

## The hierarchical structure of human language

The language hierarchy

## What is a hierarchy?

- In a hierarchy:
  - Elements at one level are combined to construct elements at the next level up --> a causal or constructive relationship
  - Elements at one level 'choose' or constrain elements at the lower level --> a regulatory (or 'grammatical', in the philosophical sense) relationship
    - We say 'low levels allow upper levels, but upper levels rule lower levels'
  - Low level elements are necessarily smaller (and/or faster) than higher level units
  - Language is roughly, but not perfectly, hierarchical in its structure

The language hierarchy

## 6 levels in the language hierarchy

- i.) Phonology: Elementary sounds
- ii.) Morphology: Elementary letter/sound combinations
- iii.) Lexical: Individual words
- iv.) Syntax: Word combinations
- v.) Semantics: Meaning
- vi.) Pragmatics: Behavioural constraints on language use

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## Why hierarchical?

- For example, syntax specifies how words can be combined (it rules over words), and it cannot operate without those words (words enable syntax)
- As another example, what we use syntax for is constrained by what we wish to say = semantics rules over syntax
  - though this is not strictly true, since syntax *can* operate independently of semantics (but rarely does)
  - i.e. Chomsky: 'Colorless green ideas sleep furiously'

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## What is 'a constraint'?

- Each level of language is constrained in many ways of which four are of main interest for our purposes:
  - Rules
  - Physiological limitations
  - Statistical regularities
  - Contextual cues

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## Rule-based constraints

- In some cases we may want to think of these constraints as 'rules': formally specifiable mappings from one entity to another
- For example, there is good reasons to think of syntax in this way, since syntax has regularities which can be filled with variable values

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## Physiological constraints

- In other cases we might prefer to think of constraints as specified by physiological or neurological limitations
- For example, the structure of the human mouth cavity and tongue makes certain phonological combinations impossible for us to produce

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## Statistical constraints

- In yet other cases, constraints might be most usefully thought of as 'statistical regularities'
- For example, we will see that very frequent words are easier to access than less frequent words
- Word frequency is just a statistical fact about the world, not a rule-governed process.

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## Contextual constraints

- Context can serve to change the way a thing is interpreted, thereby reducing ambiguity or altering the significance of an otherwise unambiguous cue
  - The meaning or purpose of one linguistic element might be one thing in one context and another thing in another context
  - Many elements at one level of the hierarchy (as well as external elements) can constrain how other levels are interpreted or processed

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## Are these constraints independent?

- These are neither necessarily nor actually independent
  - For example, memory limitations (= physiological constraint) make some kinds of sentences impossible, and may seem therefore like 'rules'
  - Moreover, rules may be implemented as statistical regularities, as when a neural network plays a game like tic-tac-toe
  - Indeed, rules themselves may be 'illusions': short-hand summaries of activity that might be more precisely explained in terms of physiology and probability
    - As shown in the history and current state of phonology

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## Is language really hierarchical?

- Language really isn't a pure hierarchy
  - For example
    - There is all sorts of questions about the relationship between morphology and syntax
    - Phonology can impinge on syntactical analysis and on semantics
      - As in 'Oh yeah, I *really* love statistics'
- And there are many other 'impurities' to the hierarchy that we will see

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## Phonology

- Spoken Language is made up of many distinguishable sounds, called phonemes
- How are phonemes within a language defined?
  - By contrast: any two phonemes are experienced as different sounds by native speakers of that language
    - For example, 'bat' and 'pat' differ by just one phoneme
- Phonemes, in turn, are composed of lower-level distinctive features
  - Different combinations of discernibly-different features make different phonemes

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## What makes 'p' into 'b'?

- For example, try saying a 'b' and 'p' sound, paying attention to the placing of your tongue and lips
  - You'll see they are almost identical
- The only difference is in a single feature, which was shown in the 1950 to be voice onset time
  - Anything with a voice-onset time < 20 ms. is a 'b'; anything with a voice onset time > 40 ms. is a 'p'
- People can't distinguish between differences within the range
- This is *categorical perception*- we perceive different sounds as identical

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## Phonology

- It seems obvious and trivial to say that a phoneme is anything that can be distinguished, but it is also not strictly true. There are two catches
  - i.) Many sounds distinguished in other languages that are not distinguished in English, and vice versa
  - ii.) Many sounds that are actually different in English are treated as if they identical (allophones: variations of the same phoneme: i.e the aspirated 'p' in 'pot' versus the unaspirated 'p' in 'spot'.)
- The difference between 'r' and 'l' does not exist in Chinese: so native Chinese speakers hear the words 'lake' and 'rake' as the same word.
- There are many phonemes that are invisible to us English-speakers too

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## Phonology

- As well as having constraints on what range of sounds we can hear and produce, there are constraints on what sounds can go together (phontactics)
  - Some are physiological and some are cultural/linguistic
  - Example: 'kt' never occurs without a vowel in front ('act') in English.

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## Phonology

- There are also regularities/rules about stress patterns and intonation (*prosody*).
  - Example: We easily tell the difference between questions and statements based entirely on prosody ("You're going?" versus "You're going.").
  - Many semantic and syntactical differences hinge on this
    - Examples: The two forms of 'conflict', 'contract', and 'exploit'
    - In some languages some words are distinguishable only by prosody

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## How many phonemes are there?

- In all languages there are about 95 consonant sounds, and 46 vowel sounds
- But no languages comes close to using all the available sounds
- English consists of about 30-40 different sounds (the precise number depends on how finely-grained you want to make the distinctions).
- Maori has the fewest, around 9

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## Morphology

- A morpheme is the smallest meaningful unit of a language (the smallest unit that carries information)
  - many words are made up of more than one morpheme, because they can take other morphemes as suffixes
  - for example, the pluralizing 's' in English is a morpheme, and so are verb endings such as 'ed' and 'ing'.

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## Morphology

- In some languages all words are made up of multiple morphemes, because they can be combined in richer ways than they can in English, often playing the role that is played by word order (at the syntactical level) in English.
  - so in English we say 'the boy pushed the girl' and the word order tells us who pushed and who received the push, but in other languages (e.g. Latin) those roles might be parked by a morphemes

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## Morphology

- Most English morphemes are suffixes, attached to the end of another morpheme (the stem), but not all
- A few languages allow infix attachment, in which the morpheme is attached inside another morpheme.
  - There is a well-known and much discussed case of this in English- *Anyone know what it is?*
  - Linguists (Mark Aranoff) have studied it and found it is quite rule-bound: the infix element can only be inserted before the stressed syllable in a word

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## What is morphology for?

- Affixes serve a huge and bewildering variety of roles, marking or changing semantic and syntactic roles in many different ways
  - ad- to, toward
  - circum- around, about
  - com- with, together
  - de- away from, off
  - dis- away, apart
  - ex- from, out
  - in- not
  - in- in, into

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## What is morphology for?

inter- between  
mis- wrong  
post- after  
re- back, again  
sub- beneath, under  
trans- across  
un- not  
ptero- indicates feather, wing or winglike part  
osteo- indicates bone or bones

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## What is morphology for?

- able/-ible)- capable of being
- ance/-ence)- the act of
- ate- making or applying
- ful- full of
- ity- the state of being
- less- without
- ly- in a certain way
- ment- the result of being
- ness- the state of being
- tion/-ion/-sion: the act of or the state of being

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## Words

- Word- whether single or multi-morphemic- are organized in particular ways in our heads.
  - For example, if I ask you to read a word aloud, you will be faster if the word you are to read is related to one you have just read: this is called priming
- Relations between words can be of various kinds: words which resembles each other prime, and so do words which are semantically-related to each other
- If I ask you to produce rhymes or words that start with a particular letter, you can do that much easier than you can produce words that contain an internal element
  - That is, you are better at producing words that start with 'th' than words that contain a 'th' inside them.

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## Words

- Much of what we think of as word meaning is contained in the relation between words
  - Although your knowledge of, say, dogs is not entirely linguistic- because you have encountered real dogs- it is likely that your knowledge of justice or Plato or East Timor probably is, because you probably know about all these things only from words.
- The lexicon is structured in various ways in your head; certain ways of moving between words are easier for us than others.
- What makes a word a word is not always obvious

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## Syntax

- Syntax is the process by which words are combined together.
- - The textbook gives a good example of its importance: having a pronouncing dictionary of a foreign language- i.e. complete access to phonology and morphological knowledge- in fact gives almost no useful information about how to say anything.
- - i.e. 'bites dog the the man'
- Huge amounts of information are contained in the word order, especially, as we have already seen, in languages that do not use morphology to tag information about what role a word plays

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## Syntax

- There are many constraints about how words can go together, but the constraints are not at the single word level but at the role level
    - a role may be played by a multiword string or a single word
    - each element that can fill a role is called a 'constituent'
- Example: NP *'The man bit the dog'*
- *'The angry man who was delivering the mail to my mother bit the dog.'*
  - We will see evidence that constituents are not just descriptions imposed on language after the fact but play a role in the way language is actually used

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## Syntax

- It was Noam Chomsky's recognition that language required some kind of internal representation that helped to launch cognitive science.
  - Chomsky's insistence on this was based on three main forces:
    - i.) Poverty of the stimulus
    - ii.) Competence versus performance distinction
    - iii.) A desire (need?) for language universals
- The hope had always been for a set of universal rules (UG) which could apply to all languages

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## Syntax

- A growing group of people believe that the rule-bound approaches will never work, and that Chomsky has taken us all on the wrong track
- The difference between an explanation and a description
  - Newton's Laws are descriptive, not explanatory, and so was early UG
- Even the faithful have backed off from their most extreme early claims, putting more and more of the power of grammar out of the UG- the rule set- and back into the lexicon,
  - Words themselves are carrying more and more weight, blurring the distinction between semantics and syntax, which Chomsky has wished to keep completely separate.
- There are also some (e.g. Elman *et al*) who are working on a much more distributed approach to capturing grammatical phenomena

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## Pragmatics

- There are additional higher-level constraints on what we can say: the constraint operating at the level of pragmatics.
  - pragmatics is what determines our word choice and our interpretation of language in different settings

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## Example: Role of relevance

- If I say "Do you want to have a beer?" the next thing you say is considered, under the rules of pragmatics, to relate to that question
  - If you reply "I'm getting too fat", this is understood not as a new topic, but as a negative answer

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## Example: Politeness

- Consider the word 'please'
  - It adds nothing to the new meaning of a phrase, but nuances its interpretation.
  - 'Pass the salt' and 'Pass the salt please' convey the same information- you want salt- but they differ in their pragmatic weight.

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## Discourse: The 7th Level

- Most linguistic interchanges do not consist of a single sentence.
- When we string multiple sentences together, there are rules about how they should relate to each other.
- Discourse is composed of iv) sentences composed of constituents composed of iii.) words composed of ii.) morphemes composed of i.) phonemes composed of features.
  - JD Salinger's 9 Stories: 'jeet jet?'
    - Because of context we can see that this is a compressed way of asking 'did you eat yet?'

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