or both of these"
- "Most historical changes in language use have a bilingual component, and most owe much more to socioeconomic and political exigencies than they do to attitude. The adoption of English by the Irish population, for example, was not accompanied – for the masses – by favorable attitudes, much less integrative ones"

Child Second Language Acquisition

- The critical period hypothesis states that the first few years of life is the crucial time in which an individual can acquire a first language if presented with adequate stimuli. If language input doesn't occur until after this time, the individual will never achieve a full command of language—especially grammatical systems
- Ages may be different for different linguistic modules (e.g. phonology, syntax, etc)
- Child L2 learners exhibit a different developmental path in their L2 (compared to L1 learners of the same language), thought to be the result of use of pre-existing cognitive and linguistic resources
- This indicates that differences between L1 and adult SLA may be better explained by bilingualism effects rather than age effect

Bilingualism and Intelligence

- Generally speaking, early studies tended to associate bilingualism with lowered intelligence, and it is unsurprising that many of them were conducted, in America, at a time of great concern with the flood of immigrants from Europe

- Later research tended to show essentially no relationship between intelligence and bilingualism, and this work was generally more carefully done than the earlier studies. Controlling sex, age and social-class differences became common procedure, and the lack of such control was increasingly seen to have produced the negative associations found in previous work
- What some have seen as a turning-point came in the early 1960s, when findings showing a positive relationship between intelligence and bilingualism began to appear
- Many methodological difficulties, however, mean that strong conclusions about bilingualism and cognition are not warranted. Some feel that there may be some link between the two, but that any cognitive advantages attaching to bilingualism are rather slight. Others have been mainly concerned to show that there is not a cognitive price to be paid for bilingualism
- As McLaughlin noted: “almost no general statements are warranted by research on the effects of bilingualism . . . in almost every case, the findings of research are either contradicted by other research or can be questioned on methodological grounds”

Borrowing and Code-Switching

- Code-switching - flipping between languages mid-conversation or even mid-sentence
- Speakers may often switch for emphasis, because they feel that the mot juste is found more readily in one of their languages than in another, or because of their perceptions of the speech situation, changes in content, the linguistic skills of their interlocutors, degrees of intimacy and so on
- It is interesting, in all of this, to recognize that attitudes towards code switching are often negative, particularly on the part of monolinguals who are sometimes inclined to dismiss it as gibberish
- There are important differences between individual bilingualism and collective or social bilingualism, regardless of whether or not the latter is officially endorsed. Collective bilingualism in many settings, ancient and modern, is an enduring quantity, unlike the impermanent, transitional variety common in many immigrant contexts in which, in fact, bilingualism is a generational way station on the road between two unilingualisms

4.2 Computational Linguistics

Natural Language Processing

- Natural language processing uses computers to do useful things with human language data
- Examples include automatic speech recognition systems, information extraction from large document collections, and “machine translation” from one human language to another
- Computers are also useful for certain kinds of linguistic analysis just as they are useful for many areas of science; this is not what we mean by computational linguistics!

Computational Linguistics

- Computational linguistics studies human language as a computational system
- A computational system is one which manipulates meaning-bearing symbols in ways which respect the meaning of those symbols
- Human language uses meaning-bearing symbols (i.e., morphemes, words)

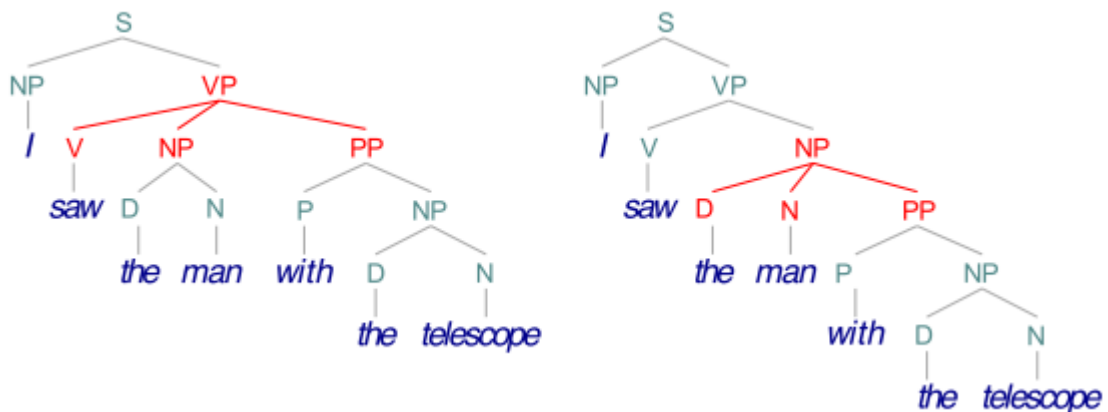
- Language comprehension maps acoustic or visual input into semantic/pragmatic representations
- Language production maps semantic/pragmatic representations into articulatory gestures
- Language acquisition maps primary linguistic data into a lexicon and grammar
- Computational linguists study human language by devising computational models of linguistic processes. These may be implemented on a computer, or may be formal (mathematical) models
- Computational models can be used to study the steps involved in performing a linguistic process, the information that the linguistic process requires, and the complexity of these linguistic processes

Context-Free Grammars

- Context-Free Grammars (CFGs) are the simplest formal model of compositional syntax
- We know that natural language is not context-free (there are more complex models, such as Chomsky's transformational grammar), but most more realistic models are elaborations of CFG models
- The job of a CFG is generally to parse a sentence - to construct a syntactic tree
- Even though a CFG only contains finitely many rules, it can generate infinitely many trees ; language makes "infinite use of finite means" (von Humbolt)
- Many sentences have multiple phrase structure analyses, each of which corresponds to a possible semantic interpretation
- Ambiguities combine multiplicatively, leading to a exponential explosion in the number of parses - thus parsing is a computationally challenging problem!

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- Human processing seems to be very sensitive to distributional properties of words and constructions, such as their frequency
- Probabilistic models can do this by associating every structure with a number called its probability, which indicates how likely the structure is to occur
- A Probabilistic Context-Free Grammar is a CFG where: rules have probabilities and the probability of a tree is the product of the probability of the rules that generated it
- Surprisal, is the probability of the next word given the preceding words, according to a particular probabilistic parsing; it turns out that the surprisal is a good predictor of reading times