Psycholinguistics and research methods - recap
Topics in psycholinguistics

- Lexicon
- Morphological processing
- Sentence processing, gap filling
- Reading, dyslexia
- Aphasia
- Language acquisition: speech, lexicon, syntax.
- SLI
Hierarchical Network Model

- Hierarchical network (Collins & Quillian 1969)
  - concepts are organized into a hierarchy
  - taxonomic and attributive relations are represented

```
Animal  <  eats  <  reproduces
/    |    |
Bird  has wings  <  has feathers
      |        |
Canary  can sing  <  is yellow
        |        |
Raven  is black  <  says "Nevermore"
       |        |
Shark  is dangerous  <  starred in Jaws
         |        |
Salmon  can swim  <  has gills
          |        |
Fish    is pink  <  is edible
```

Principle of cognitive economy: properties and attributes are stored at the highest of all appropriate levels, e.g. ‘reproduces’ modifies ‘animal’
Predictions?
Spreading Activation Model of ML

- Collins & Loftus 1975
- ML is a network, but the organization is not strictly hierarchical
- Web of interconnected nodes

- Distance between nodes is determined by structural characteristics, e.g. taxonomic relations, and typicality

Diagram: www.awa.com/norton
Priming Technique

- PRIMING technique:
  - prime – TARGET pairs
  - how presence of the first member of the pair (the prime) affects the processing of the second member of the pair (the TARGET)

![Diagram showing the priming technique with a prime stimulus followed by a target stimulus and measuring response time.](image)
Semantic Priming

- Priming + Lexical decision to the target (Meyer and Schvaneveldt 1971)

- **doctor** facilitates **NURSE**

  - Spreading activation from the prime to semantically related words

  It takes less time to identify **NURSE** as a word when it is preceded by **doctor** than when preceded by **driver**.
Priming

• **Improved processing** of an item as a result of a previous encounter with that item or a related item.

• **Improved processing** = better/faster identification, production or classification, choose more of a kind..

• Exposure to a stimulus at time 1 influences responding to a related stimulus at time 2
Priming Types - Preview

By type of relationship
- Repetition - identity
- Semantic
- Phonological
- Morphological
- Orthographic

Methodology
- Delayed
- Masked vs. Unmasked
  (###)
- Cross Modal

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How can we use priming to test the spreading activation model of the mental lexicon?
Extended Network Model of ML

- Bock & Levelt (1994)
- 3 types of information involved in word knowledge
  - Conceptual level: word’s meaning
  - Lemma level: syntactic properties
    - sheep – noun; French: mouton – noun, masc & chèvre – noun, fem
    - give <smth to smb> or <smb smth>
  - Lexeme/sound level: phonological & morphological word properties
Updated Network Model of ML

- Bock & Levelt (1994)
- Support for the Lemma and Lexeme levels: tip-of-the-tongue (TOT) phenomenon
- TOT: the speaker must name a defined object, but cannot quite find the right word, despite being aware of some of the properties of the word, e.g. its gender/number
Cohort Model of Lexical Access

Activation  Competition  Selection

Stimulus: TURN
Derivational vs. Inflectional Morphology

• Inflectional morphology - permits a word to agree with other words in its context.
  – Number (-s, Pl: cat -cats)
  – Person (-s, 3Sg: talk -talks)
  – Tense (-ed: talk-talked)

• Derivational morphology – builds new words (may change the category or meaning of a word)
  – English: Adj+ -ly = Adverb: calm -calmly
  – Other: /un-/, /-able/, /-ish/
Wug test

• Jean Berko, 1958
• 3 allomorphs of English regular plural -s: [z] (dogs), [s] (cats), [əz] (horses)
• When/how do children learn these rules?

   **Test paradigm**
   - Children are presented with a pretend creature and told, "This is a wug."
   - Another wug is revealed, and the researcher says, "Now there are two of them. There are two __." 

• **Results**
  - Very young children are baffled by the question and are unable to answer correctly, responding with e.g. “two wug.”
  - Children in grade 1 were almost fully competent with both [s] and [z].
  - Both preschool and first-grade children dealt poorly with [əz], giving the correct answer less than half the time, possibly because it occurs in the most restrictive context.

• **Major finding**
  - The first experimental proof that young children have extracted generalizable morphological rules from the language around them.

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This is a wug.

Now there is another one.
There are two of them.
There are two __.
The ‘words and rules’ hypothesis
(Pinker and Ullman, 2002)
Alternative perspectives on morphology

Traditional perspective  (Decompositional view)

- Words are built out of discrete units called morphemes \(\text{WALKED} = \text{WALK} + \text{-ED}; \text{TEACHER} = \text{TEACH} + \text{-ER}\) that contribute systematically to grammar/meaning.

- Exceptional/opaque forms \(\text{SING} \Rightarrow \text{SANG}; \text{CORNER} \neq \text{CORN} + \text{-ER}\) are handled as whole, undecomposed forms.

Distributed connectionist perspective

- Morphology is a characterization of learned sensitivity to systematic relationships within and among surface forms of words (phonology, orthography) and their meanings (semantics).

- Properties of morphology derive from the nature of semantics, phonology, orthography and their interrelationships in a given language.

- Provides natural instantiation of partial decomposition \(\text{DRESSER} \approx? \text{DRESS} + \text{-ER}\).
Morphological decomposition & Semantic transparency

  - Cross-modal (auditory-visual) priming
  - *government* facilitates its base *govern*
  - *apartment* does not facilitate its etymological base *apart*

  - $\Rightarrow$ an opaque word is stored as a whole; a transparent word is stored as separate morphemic units
  - $\Rightarrow$ semantic transparency is important in organization of the lexicon
The dual route model of reading

Coltheart et al., http://www.maccs.mq.edu.au/~ssaunder/DRC/
The dual route model

- Which stimuli can be read only through the phonological route?
- Which stimuli can be read only through the direct route?
Fig. 4. A connectionist model of word processing. In this connectionist model adapted from Seidenberg & McClelland (1989), there are no separate input and output modules for phonology and orthography and the 4 input and output lexicons specified in Figure 3 are replaced by connections/interactions between phonology and semantics (P-S and S-P), semantics and orthography (O-S and S-O) and orthography and phonology (O-P and P-O). Retrieving the phonology (P) of seen words from orthography (O) can either occur via direct links (O-P) or indirectly via semantics (O-S, S-P).
Developmental dyslexia is a neurologically-based condition in which a person is unable to acquire the basic language skills of reading. This difficulty occurs despite having average intelligence, attention, motivation and education.

Acquired dyslexia is a loss of literacy skills as a result of a neurological trauma, illness or brain disease.
Acquired dyslexia types

- Phonological dyslexia
- Surface dyslexia
- Deep dyslexia
Sentence processing
Syntactic ambiguity

- **Global:** The whole sentence can be analyzed in two different ways
  - John told the girl that Bill liked the story

- **Local:** At a certain point in the sentence, it is unclear which analysis should be applied. Followed by disambiguation
  - John told the girl that Bill likes he hates jazz
  - Special case: Garden path sentence
    - Local syntactic ambiguity
    - Resolved towards the unpreferred structure
    - Reanalysis is so hard that the sentence is perceived as ungrammatical
PP attachment ambiguity

A. Preferred

B. Unpreferred
The sausage machine

- Frazier and Fodor 1978 proposed a two stage model of parsing:
  - Preliminary phrase packager (PPP)
    - Limited window of 6 words
    - Employs syntactic heuristics (MA)
  - Sentence structure supervisor (SSS)
    - Cannot undo the products of PPP
The Garden Path model

- Frazier 1987 developed the Garden path model:
  - 1st pass parse, syntactic only, produces a single structure
    - Uses 2 complementary principles: minimal attachment, late closure. MA precedes.
  - 2nd pass necessary if the first structure is incompatible (based on semantics, pragmatics, thematic or syntactic info)
    - Thematic info only accessible in second pass
Constraint based models

- An interactive model
- Use multiple sources of info
- Parse aims to satisfy as many constraints as possible
- Lower ranking parses are kept as well, but some are harder to access
Another common example for on-line parsing: gap-filling

This is **the girl** that John **pushed**
What is the time course of gap filling?

- Active filler hypothesis: the processing of \textit{wh}-phrases initiates a search for a gap, which is posited at the earliest point allowed by the grammar. (Frazier and Clifton 1989).
- Gap as last resort: wait until there’s no alternative parse for a sentence except for one that has a gap (J. Fodor, 1978)
Filled Gap Effect

My brother wanted to know

Readers slow down upon encountering an NP where a gap was expected, relative to a control structure, in which no gap was expected.

Crain & Fodor 1985, Stowe 1986
Further tests of the active filler hypothesis: visual world paradigm

Jody was eating breakfast one morning when she saw a big hairy spider creeping across the table towards her. Jody, whose terrible arachnophobia had caused her to seek therapy a few years ago, drew on the techniques of relaxation and anxiety management that her psychologist had taught her. Instead of screaming or freaking out, she calmly took off her shoe and slammed it down on top of the spider. She ate the rest of her Froot Loops in peace.

Did Jody squash the spider with her shoe? What did Jody squash the spider with?

Figure 1. Visual display.

Sussman & Sedivy (2003)
On line sentence processing: cross modal lexical priming

(1) The policeman saw the boy that the crowd at the party accused of the crime.

Table I. Priming Scores (Lexical Decision RTs to Control Words Minus RTs to Semantically Related Words for Each Referent) at Each Probe Point

<table>
<thead>
<tr>
<th>Referent</th>
<th>Probe point</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>12</td>
<td>27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Crowd</td>
<td>44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup><sup>p</sup> < .05.

Nicol and Swinney, 1989
Sentence complexity: theories

- Derivational theory of complexity
- Dependency locality theory (Gibson)
According to the Derivational Theory of Complexity (Miller, 1962):
- Sentences have to be "de-transformed" during comprehension.
- Sentences are represented in memory as a simple active "kernel" plus a list of transformations.
  - "The frog ate the bug." --> (ATE FROG BUG)
  - "The bug was eaten by the frog." --> (ATE FROG BUG) + PASSIVE
  - "Was the bug eaten by the frog?" --> (ATE FROG BUG) + PASSIVE + QUESTION

- This suggests that as the number of transformations increases, comprehension difficulty and memory load should increase.
Experimental support

- Present Sentence --> Present Digits --> Recall Sentence --> Recall Digits
- As the number of transformations increases, the number of digits recalled decreases.
- It’s as if people encode the kernel (DS) + transformation tags, and the tags take memory space.
Counterexamples

- Slobin 1966: Miller and McKeans’s results fail to replicate with irreversible passives
- Ellipsis sometimes makes the sentence easier:
  - Fred runs faster than the girl runs." > "Fred runs faster than the girl."
- Heavy NP Shift makes the sentence easier:
  - We showed the long-awaited and astoundingly beautiful pictures of the Himalayan trip to Mary.
  - We showed Mary the long-awaited and astoundingly beautiful pictures of the Himalayan trip.
The Dependency locality Theory
(Gibson 1998, 2000)

- Processing resources are assigned to two tasks:
  - Storage of the structure built so far
  - Integration of current word to structure built so far
- Structural integration costs depends on locality
Cost function

- Storage cost: 1 cost unit for each discourse referent in the intervening region
- Integration cost: 1 cost unit if the new element introduces a new discourse referent
The total cost of “sent” in the object RC is 3: 1 cost unit for adding a new discourse referent, and 2 units for the structural integration (coindexing) of the object gap with “who”, due to the two intervening referential items, \textit{photographer}, \textit{sent}, between the gap position and the relative pronoun \textit{who}.

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**Table 5.1**

Word-by-word predictions of the DLT for the object-extracted RC structure in (13)

<table>
<thead>
<tr>
<th>Cost type</th>
<th>The</th>
<th>reporter</th>
<th>who</th>
<th>the</th>
<th>photographer</th>
<th>sent</th>
<th>to</th>
<th>the</th>
<th>editor</th>
<th>hoped</th>
<th>for</th>
<th>a</th>
<th>good</th>
<th>story</th>
</tr>
</thead>
<tbody>
<tr>
<td>New discourse referent</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Structural integration</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 5.2**

Word-by-word predictions of the DLT for the subject-extracted RC structure in (12)

<table>
<thead>
<tr>
<th>Cost type</th>
<th>The</th>
<th>reporter</th>
<th>who</th>
<th>sent</th>
<th>the</th>
<th>photographer</th>
<th>to</th>
<th>the</th>
<th>editor</th>
<th>hoped</th>
<th>for</th>
<th>a</th>
<th>good</th>
<th>story</th>
</tr>
</thead>
<tbody>
<tr>
<td>New discourse referent</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Structural integration</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Aphasia
Non-fluent (Broca’s) aphasia
- telegraphic speech
- open/closed class distinction
- agrammatism

Spontaneously speaking

"Son ... university ... smart ... boy ... good ... good ..."
Fluent (Wernicke’s) aphasia

- Fluent production, well structured speech output
- Content mismatch
- Paraphasias – replace many content words with pseudowords
Classical Understanding of Language in the Brain, based on Aphasias

- **Broca's Area**: responsible for speech production (close to motor areas)
- **Wernicke's Area**: responsible for speech comprehension (close to auditory areas)
- Striking confirmation: **Conduction Aphasia**
- Often associated with damage to Arcuate Fasciculus -- a tract of fibers connecting BA and WA
- Patients reported to show good comprehension, good production, poor repetition

![Diagram](image)
Aphasia classification by the center model

Figure 1. Lichtheim’s diagram of the language system. A, Wernicke’s area; B, concept center; M, Broca’s area; a → A, auditory input to Wernicke’s area; M → m, motor output from Broca’s area. A → M, tract connecting Wernicke’s and Broca’s areas; A → B, pathway essential for understanding spoken input; B → M, pathway essential for meaningful verbal output. Lesions: at A, Wernicke’s aphasia; at M, Broca’s aphasia; a → A, pure word deafness; M → m, articulatory disorder (aphemia); A → M, conduction aphasia; A → B, transcortical sensory aphasia; B → M, transcortical motor aphasia.

Saffran 2000
But..

Broca's patients turn out to have a comprehension problem, when carefully tested

point to the girl [who is drying the woman]  ✓
point to the girl [who the woman is drying _]  ✗

→ Deficit may be syntactic
Wernicke's patients clearly don't have just a comprehension problem

C.B. Uh, well this is the ... the /dødøû/ of this. This and this and this and this. These things going in there like that. This is /sen/ things here. This one here, these two things here. And the other one here, back in this one, this one /gøš/ look at this one.

Examiner Yeah, what's happening there?

C.B. I can't tell you what that is, but I know what it is, but I don't now where it is. But I don't know what's under. I know it's you couldn't say it's ... I couldn't say what it is. I couldn't say what that is. This shu-- that should be right in here. That's very bad in there. Anyway, this one here, and that, and that's it. This is the getting in here and that's the getting around here, and that, and that's it. This is getting in here and that's the getting around here, this one and one with this one. And this one, and that's it, isn't it? I don't know what else you'd want.

→ deficit may be in semantic component of language
More recent models

• “Neurolinguistic model”: Syntax in Broca’s area, semantics in Wernicke’s area.
• Specific deficit: Broca’s area performs specific types of syntactic computations, or houses a specific type of syntactic representation (e.g., traces)
• Different theories for production and in comprehension
• Network implementation of functions
Picture selection task

point to **the girl** [who the woman is **drying** ]

- Participant is presented with an auditory language stimulus and a set of pictures
- Task: Select the picture that best matches the linguistic stimulus
- This task is commonly used in children and patient populations. WHY???
Example: SLI (Novogrodsky and Friedmann, 2004)

Three types of Hebrew sentences were used: simple SVO sentences (3), right-branching subject relatives (4), and right-branching object relatives (5).

(3) Ha-safta menasheket et ha-yalda. (the-grandmother kisses ACC the-girl) ('The grandmother is kissing the girl.')

(4) Zot ha-safta she-menasheket et ha-yalda. (this the-grandmother that-kisses ACC the-girl) ('This is the grandmother that is kissing the girl.')

(5) Zot ha-safta she-ha-yalda menasheket. (this the-grandmother that-the-girl kisses) ('This is the grandmother that the girl is kissing.')
Table 1. Mean percentage correct by group and sentence type, S.D. in parentheses (10 subjects per group, total of 200 sentences per cell)

<table>
<thead>
<tr>
<th>Age</th>
<th>Simple SVO</th>
<th>Subject relative</th>
<th>Object relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four-year-olds</td>
<td>4;0–5;0</td>
<td>93.5 (1.6)</td>
<td>85.5 (1.9)</td>
</tr>
<tr>
<td>Six-year-olds</td>
<td>5;11–6;5</td>
<td>99 (0.4)</td>
<td>95 (1.0)</td>
</tr>
<tr>
<td>SLI</td>
<td>7;3–11;2</td>
<td>96.5 (0.5)</td>
<td>98.5 (0.5)</td>
</tr>
</tbody>
</table>
Example: agrammatism

(6) **Verbal passive**
   
   The girl was dried by the woman

(7) **Adjectival passive**
   
   a. The man was unimpressed by the woman
   
   b. The man was interested in the woman

Grodzinsky, Pierce & Marakowitz, *NLLT*, 1991
Picture selection task - advantages

• Probes comprehension without relying on intact production

• This is essential in cases where we production is limited but comprehension could go beyond production constraints:
  – Children at an early stage of language production
  – Aphasic patients
  – Children with specific language impairments
Picture selection task – use and limitations

• The linguistic stimuli should be pre-recorded, rather than spoken by the experimenter
  – Consistency
  – Minimize prosodic cues
  – Minimize experimenter’s bias

• Pictures should be equally likely to be true regardless of the language stimulus

Beretta and Munn, 1998
Picture selection task – use and limitations

- The linguistic stimuli should be pre-recorded, rather than spoken by the experimenter
  - Consistency
  - Minimize prosodic cues
  - Minimize experimenter’s bias

- Pictures should be equally likely to be true regardless of the language stimulus

- Pictures should be equally salient (to avoid a bias towards one picture based on color, cuteness, funny content, etc.)

- One common solution is to use the same set of pictures as targets and as distracters (but: memory effects)
Language Acquisition

HIGHLIGHTS
Universal timeline of speech acquisition: 1\textsuperscript{st} year

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**Perception**

- Infants discriminate phonetic contrasts of all languages
- Statistical learning (distributional frequencies)
- Detection of typical stress pattern in words
- Recognition of language-specific sound combinations
- Increase in native-language consonant perception

**Production**

- Infants produce non-speech sounds
- Infants produce vowel-like sounds
- 'Canonical babbling'
- Language-specific speech production
- First words produced

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**Sensory-motor learning**

- Universal speech production
- Language-specific speech production

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**Figure 1 | The universal language timeline of speech-perception and speech-production development.** This figure shows the changes that occur in speech perception and production in typically developing human infants during their first year of life.

Kuhl, NRN 2004
Early models of acquisition

- Language knowledge is learned, by copying and analogy (behaviorism, Skinner)
  - But: children produce forms they never heard
    - analogy?
  - But: some generalizations they learn are very complicated
- Reinforcement learning
  - ??Children do not seem to respond to positive and negative reinforcement
- An innate mechanism for language acquisition (LAD), domain specific, human only (Chomsky)
Categorical perception is the tendency for adult listeners of a particular language to classify the sounds used in their languages as one phoneme or another, showing no sensitivity to intermediate sounds. Laboratory demonstrations of this phenomenon involve two tasks, identification and discrimination. Listeners are asked to identify each sound from a series generated by a computer. Sounds in the series contain acoustic cues that vary in small, physically equal steps from one phonetic unit to another, for example in 13 steps from /ra/ to /la/.

In this example, both American and Japanese listeners are tested. Americans distinguish the two sounds and identify them as a sequence of /ra/ syllables that changes to a sequence of /la/ syllables. Even though the acoustic step size in the series is physically equal, American listeners do not hear a change until stimulus 7 on the continuum. When Japanese listeners are tested, they do not hear any change in the stimuli. All the sounds are identified as the same — the Japanese ‘ɾ’.

When pairs of stimuli from the series are presented to listeners, and they are asked to identify the sound pairs as ‘same’ or ‘different’, the results show that Americans are most sensitive to acoustic differences at the boundary between /ɾ/ and /l/ (dashed line). Japanese adults’ discrimination values hover near chance all along the continuum. Figure modified, with permission, from REF. 7 © (1975) The Psychonomic Society.

Fast Mapping

- Fast mapping: children who heard a new word only once, have already developed hypotheses about what that new word means (Carey, 1978).
- Around 18m, children use this efficient mechanism to learn words FAST.
- How fast? Carey 78 says as many as 10 words a day.
How do children learn words?
Nativist solutions

- Children have innate knowledge that enables them to learn words
  - built-in assumptions allow direct mapping of words onto meanings - CONSTRAINTS:
    - Whole object constraint
    - Taxonomic constraint
    - Mutual exclusivity constraint
How do children learn words?
Constructivist solutions

- Children learn word meanings with no innate knowledge to help them

- Semantic feature theory (Clark, 1973, 1975)
  - each word has a list of semantic features:
    - e.g. DOG = +OBJECT +ANIMATE +FOUR-LEGGED +FURRY +WHISKERS +WOOFS
  - a referent (object) must be characterised by all these features for the word to be applicable
  - children start with more general features (e.g. +OBJECT +ANIMATE) then extend to include more specific features (+WOOFS) later on
Prototype theory

- Widely supported
  - Meaning of a referential word is initially acquired in the form of a prototypical referent for that word
  - e.g. meaning of word *dog* first applies only to a typical dog
  - child then generalises to other objects on basis that they share common features with the prototype:
Do kids at the one-word stage have syntax?

- More recent studies suggest yes.
- Hirsh-Pasek & Golinkoff (1991), preferential looking task.

Hey, Cookie Monster is tickling Big Bird.
Different views about syntactic acquisition

• Experience based account: children are building their syntactic knowledge based on evidence. Their linguistic errors reflect strategies that they use.

• Continuity hypothesis: Children are born with innate principles and parameters. Acquisition is parameter setting. At any given point in time, children use a grammar which is possible in some natural language, maybe not their own.
Specific Language Impairment (SLI)

- Developmental language disorder in the absence of neurological, sensori-motor, non-verbal cognitive or social emotional deficits.
- Affects about 7% of the population, males more often than females.
- A delay or deficit in the use of function morphemes. Omission of function morphemes long after age-matched children with typical language development show consistent production of these elements.
- Diagnosis based on behavioral evaluation but is likely to have a genetic basis.
- Control group is either age-matched, IQ-matched or language-matched (usually MLU(mean length of utterance))-matched.
Hypotheses about what goes wrong in SLI

- **Gopnik**: It’s a grammar problem. SLI individuals are impaired in their ability to use grammatical morphemes.

- **Wexler (& Rice)**: It’s a grammar problem. SLI individuals are impaired in specific type of verbal inflection.

- **Tallal**: It’s not a grammar problem! It’s a problem in rapid auditory processing (which has consequences for language).

- Fundamental problem: Since the SLI individuals are a heterogeneous group, these research groups are not necessarily studying the same types of individuals.
Friedmann’s account: subtypes

Based on a handout by Prof. Naama Friedmann
Topics in methodology

- Experimental design: variables, conditions, measurement
- Descriptive stats: sampling, scales, mean, SD
- Inferential stats
  - Parametric: t test, correlation, ANOVA
  - (Nonparametric)
- Psycholinguistic paradigms:
  - Priming
  - Self paced reading
  - Visual world paradigm
  - Magnitude estimation
  - Picture selection task
  - Preferential looking
  - High amplitude sucking
Popular tasks

- Naming
- Lexical decision
- Acceptability judgment

Popular measures

- Reaction time
- Accuracy
- Preference, ratings
Measurement scales (levels)

- **NOIR** (Stanley Smith Stevens)
  - Nominal scale
  - Ordinal scale
  - Interval scale
  - Ratio scale
The measuring scale dictates the way the data is analyzed (e.g., computing average and standard deviation)
Dependent and Independent Variables

In studies we usually check how a change or a manipulation in one variable is related to a change in another variable.

**Independent**

Normally researchers like to manipulate this variable.

**Dependent**

What is measured
Summary: Research Types

• **Experimental** - changes in the independent variable are created by experimenter’s manipulations

• **Correlational** – changes in the independent variable are given and are not within the control of the experimenter
Researchers prefer experimental studies, but sometime they don’t have a choice

Explain this statement and give an example for situations that do not allow for an experimental approach
A Confound

• an external variable that correlates (positively or negatively) with both the dependent and the independent variables.

• Confounds affect results!

Examples:
  – Verbs yield longer RTs than nouns
  – People who stutter have a different speaking rate compared with controls.

• How do we deal with a confound?
אל החבים והсыפיות והʩ משנית

מחוק ברית: עם השנות ה'90 לברצון ייצוג של רבה, עם שיתוף כלים.

שאני מרקט ואיניקו, גוטיס על לблок שלושת המחיו, להרוו ערכו החזון של הע jeuית הלולו.

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ביאנלה...
Dealing with confounds

- Controlling for sex, gender, education etc.
- Double blind analysis.
- Randomized stimuli
- Confounders should exist for both study and control groups.
- And many many more..
Statistics

• Please refer back to the 4 handouts you have which summarize it well.
Definitions

- Minimal attachment
Minimal attachment

- On-line sentence processing
- Within the sausage machine model, also part of the Garden Path model
- Strategy/heuristic used in the first pass of processing
- Core: MA means that we attach new phrases at the highest node currently available in the partial tree of the sentence
- Prefer flatter tree representations
- Explains preference of one interpretation over the other in synamb sentences
- Example
Minimal attachment

In sentence processing, this is a strategy that people use for assigning structure to the sentence on line (as the sentence unfolds). According to the minimal attachment strategy, we tend to attach an incoming phrase at the highest node possible, preferring flatter trees.

For example, when we process the ambiguous sentence

Mary told the woman that Bill likes to jump the cp [that Bill ...] is attached as a complement to the verb ‘told’, not as a relative clause describing ‘the woman’, because the latter would generate a taller tree. MA predicts that the sentential complement interpretation is favored in these cases over the relative clause interpretation. It is not always correct but it is fast. MA is part of the initial syntactic phase in the garden path model.
Definitions

- Derivational theory of complexity
Derivational theory of complexity

- Context: syntactic processing
- Aims to explain why some sentences are harder to comprehend than others
- Core idea: sentences are stored as a kernel (deep structure) and transformation tags
- The more transformations involved in deriving a sentence, the harder it is to comprehend (the more complex it is)
- Supporting evidence: remember less digits for passive negative sentence (2 transformations) compared to active positive (0)
- Criticism: Ellipsis sentences are easier to understand than no ellipsis
Derivational theory of complexity

This theory is concerned with the syntactic processing of sentences. It aims to explain why some sentences are harder to understand than others, that is, what makes a sentence syntactically complex. The theory suggests that sentence complexity can be predicted based on the number of transformations applied to derive the sentence. More specifically, it suggests that sentences are stored as a kernel (deep structure) and transformation tags (one for each transformation). In one of the supporting experiments, participants were asked to remember a sentence and a set of numbers, then recall the sentence and recall the numbers. The authors found that the more transformations were involved in deriving the sentence, the less digits were correctly recalled. The critics of this theory point to some transformations that actually simplify sentences, such as Ellipsis (‘Mary kicked the ball and Bill did too’ is easier than ‘Mary kicked the ball and Bill kicked the ball too’).