The genetic bases of language and the innateness hypothesis
The biological bases of language

Wernicke-Geschwind Model

- Primary motor cortex
- Arcuate fasciculus
- Broca's area
- Primary auditory cortex
- Wernicke's area
- Primary visual cortex
Classical aphasialogy

Aphasia: an acquired language disorder (generally due to brain injury from trauma or stroke)
Classical aphasiology

The cookie theft
Classical aphasialogy

Broca’s aphasia:

B.L.: Wife is dry dishes. Water down! Oh boy! Okay Awright. Okay ...Cookie is down...fall, and girl, okay, girl...boy...um...Examiner: What is the boy doing? B.L.: Cookie is...um...catch Examiner: Who is getting the cookies? B.L.: Girl, girl Examiner: Who is about to fall down? B.L.: Boy...fall down!
Wernicke’s aphasia:

H.W.: First of all this is falling down, just about, and is gonna fall down and they're both getting something to eat... but the trouble is this is gonna let go and they're both gonna fall down... but already then... I can't see well enough but I believe that either she or will have some food that's not good for you and she's to get some for her too... and that you get it and you shouldn't get it there because they shouldn't go up there and get it unless you tell them that they could have it. and so this is falling down and for sure there's one they're going to have for food and, and didn't come out right, the uh, the stuff that's uh, good for, it's not good for you but it, but you love it, um mum mum (smacks lips)... and that so they've... see that, I can't see whether it's in there or not.

Examiner: Yes, that's not real clear. What do you think she's doing?

H.W.: But, oh, I know. She's waiting for this!

Examiner: No, I meant right here with her hand, right where you can't figure out what she's doing with that hand.

H.W.: Oh, I think she's saying I want two or three, I want one, I think, I think so, and so, so she's gonna get this one for sure it's gonna fall down there or whatever, she's gonna get that one and, and there, he's gonna get one himself or more, it all depends with this when they fall down... and when it falls down there's no problem, all they got to do is fix it and go right back up and get some more.
Classical aphasialogy

Broca’s aphasia
Front (frontal lobe)
‘production’
expression
motor
nonfluent

Wernicke’s aphasia
Back (temporal lobe)
‘comprehension’
reception
sensory
fluent
# Classical aphasialogy

<table>
<thead>
<tr>
<th>Broca’s aphasia</th>
<th>Wernicke’s aphasia</th>
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<tbody>
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<td>motor</td>
<td>sensory</td>
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<tr>
<td>nonfluent</td>
<td>fluent</td>
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</tbody>
</table>

**Wernicke’s aphasia:**
- poor comprehension (spoken & written)
- rapid and grammatical speech, lacking meaning
- phonemic and semantic paraphrasis (circumlocution); neologisms
- poor repetition; don’t detect spoken errors

**Broca’s aphasia:**
- speech is slow, labored, ungrammatical (‘agrammatic’), telegraphic
- difficulty with ‘function’ words and morphology (e.g., *of, the, -s*)
- subtle comprehension deficits
Localization (lateralization) and brain plasticity

Age of trauma matters:

- Children who undergo left hemisphere removal surgery (functional hemispherectomy) before puberty can significantly (but not fully) reacquire language capabilities in the right hemisphere.

- The degree of success in such cases is a function of age at surgery and etiology (reason for the hemispherectomy).
Critical period: Genie

Negation
- Perfect on comprehension tasks
- Production: No more ear hurt.
  No like hospital.
  Not good fish tank.

Actives vs. Passives
- Picture task: “Point to ‘The boy is pulling the girl’.”
  “Point to ‘The girl is pulled by the boy’.”
Result: Performance at chance (51% correct, 49% incorrect)
  (like 4-yr-olds, aphasics)
- No production of passives
Critical period: Genie

Wh-questions

• Picture task: “Who is the girl pulling?”
  “Who is pulling the girl?”

Result: Performance inconsistent. “usually unable to respond at all even though she had been answering various types of wh-questions for more than a year. The responses she did give did not reveal any consistent strategy”

Spontaneous:
Q: “When does Curtiss come?”
Genie: “Monday.”
Q: “Where is your toy radio?”
Genie: “On chair.”

• No reported spoken production; on word card task, Genie constructed “What is under the green box?”
Critical period: Chelsea

- born profoundly hearing impaired to hearing parents
- misdiagnosed as retarded, but raised by family normally (not institutionalized)
- hearing loss diagnosed at age 31, fitted with hearing aids
- after nine years with hearing aids and training (at age 40):
  - vocabulary about 2000 words
  - reading at grade 2 or 3 level
  - speaking clearly enough to shop, order in restaurants, hold a part-time job as a veterinarian’s assistant
- after 12 years (at age 42)
  - production of syntactic structure about = 2.5-yr-olds
    - “hit ball”
    - “cupboard put food”
- function words and inflections largely absent, word order variable
The diagram illustrates the concept of modularity in the context of mental grammar. It shows the flow of information through different modules:

- **Thought** leads to:
  - **Semantic structure**
  - **Syntactic structure**
  - **Phonological structure**

These structures are interconnected and form the 'Language module'. Other modules include:

- **Motor instructions**
- **Auditory patterns**

Other inputs and outputs interact with these modules as well. The diagram also highlights the different types of reasoning and memory processes:

- **Number reasoning**
- **General reasoning**
- **Memory**
- **Perception**
Modularity: Christopher

Clinical history
• Born 1962; moderately brain-damaged at birth, possibly hydrocephaly, possibly due to maternal factors (mother 45, had German measles early in pregnancy)
• MRI in 1993 showed moderate cerebral atrophy with wide sulci
• Studied beginning at age 30

Nonverbally, Christopher is severely impaired
• institutionalized
• cannot find his way around, poor eye-hand coordination
• IQ (Raven’s Matrices, nonverbal): 75, 76
• IQ (WISC-R, preformance, nonverbal part): 42, 67, 52
• Columbia Greystone Mental Maturity Scale: 68 (= mental age of 9.2 and IQ of 56)
• Embedded Figures Test (match of geometric shapes with likes embedded in more complex designs): 1 out of 12 correct
• Fails conservation of number tasks (normally passed by age 5)
• Fails ‘Sally-Anne’ and most related tests for appropriate attribution of beliefs to others different from one’s own
Modularity: Christopher

Verbally, Christopher is gifted

- Verbal WISC-R: 89, 102, 98
- Has some knowledge (ranging from fluency to bare elements) of 16 languages: Danish, Dutch, Finnish, French, German, Greek, Hindi, Italian, Norwegian, Polish, Portuguese, Russian, Spanish, Swedish, Turkish, Welsh

Translations:

Greek

(1) Otan perase t’amaksi, epsakse ja tis pantufles tis, ala ena paljipedho ihe pari tii mja ke efévje jelontas.

*When the car passed, she looked for her slippers, but a naughty child had taken on and was leaving laughing.*

C: ‘When she passed the car ... when the car passed, she was looking for her slippers but an old child had taken one away and left ... and was laughing.’
Modularity: Christopher

Dutch
(2) ‘In elk geval,’ zegt ze ‘ik zal de ketel opzetten voor een kopje thee.’ ‘Ja graag, en dan moet ik eens opstappen. Ze zal niet weten waar ik blijf.’ ‘Anyway,’ she says, ‘I will put on the kettle for a cup of tea.’ ‘Yes, thanks; and then it will be time for me to go. She’ll be wondering when I’m coming.’

C: ‘ “In any case,” he --she says, “I will put the kettle on for a cup of tea.” “Yes, please, then I must stop. You know, you you you should not -- she shall not know where I am.” ’

Turkish
(3) Tatilde, herkes görmediği yerleri gezmeye gider. Hem bilgilerini geliştirmirler, hem eğlenirler ve hem de yeni yeni yerler görürler. On holiday, everyone goes to visit places they haven’t seen. Either they are strengthening their knowledge, or they are enjoying themselves, or they are looking at totally new places.

C: ‘On holiday when I was staying in different places I saw different places. The people were were scientists and some are students and some are new [inaudible] new places.’
Modularity: Christopher

Novel tests:
- Rapidly acquired a new language, Berber
- Correctly posited that Berber is null-subject, despite deliberate absence of relevant data in the input

Failed to acquire an ‘impossible’ rules in a made-up language (while controls did), ‘Epun’.
- SV(O) positive (present and future)
- VS(O) negative (present and future)
- (O)SV positive (past)
- (O)VS negative (past)

Negation Rule: To construct a negative clause in Epun, move the verb to the pre-subject position
Past Rule: To construct a transitive sentence in the past tense, mark the verb with *ha*- and move the object to initial position
Specific Language Impairment (SLI)

- delayed onset of language
- lasting difficulties in understanding, producing, and judging grammatical sentences
- grammatical deficits
- speech dyspraxia (difficulty making the complex, oral motor movements necessary for speech)
- depressed nonverbal IQ
- nonverbal developmental learning disorders

By definition, Specifically Language Impaired people show such deficits despite the absence of cognitive problems like retardation, sensory problems like hearing loss, or social problems like autism.
Genetic bases of language: SLI

1. SLI people judge examples like the following as acceptable:
   The boy eat three cookie.
   Yesterday the girl pet a dog.

2. Very poor performance on ‘wug’ test:
   wug  wugness
   zat  zackle
   zoop zoopes
   tob  tobyes
   zash zatches

3. Absent tense inflection
   Q: Every day he walks eight miles. Yesterday he...
   Response: “Walk.”
   Tense inflection more frequently absent with regular verbs than with irregulars
Genetic bases of language: SLI

SLI found in KE family (affected members underlined, age in 1992 in parentheses)

Grandparents: F(76)-M(deceased)

Parents: F(48)-M  M(47)-F  F(45)-M  M(42)-F  F(40)-M

F(14) M(22) F(19) F(12) M(17)
M(10) F(20) F(14) F(7) M(16)
F(14) M(13) F(13) F(4) F(14)
M(9) M(9) M(9) M(9)
F(8) F(8) F(8) F(8)

Mutation in FOXP2 gene on 7q31 (a dominant gene)
Genetic bases of language

Heritability: Measure of phenotypic variance that is due to genetic variance

Monozygotic (MZ) (‘identical’) twins are linguistically more similar to one another than dizygotic (‘fraternal’) twins
  • environment is the same
  • MZ twins share 100% of DNA, DZ 50%

Mean proband concordance rates for language disorders:
  80% for MZ twins
  46% for DZ twins
Genetic bases of language: WS

Williams Syndrome (WS) an inherited condition (1 in 20000 births, deletion of 15 or more genes from one of the two copies of chromosome 7)

Physical abnormalities:
- Characteristic facial appearance ("pixie-like", "elfin": elongated mouth, upturned nose, small chin, round ears); Heart and blood vessel problems (aortic stenosis), Hypercalcemia (elevated blood calcium levels); Low birth-weight / low weight gain; dental and kidney abnormalities; Hernias; Hyperacusis (sensitive hearing); Musculoskeletal problems

Cognitive abnormalities:
- Significant retardation (the average IQ is about 60), incompetence at simple everyday tasks (tying shoelaces, finding one's way, adding two numbers, and retrieving items from a cupboard)
- Social warmth and gregariousness (excessively social personality)
- Developmental delay, learning disabilities and attention deficit
- Fluent, (hyper)articulate language abilities

*
Genetic bases of language: WS

Stimulus: Three drawings of boy, dog, frog

Williams subject, age 17, IQ 50 “Once upon a time when it was dark at night, the boy had a frog. The boy was looking at the frog, sitting on the chair, on the table, and the dog was looking through, looking up to the frog in a jar. That night he slept and slept for a long time, the dog did. But the frog was not gonna go to sleep. The frog went out from the jar. And when the frog went out, the boy and the dog were still sleeping. Next morning it was beautiful in the morning. It was bright, and the sun was nice and warm. Then suddenly when he opened his eyes, he looked at the jar and then suddenly the frog was not there. The jar was empty. There was no frog to be found.”

Down Syndrome subject, age 18, IQ 55 “The frog is in the jar. The jar is on the floor. The jar on the floor. That’s it. The stool is broke. The clothes is laying there.”
Acquisition of syntax

First words appear between 12-18 months

<table>
<thead>
<tr>
<th>Age in months:</th>
<th>15</th>
<th>18</th>
<th>20+</th>
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</thead>
<tbody>
<tr>
<td># of words:</td>
<td>10</td>
<td>50</td>
<td>30-50/mo., later up to 20/day</td>
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</table>

Tad’s early words

<table>
<thead>
<tr>
<th>Age</th>
<th>Nominal</th>
<th>Predicate</th>
<th>Expressive</th>
<th>Indeterminate</th>
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</thead>
<tbody>
<tr>
<td>11</td>
<td>dog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>duck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Daddy Mama teh (teddy bear) car</td>
<td>yuk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>dipe (diaper) owl toot toot (horn)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>keys cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>eye</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>cow cup truck</td>
<td>hot</td>
<td></td>
<td>bath</td>
</tr>
<tr>
<td>19</td>
<td>kitty juice bottle spoon bowl towel</td>
<td>happy</td>
<td>oops</td>
<td>peepee</td>
</tr>
<tr>
<td></td>
<td>apple teeth cheek knee elbow</td>
<td>down</td>
<td>boo</td>
<td>tv</td>
</tr>
<tr>
<td></td>
<td>map ball block bus jeep</td>
<td>up</td>
<td>hi</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>bye</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>uh oh</td>
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</table>
Acquisition of syntax

Two words (Relative frequency of three utterance types)

Eve read; Adam put; hit ball; put book; Daddy cookie (= ‘Daddy eat cookie’); Daddy shoe; big train; red train; book table; sweater chair; come here; walk street; that book; it cat; more cookie; no milk; allgone egg; push it; milk cup; all broke; other bib; boot off; Papa away

Age (yr;mo)

1;7

1;10

Single-word utterances

Word successions

Two word combinations
Acquisition of wh-questions

Developmental order for wh-words

<table>
<thead>
<tr>
<th>wh-word</th>
<th>Average age of acquisition in months</th>
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</thead>
<tbody>
<tr>
<td>where, what</td>
<td>26</td>
</tr>
<tr>
<td>who</td>
<td>28</td>
</tr>
<tr>
<td>how</td>
<td>33</td>
</tr>
<tr>
<td>why</td>
<td>35</td>
</tr>
<tr>
<td>which, whose, when</td>
<td>after 36</td>
</tr>
</tbody>
</table>

Formulaic wh-questions:

- What’s that?
- What’s these? (26 mos., 28 mos.)
- What’s those? (28 mos.)
- Where’s my hankies? (28 mos.)
- What this?
- Who that?
- Where mummy?
Syntactic recursion

• The set of possible sentences in any human language is infinite, in principle

$\text{Embedding:}$

(4) a. Mr. Burns bribed Mayor Quimby.
    b. Bart claims that Mr. Burns bribed Mayor Quimby.
    c. Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.
    d. Marge’s been saying that Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.
    e. Homer thinks that Marge’s been saying that Lisa insists that Bart claims that Mr. Burns bribed Mayor Quimby.
The set of phrase structure rules is finite, but *recursive*.

(5) Lisa insists that Bart claims that Mr. Burns bribed Quimby.

(6)  
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<table>
<thead>
<tr>
<th>S</th>
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<tbody>
<tr>
<td>NP  VP</td>
</tr>
<tr>
<td>Lisa  V CP</td>
</tr>
<tr>
<td>V CP</td>
</tr>
<tr>
<td>C S</td>
</tr>
<tr>
<td>that</td>
</tr>
<tr>
<td>NP VP</td>
</tr>
<tr>
<td>Bart V CP</td>
</tr>
<tr>
<td>V CP</td>
</tr>
<tr>
<td>C S</td>
</tr>
<tr>
<td>that</td>
</tr>
<tr>
<td>NP VP</td>
</tr>
<tr>
<td>Mr. Burns V NP</td>
</tr>
<tr>
<td>V NP</td>
</tr>
<tr>
<td>bribed Quimby</td>
</tr>
</tbody>
</table>
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Long distance dependencies

• *wh*–‘movement’ in questions

(7) Who did Mr. Burns bribe?

- For purposes of semantic role assignment, syntactic case, etc., the *wh*-word *who* in (7) behaves like an ordinary object of the verb *bribe*
- For purposes of pronunciation, *who* is at the front of the clause: pronounced *before* the verb
Long distance dependencies

- A constrastive phrase or a question word can be a long distance from its gap (trace):

(8) a. Who did Mr. Burns bribe?

(9)
Long distance dependencies

- A constrastive phrase or a question word can be a long distance from its gap (trace):

(10)  a. Who did Mr. Burns bribe?
    b. Who does Bart claim that Mr. Burns bribed?
    c. Who does Lisa insist that Bart claims that Mr. Burns bribed?
    d. Who has Marge been saying that Lisa insists that Bart claims that Mr. Burns bribed?
    e. Who does Homer think that Marge’s been saying that Lisa insists that Bart claims that Mr. Burns bribed?

- An apparently *unbounded* distance, in fact: subject to memory and fatigue (performance) limits, but not to a *grammatical* limit.
Who does Lisa insist that Bart claims that Mr. Burns bribed __?
Bounded long distance dependencies

Who does Lisa insist ___ that Bart claims ___ that Mr. Burns bribed ___?

(12)

Long distance dependencies are in fact **bounded**: the dependency is **cyclic**
1. Embedded questions

(13) Bart wondered who bribed Quimby.

(14) *Who did$_1$ Bart$_2$ wonder$_3$ who$_4$ bribed$_5$ ___? \\

---

cf.

(15) Who does$_1$ Homer$_2$ think$_3$ that$_4$ Marge$_5$’s$_6$ been$_7$ saying$_8$ that$_9$ Lisa$_10$ insists$_{11}$ that$_{12}$ Bart$_{13}$ claims$_{14}$ that$_{15}$ Mr.$_{16}$ Burns$_{17}$ bribed$_{18}$ ___?
Constraints on long distance dependencies (islands)

(16) *Who did\textsubscript{1} Bart\textsubscript{2} wonder\textsubscript{3} who\textsubscript{4} bribed\textsubscript{5} ___ ?

(17) Long distance dependencies are in fact \textit{bounded}: intervening wh-phrases block movement over them: no ‘skipping’ a potential cyclic landing site
Acquisition of wh-questions

Children’s extraction from embedded clauses: adjuncts

Story (with illustrations):

The boy loves to climb trees in the forest. One day he slipped and fell to the ground. He picked himself up and went home. That night when he had a bath, he found a big bruise on his arm. He said to his Dad, “I must have hurt myself when I fell this afternoon.”

(18) Q: When [did the boy say [that he hurt himself __2] ___1]?

(19) CP
   | whP
   | when
   | did
   | C
   | S
   | NP
   | V
   | C
   | S
   | NP
   | V
   | NP
   | hurt
   | himself

interpretation 1: when asks about the time of the saying
Answer: “At night”

interpretation 2: when asks about the time of the hurting
Answer: “In the afternoon”

This is the ‘long distance’ (LD) interpretation
Acquisition of wh-questions

Children’s extraction from embedded clauses: arguments

Story (with illustrations):
Kermit and Cookie Monster were baking. Big Bird came in and wanted to help someone. He wanted to do his favorite kind of baking, but he didn’t know who he should help. So he asked Bert if he could help Kermit.

(20) Q: Who [did Big Bird ask ___1 [to help ___2 ]]? 
(21) CP
   whP           C'
   who
   C
   did
   NP        VP
   Big Bird
   ask
   V
   t1
   S
   Inf
   to
   VP
   help
   V
   t2

interpretation 1: who is the object of ask
Answer: “Bert”

interpretation 2: who is the object of help
Answer: “Kermit”

This is the ‘long distance’ (LD) interpretation
# Acquisition of wh-questions

Children’s extraction from embedded clauses

## Results (percentages):

<table>
<thead>
<tr>
<th>Sentence Type</th>
<th>Long distance Interpretation</th>
<th>Non-LD Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$wh$ adjunct</td>
<td>44%</td>
<td>50%</td>
</tr>
<tr>
<td>$wh$ argument</td>
<td>32%</td>
<td>68%</td>
</tr>
</tbody>
</table>

**Conclusion:** Children permit LD extraction
Acquisition of wh-questions

Children’s extraction from islands

Story (with illustrations):

The boy loves to climb trees in the forest. One day he slipped and fell to the ground. He picked himself up and went home. That night when he had a bath, he found a big bruise on his arm. He said to his Dad, “I must have hurt myself when I fell this afternoon.”

(22) Q: When [did the boy say [how he hurt himself ___2] ___1]?

(23) This is the ‘long distance’ (LD) interpretation
Acquisition of wh-questions

Children’s extraction from islands

Results (percentages):

<table>
<thead>
<tr>
<th>Sentence Type</th>
<th>Long distance Interpretation</th>
<th>Non-LD Interpretation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>wh adjunct</td>
<td>6%</td>
<td>48%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Conclusion:

Children do not permit LD extraction out of islands

(24) Q: When [did the boy say [how he hurt himself \(\underline{2}\) \(\underline{1}\)]? 
(25) Q: When [did the boy say [that he hurt himself \(\underline{2}\) \(\underline{1}\)]?

Q: When [did the boy say [how he hurt himself \(\underline{2}\) \(\underline{1}\)]?
Acquisition of yes-no questions

(26)  Abby is sleeping.
(27)  Is Abby sleeping?

Hypothesis 1: Move the 2nd word to the front of the clause
Acquisition of yes-no questions

(28) Abby is sleeping.
(29) Is Abby sleeping?

Hypothesis 1: Move the 2nd word to the front of the clause

(30) The girl is sleeping.
(31) *Girl the is sleeping?
(32) → Is the girl sleeping?

Hypothesis 2: Move the first *auxiliary to the front the clause
Acquisition of yes-no questions

(33) Abby is sleeping.
(34) Is Abby sleeping?

Hypothesis 1: Move the 2nd word to the front of the clause

(35) The girl is sleeping.
(36) Girl the is sleeping?
(37) → Is the girl sleeping?

Hypothesis 2: Move the first *auxiliary* to the front the clause

(38) The girl that was tired is sleeping.
(39) *Was the girl that tired is sleeping?*
(40) Is the girl that was tired sleeping?
Acquisition of yes-no questions

Hypothesis 3: Move the *structurally highest auxiliary* to the front of the clause

(41)
How do kids do this?

Traditional view: Learning by ‘analogy’

Analogic learning must be constrained:

(42)
It is likely that John will be late. John is likely to be late.
It is probable that John will be late. *John is probable to be late.

(43)
Mark likes ham with eggs What does Mark like ham with?
Mark likes ham and eggs. *What does Mark like ham and?

(44)
John ate the sandwich cold John ate the cold sandwich
John ate the sandwich naked *John ate the naked sandwich
Analogy gone wrong

(45) Mark said Sue invited Bob.
     Mark said that Sue invited Bob.

(46) Who did Mark say Sue invited ___? 
     Who did Mark say that Sue invited ___? 

(47) Who did Mark say ___ invited Bob? 
    *Who did Mark say that ___ invited Bob? 

(Even youngest kids tested [3;0] are *highly* sensitive to this effect. Test item type: Who did the lion know ___1 that ___2 swam in the pond?)
No analogic learning?

Maybe kids are ‘conservative’ learners? Maybe they generalize only when positive evidence for doing so is present? (I.e., they use ‘indirect negative evidence’)

But:

(48) _Kid hears:_
    house   houses
    mow     mowed

(49) _Kid produces:_
    mouse   mouses
    go      goed

(50) She made me clean.       She cleaned me.
    She made the door open.  She opened the door.
    She made me giggle.      She giggled me.
Plato’s Problem

How do kids know so much on such little evidence?

Poverty of the stimulus
  • Evidence underdetermines the possible grammars
  • Potentially disambiguating evidence is absent or equivalent to noise in the input

No (direct) negative evidence
  • Children don’t receive grammatical correction or instruction
So how do kids do it?

A: By “pattern matching.”
So how do kids do it?

A: By “pattern matching.”
Q: What kinds of “patterns”? 
So how do kids do it?

A: By “pattern matching.”
Q: What kinds of “patterns”?
A: Syntactic structures (not e.g. word adjacencies, linear counting, etc.)
So how do kids do it?

A: By “pattern matching.”
Q: What kinds of “patterns”?  
A: Syntactic structures (not e.g. word adjacencies, linear counting, etc.)
Q: How do kids know to use these kinds of “patterns” and not others, obvious ones also present and deducible from the data
So how do kids do it?

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Q: What kinds of “patterns”?
A: Syntactic structures (not e.g. word adjacencies, linear counting, etc.)
Q: How do kids know to use these kinds of “patterns” and not others, obvious ones also present and deducible from the data
A: That’s how human language works.
So how do kids do it?

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Q: What kinds of “patterns”?
A: Syntactic structures (not e.g. word adjacencies, linear counting, etc.)
Q: How do kids know to use these kinds of “patterns” and not others, obvious ones also present and deducible from the data
A: That’s how human language works.
Q: But why does it work that way?
So how do kids do it?

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A: Syntactic structures (not e.g. word adjacencies, linear counting, etc.)
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Q: What kinds of “patterns”? 
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Q: How do kids know to use these kinds of “patterns” and not others, obvious ones also present and deducible from the data
A: That’s how human language works.
Q: But why does it work that way?
A: Because language is a tool for communication.
So how do kids do it?

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Q: What kinds of “patterns”?  
A: Syntactic structures (not e.g. word adjacencies, linear counting, etc.)
Q: How do kids know to use these kinds of “patterns” and not others, obvious ones also present and deducible from the data
A: That’s how human language works.
Q: But why does it work that way?
A: Because language is a tool for communication.
Q: But why would such patterns and not others (like word adjacencies) be “better tools”? 
So how do kids do it?

A: By “pattern matching.”
Q: What kinds of “patterns”? 
A: Syntactic structures (not e.g. word adjacencies, linear counting, etc.)
Q: How do kids know to use *these* kinds of “patterns” and not others, obvious ones also present and deducible from the data?
A: That’s how human language works.
Q: But why does it work that way?
A: Because language is a tool for communication.
Q: But why would such patterns and not others (like word adjacencies) be “better tools”? 
A: ??
A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.
So how do kids do it?

A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.

Q: What is “bias”? 
So how do kids do it?

A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.

Q: What is “bias”?  
A: A predisposition. A prior constraining of the hypothesis space.
So how do kids do it?

A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.

Q: What is “bias”?

A: A predisposition. A prior constraining of the hypothesis space.

Q: Where does this “predisposition” come from?
So how do kids do it?

A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.

Q: What is “bias”?
A: A predisposition. A prior constraining of the hypothesis space.

Q: Where does this “predisposition” come from?
A: From the structure of the mind.
So how do kids do it?

A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.

Q: What is “bias”?
A: A predisposition. A prior constraining of the hypothesis space.

Q: Where does this “predisposition” come from?
A: From the structure of the mind.

Q: Huh??
So how do kids do it?

A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.

Q: What is “bias”?
A: A predisposition. A prior constraining of the hypothesis space.

Q: Where does this “predisposition” come from?
A: From the structure of the mind.
Q: Huh??
A: That is, from the mental organizational principles that arise from the brain, from the course of the brain’s development and maturation.
So how do kids do it?

A: Hierarchical, recursive syntactic structure is something that the child is biased to search for; the grammars posited by the learner are biased to be stated in such terms.

Q: What is “bias”?
A: A predisposition. A prior constraining of the hypothesis space.

Q: Where does this “predisposition” come from?
A: From the structure of the mind.

Q: Huh??
A: That is, from the mental organizational principles that arise from the brain, from the course of the brain’s development and maturation.

Q: And what determines these?
So how do kids do it?

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A: From the structure of the mind.
Q: Huh??
A: That is, from the mental organizational principles that arise from the brain, from the course of the brain’s development and maturation.

Q: And what determines these?
A: The genes (“nature”) and their phenotypic expression given environmental conditions (“nurture”)
“The” Innateness Hypothesis

Weak version
1. Human grammars are innately constrained
   (Everyone agrees with this: humans acquire language, chimps don’t.)
“The” Innateness Hypothesis

**Weaker version**

1. Human grammars are innately constrained  
   (Everyone agrees with this: humans acquire language,  
   chimps don’t.)

**Stronger version:**

2. There are *language-specific* innate constraints  
   [1] doesn’t follow from innate *general* cognitive or learning  
   biases.

These language-specific constraints are what Chomsky  
 calls **Universal Grammar**: a modular, innate component of  
 the mind/brain