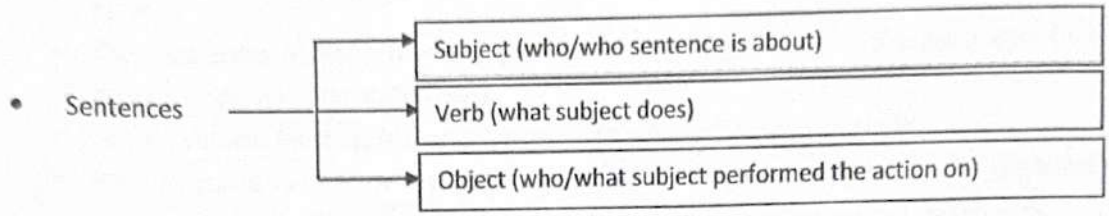
Sentence processing involves three ~~steps~~ levels:-
(1) Conceptual level → intended msg
(2) Syntactic level → structure of the sentence
(3) Phonological level → spoken sentence form

Week 6 Part I

SENTENCES

- Robin Dunbar (1998) suggests the language evolved from gossip. Language compels us to organize our thoughts into sentences which are basically tidbits of gossips.



SENTENCE STRUCTURE

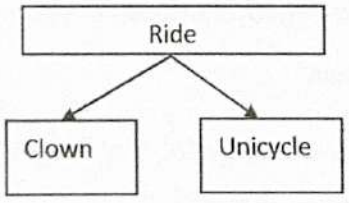
- Unlike our primate cousins (utter single words), we combine words together to express complex ideas and relationships.
- We do this by using syntax (set of rules for ordering words in a sentence).
- Language enables us to transfer thoughts among minds as spoken sentences.

Psycholinguists suggest three stages of sentence production:

1. Conceptual Level- intended message is formulated. We organize our thoughts into concepts that we have name for.
    - We search mental lexicon for words to match up to concepts (lexicon store abstract word forms or lemmas).
    - At this point there is no particular order to the concepts in our intended message.

I see a clown riding a unicycle.

Conceptual level [RIDE, CLOWN, UNICYCLE]



Intended msg → Event + Participants
[Ride, clown, unicycle]

Thematic Roles → various participants in event
Agent → Causes the event
Patient → Is acted upon in the event

Sentence - (some kind of event/state of affairs)

↕

Nature of events – (kind of participants involved in the event)

- Agent (entity that causes the event portrayed in a sentence to occur is called agent)
- Patient (entity that is acted upon is the event that is portrayed in a sentence is called patient)
- Thematic roles (various types of participants involved in an event portrayed in a sentence are called thematic roles).
- At the syntactic level the language forces us to put our thoughts in order.
- Each language has its own typical sequence of sentence elements, but the canonical word order for English is subject-verb-object. (SVO) → canonical word form.
- The mapping of thematic roles onto syntactic positions such as subject and object is called thematic role assignment.
- Referring to our earlier example
  [RIDE CLOWN UNICYCLE]
  Thematic role assignment

Proto Sentence	CLOWN	–	Subject
	RIDE	–	Verb
	UNICYCLE	–	Object

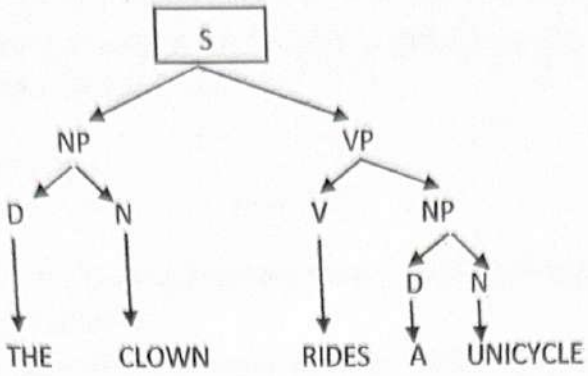
- We need to add some inflectional suffixes and function words to satisfy the rules of grammar.
  e.g.: Noun (sig/ plus), (a, an, the)
  Verb (when event occur) [Tense]
  (Verb agrees with subject in number) (Rides)
- The syntactic position subject, verb and object are phrases not words.
  Noun phrase – Subject, object, determiner, adjectives
  Verb phrase - Main verb, auxiliary verb [rides, is riding]

Auxiliary verb Main verb

Subject → Singular or Plural? Just one → So Clown
Already mentioned? → Yes, So add the
CLOWN → The clown

Verb → Present or past → Present, so ride
Subject agreement → Yes, So add S
RIDE → ride – S

Object → Singular or plural → So unicycle
Already mentioned? No, So add a
UNICYCLE → a unicycle



3rd level

- The syntactic sequence now goes to the phonological level, where it is spelled out in terms of syllables and stresses so that it can be articulated.
- Syllables separated by hyphen and stress in capital.

the – CLOWN – RIDE – Za – U – ni – cy - cle

ride-za (syllables span word boundaries)

- The sentence is spoken as a single prosodic phrase.
- Start sentence with fundamental frequency of my voice at a medium level, it rises through the course of sentence until I reach the unicycle, which I want to emphasize and after that voice falls.

SYNTACTIC STRUCTURE

- Grammar is exceedingly complex however psycholinguist use some common syntactic structure - as these structures can shed light on how sentences are processed.
- Analyzing sentence.
- The way that thematic roles at the conceptual level are mapped onto syntactic categories at the syntactic.
- Canonical word order SVO
  Subject noun phrase – verb phrase – object noun phrase.
- Sentence consists of two main components

Subject + predicate

Topic of sentence comment about subject

- Active voice is a sentence structure in which the agent is mapped onto the subject position.

Active → Agent maps onto Subject

Passive → Patient maps onto subject

- Passive voice is a sentence in which patient is mapped to subject position.
- Syntactic structures tell us who did what to whom. In addition we often rely on real-world knowledge to infer thematic roles.

"The unicycle rides the clown"

- Irreversible sentence – are those that no longer make sense if the agent and patient swap subject and object position.
- Reversible sentence – that still makes sense, but with different meaning. if agent & patient swap subject & object position

"The clown was chased by the lion"

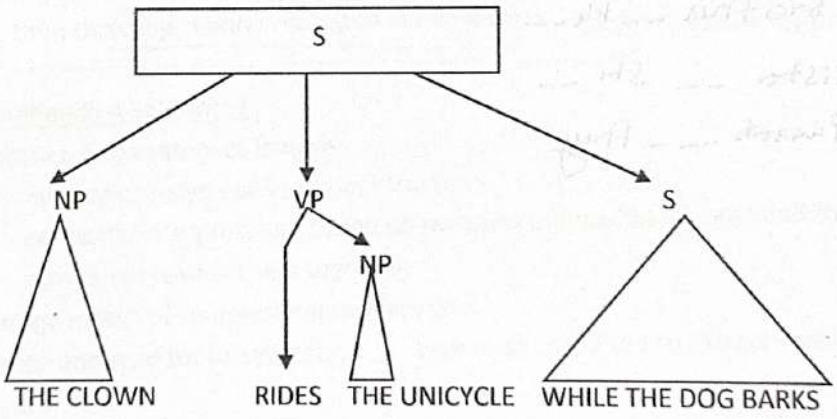
Reversible passive → Reversible sentence in passive voice

Adding complexity : Cleft Sentence

- A simple sentence that is part of a large complex sentence is known as a clause.
- One way to build complex sentences is through the use of conjunctions.

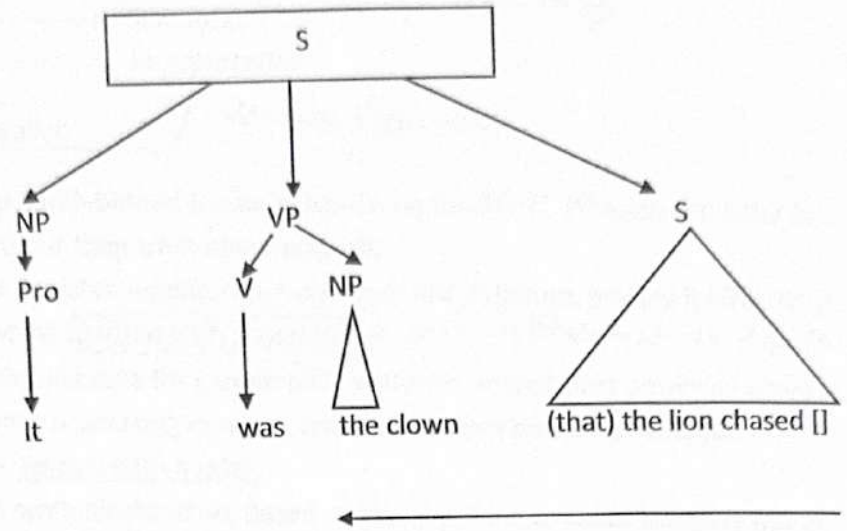
"The clown ride the unicycle while the dog barks"

- We turn simple sentence into complex one in order to focus attention on a particular participant in the event. Recursion allows us to put sentences inside sentences to express complex thoughts.
- Cleft sentence – is a syntactic structure that attaches an introductory clause to the beginning of a sentence for the purpose of highlighting one of the participants in the event.



→ Subject cleft
→ Object Cleft

CLEFT SENTENCE



- Inserting clauses inside of other sentences through the use of relative clause (sentence that is placed inside of another sentence for the purpose of describing a noun).
  e.g. "The lion chased the clown that rides the unicycle".
- Subject relative clause (the noun in the main clause that is being described).
- The object of a relative clause can also be matched up with a noun in the main clause.
- At the heart of the clause is the verb. Some verbs don't take an object, but most and some take more than one.
- Finally we look at syntactic agreements. Agreements is a set of syntactic device for linking related elements within and between sentences.
- In English, agreement is simple. If the subject is in third person, and if verb is present tense, then the subject and verb agree in number. → Subject-verb agreement

Comprehending Sentences

- Comprehending sentences involve:
  1. Syntactic analysis of sentence structure.
  2. Semantic interpretation based on meaning of individual words and the way that structures relates them together.
- Two stage model of sentence comprehension:
  Sentence analyzed for its syntactic structure | Lexicon is consulted to extract meaning

Dative construction:-

→ Syntatic structure expressing the meaning of doing something for the benefit of someone else.

→ Requires two objects with thematic roles of patient & recipient

Double object construction:-

→ Recipient + Patient

→ The clown fed the lion a steak (eg)

Prepositional dative construction:-

Patient + Preposition + Recipient

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① Subject-verb agreement

→ eg The clown ride-s the unicycle

The clown-s ride the unicycle

② Noun Pronoun agreement

Pronouns agree with the noun they refer to in number & gender (in some cases in Eng)

eg → My brother --- He---

My sister --- She --

My Parents --- they

Garden path model

2 stage model → (1) Syntactic Analysis
(2) Semantic analysis

→ the use heuristics → (mental shortcuts) to analyse syntax quickly

Stage 1

- One stage (constraint based)

Syntactic analysis ⟷ Semantic interpretation

(parallel) influences each other

- Consider "While Sarah bathed her baby played on the floor". [We assume baby was object of bathed but then what about played].
  A sentence that deviates significantly from expected structure, making it difficult to process is known as 'garden path sentence'. → High attachment is difficult.
- Based on eye tracking data for garden path sentence, researchers proposed a two stage model of sentence processing in which syntactic analysis precedes semantic interpretation – garden path model.
- We first build a syntactic structure based on the apparent syntactic category (noun, verb, etc.) of each incoming word. This follows looking up meaning of words and linking them to sentence.

Late closure — Minimal Attachment Strategy ← Syntactic parsing strategy that assumes the simplest possible sentence structure.

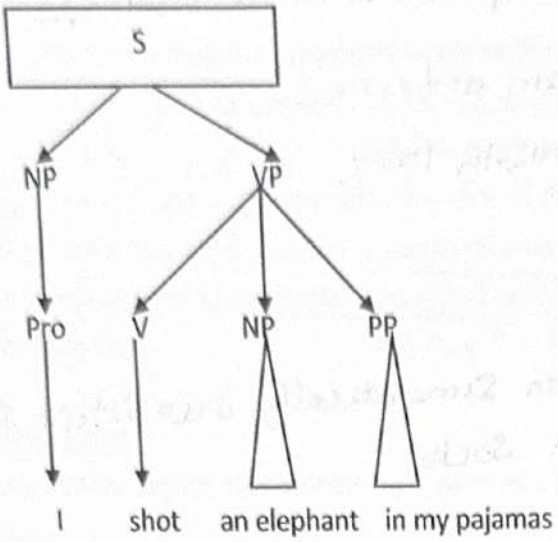
- We use two heuristic when assigning sentence structure.
  a) Late closure – is a syntactic passing strategy that continues to add new words to the current structure unless there is sufficient evidence that a new structure should begin.
     - The late closure heuristic leads us to closing a structure too early.
     - "The horse raced past the barn fell" – make use of an oddity in English grammar known as "reduced relative clause" – is a kind of embedded syntactic structure that allows for economy of expansion but can be extremely difficult to process in some cases.
  b) The second heuristic of the garden path model is minimal attachment.
     - A syntactic passing strategy that assumes the simplest possible structure
     - Groucho Marx used minimal attachment "I shot an elephant in my pajamas". How he got in my pajamas I'll never know.
     - The passing strategy of attaching a prepositional phase to the verb is called high attachment and the passing strategy of attaching a prepositional phase to an object is called low attachment.

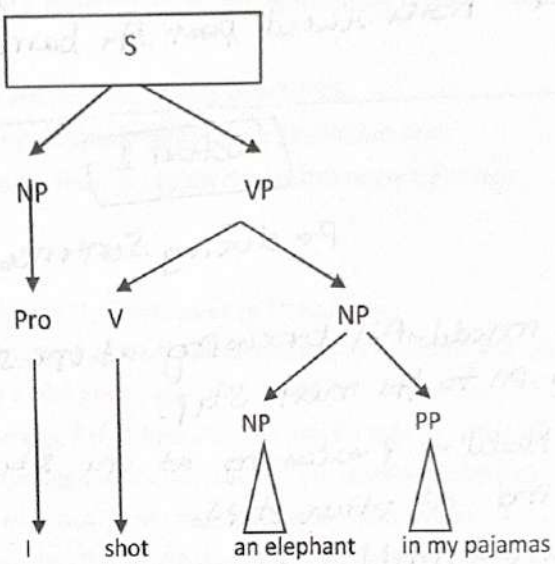
object

Hence, the elephant was wearing the pajamas

High attachment → Parsing Strategy of attaching a prepositional phase to the verb.

Hence, the speaker was wearing the pajamas





- In syntactic theory the verb is considered higher in the sentence than the object hence the names.
- High attachment – simple sentence is favored by minimal attachment.

  e.g.: The thief open the safe with a stick in dynamite (high attachment). The thief opened the safe with the rusty lock (low attachment) as rusty lock describes safe not how it was opened.

High attachment has simpler structure than low attachment
Hence it is considered minimal

Priming

- The tendency to repeat a previously heard sentence structure is called syntactic priming.
- Does syntactic priming support 1 or 2 stage model.
- Pure syntactic priming, in which only the structure but none of the words are repeated, suggests we do in fact process sentence first at the syntactic level (2 stage model).
- Researchers find an increase in syntactic priming when the verb is repeated between the prime and the target sentences (lexical boost) suggest early role of semantics (1 stage model).

Anticipation

- As listeners we not only process each word as it comes in, we also predict what's coming next.
- The likelihood that a person will complete a sentence with a particular word is known as that words cloze probability.
- One way we can observe listeners as they anticipate upcoming words is by using a visual word paradigm.
- We anticipate not only upcoming words but also upcoming structures.
- As a general principle expectation guides perception generating prediction and comparing them against the sensory input is how the brain deals with noisy evidence from a messy world.

Broca's Area Revisited

- Broca's area plays a role in working memory or executive functioning, consistent with its location in the frontal lobe.
- Based on clinical evidence, it has long believed that Broca's area plays a role in syntactic processing, but recent clinical and neuroimagining calls this view into question; instead new theories suggest that the function of Broca's area may instead be involved in working memory, executive control or action planning.

Producing Sentences

- As we produce a sentence, information flows along 2 dimensions :
    a. The vertical dimension represents the processing of individual words from conceptual activation through lexical selection to phonological encoding.
    b. The horizontal flow refers to the linked processes of producing words and phrases in the right sequence.
- Sentence production is incremental. We do not plan the entire sentence, nor do we plan and produce one word at a time.

Cloze probability:

- Likelihood that a person will complete a sentence with a particular word.
- I take my coffee with cream and ___
- Cloze probability of sugar is nearly 100%.

N400

- ERP component elicited after semantically inconsistent stimulus.
- She spreads her toast with socks.

P600

- ERP component elicited after syntactically inconsistent stimulus
- The horse raced past the barn fell.

Lecture 2

Producing Sentences: Models of Sentence Production

1) Serial model: All processing at one step needs to be completed before moving on to the next step.
2) Parallel Model: Processing at one step occurs simultaneously with same processing at other steps.
3) Incremental model: Processing at one step is still underway when processing at next step begins.

Most evidence supports incremental model.

That's why, we start a sentence before we've planned it all the way to the end.

Hierarchical structure in advance planning:
→ Main general plan at highest level, restrict scope of planning at lower levels

Data are inconsistent
→ content word
→ Phrase
→ Clause

a. As the processing of the first part of the sentence is underway the activation of the second part begins.
b. Incremental processing involves a trade-off between fluency and efficient use of resources.

- Given that spoken sentence production is incremental, psycholinguistics disagree on how far ahead we plan.
- Some evidence suggest that we plan clause by clause, while other evidence suggests the scope of planning is the phrase or content word.
- Inconsistency in the scope of planning data can be explained in a number of ways.
  a. The experimental procedure may bias the participant towards one scope or another.
  b. Planning scope may vary according to processing demands [chit chat idle or speech].
  c. Different level of processing may have different scopes of planning. The scope of planning at conceptual level may be the clause, while the scope of planning at the lexical level may be the phrase or content word.

Proceeds sequentially as series of saccades & fixations

- Visual attention plays an important role in sentence production
  a. Eye movements across the visual display are correlated with the order in which items are mentioned in a sentence.
     Visual attention proceeds in sequential fashion, just like sentences do.
  b. Visual attention plays an important role in subject selection. At least in English.

- A number of other factors can also influence subject selection
  a. Animate things are more likely to be subject.
  b. Recently mentioned item.
  c. Strong tendency to select agent as subject.
- Syntactic priming biases speakers towards producing a particular sentence structure.
  a. fMRI studies show that syntactic priming is correlated with the suppression of activity in the left temporal and frontal lobes.

Learning syntactic Structures

- Infants use prosodic patterns to group words into phrases in a process called prosodic bootstrapping.
  a) The process provides them with insights into sentence structure.
  b) As children become more familiar with syntactic patterns, they also become more sensitive to prosodic cues.

Scrambling:-

- Syntactic process of putting object before subject

Active:- Indiana Jones is chasing the Nazis

Passive:- The Nazis are being chased by Indiana Jones

Scrambling:- The Nazis Indiana Jones is chasing.

Sentence Production & the Brain

* Dual Stream model →
  (1) Ventral "what" stream through temporal lobe → lexical selection
  (2) Dorsal "how" stream through parietal and frontal lobe → Syntactic processing

* Syntactic priming
  (1) Prior experience can bias speakers toward using particular structure
  (2) After hearing several passive sentences, participants more likely to produce passive sentences in picture description task.

* Repetition suppression
  Reduction in brain activity when syntactically primed sentence is process.

Syntactic Bootstrapping: Use of syntactic info to infer word meaning

- At first infants use pauses to detect phase boundaries.
- Familiarity with syntactic structure make them associate drops in pitch and pre boundary lengthening as addition cues to phase boundaries.
- At 3 years they are sensitive to intonational phrases.
- Vocabulary and syntax develop in parallel during early years of childhood, and they reinforce each other.
    a) Children use syntactic bootstrapping to infer the meaning of new words
    b) They use lexical bootstrapping to infer the meaning of new structures
- Between 2nd and 3rd years of life, children's vocabulary and understanding of syntax grows rapidly.
- The standard measure of children's syntactic complexity is the mean length of utterance (MLU).
- A common measure of the child's productive vocabulary is the number of different words (NDW) the child uses.
- Generativist approach argues that language acquisition is driven by innate, language specific abilities. Chomsky proposed the poverty-of-the-stimulus-argument which states that the linguistic input children receive is insufficient for them to learn language as adult speech if full of error.
- The usage based framework argues the children use general cognitive mechanisms to gradually construct a grammar of their language.
    a) Instead of acquiring rules the child stores examples in memory that gradually converges into adult grammar.
- Children often learn collocations like "brush your teeth" before they understand the grammar of the individual words making up the language chunk.
    a) They also use practical structures that hear in adult speech, like "Eat yet"? to build up canonical structures like "Did you eat yet".
- Specific language impairments involve a deficit in the use of grammatical morphemes. Children with late language emergence exhibit a delay in development but a normal trajectory, and they usually end up within normal range as dyslexia though considered a reading disorder, also has effects on spoken language perception and production.
- Recent neuroimaging studies show that language processing in bilateral in infancy but gradually lateralizes to the left hemispheres by the early school years.
    a) The ventral stream matures before the dorsal stream consistent with the behavioral evidence that meaning drives syntax in the early years.

Poverty of the Stimulus Revisited

Usage-based theorists view adult errors & incomplete sentences as basis to language learning.

English yes-no Qs are complex
(1) It is raining → Is it raining?
(2) You can swim → Can you swim?
(3) He wants to come → Does he want to come?

Adults often use reduced forms
You want your lunch?
↓
Want your lunch?
Non-canonical forms are structurally simpler → Provides scaffolding for learning more complex structures

Models of Syntax Acquisition (I)

* Generativist Approach → Syntax acquisition driven by innate mechanism
* Poverty-of-the-Stimulus → Position that linguistic input children receive is insufficient for them to learn
* Language acquisition Device → Hypothetical brain module containing universal set of grammar rules, guiding language development
* Usage based framework → Position that child uses general cognitive mechanisms like pattern detection and categorisation.
  → Gradually builds understanding of the grammar of the lang.

Models of Syntax Acquisition (II)

U-shaped learning curve for plural & past-tense inflections :-

→ At first, children produce both regular & irregular forms correctly (walk-walked, go-went).

→ Later, overgeneralization → treating irregular words as if regular (walk-walked, go-goed)

→ Eventually, they sort out regular & irregular forms.

→ Generativist Approach → learning rules

→ Usage based framework → learning patterns

→ Connectionist n/w → Computer program that models statistical learning

- Exhibits U-shaped learning & overgeneralization.