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On the Strong Minimalist Thesis:
Is there room for *there* in the Workspace?

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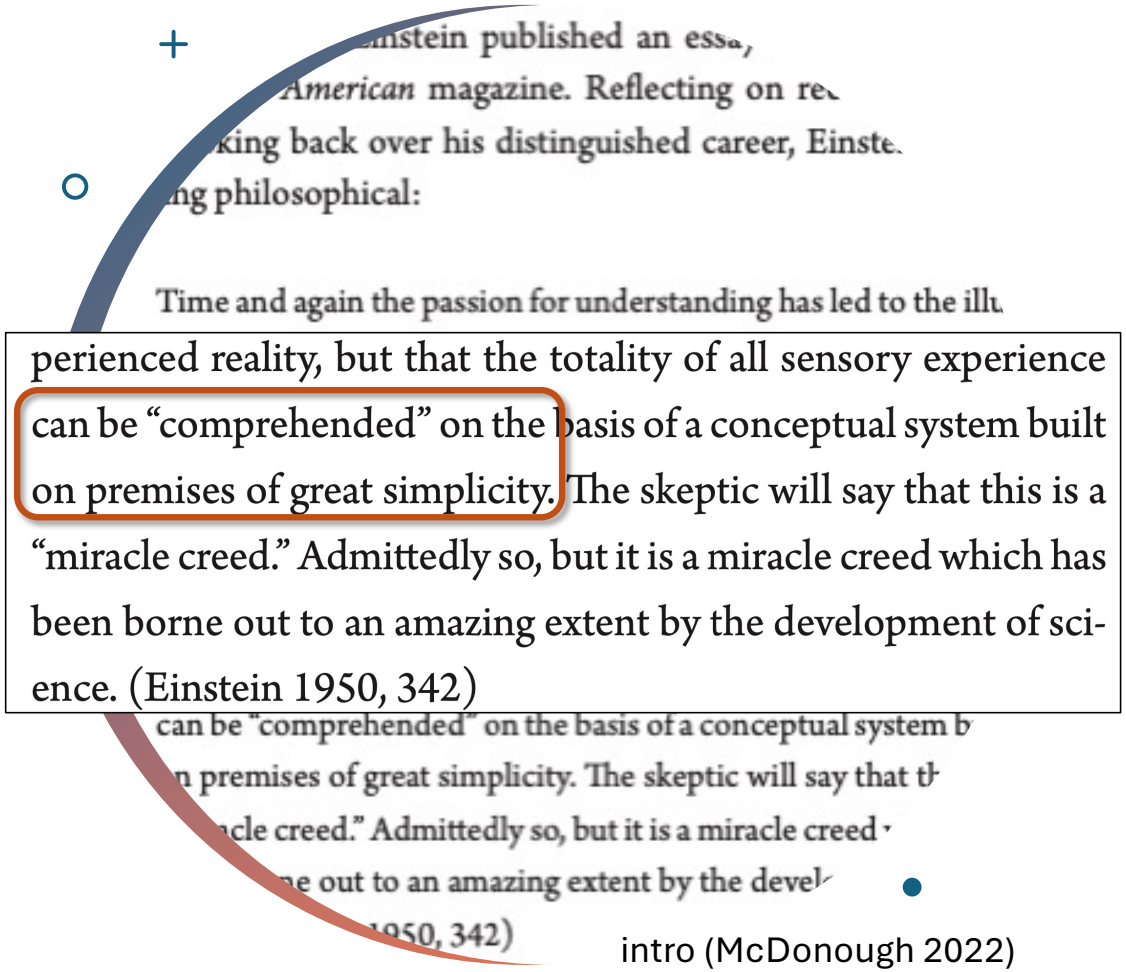
Talk Outline

- **Part 1: Background assumptions**
  - **Strong Minimalist Thesis** (SMT)
  - the simplicity of **I-Language**
  - **Basic Property (BP) of Language**
  - **Merge** and **operative complexity**
  - The **slow brain**
  - **Evolution**
  - Examples of derivations
- **Part 2: there-insertion**
  - Should ***there*-insertion** be part of I-Language?
  - Reasons yes and no
  - A radical proposal



intro (McDonough 2022)

What is the Strong Minimalist Thesis (SMT)?

- a theory design guideline (Chomsky 2024)
- **SMT**: **Language** satisfies Einstein's *Miracle Creed*

(Wikipedia) LLMs: "*largest models typically have 100 billion parameters*"
GPT-4 1,760 billion

What does it mean for I-Language?

- "The Strong Minimalist Thesis (SMT) holds that language too may satisfy the miracle creed **at its core**." (Chomsky 2024)
- At the core: **I-Language**
  - **I = internal**: the expressions computed by Merge
  - could be a **well-formed thought** but not (directly) externalizable

    Eagles that *can* fly *can swim*

well-formed thought but not externalizable

[pg.39, (Chomsky 2013)]

{C_Q, {INFL, {{eagles, {C_{rel}, {INFL, ~~{eagles}~~, {v_θ, fly}}}}}, {v_θ, swim}}}}

can

- Eagles that fly swim
- Eagles that fly *can* swim **?** (*turn into a question: front modal verb*)
- *Can* eagles that fly *swim*? C_Q: question about *swim* (not *fly*)

{C_Q, {INFL, {{eagles, {C_{rel}, {INFL, {can, ~~{eagles}~~, {v_θ, fly}}}}}}, {v_θ, swim}}}}

- Eagles that *can fly* swim (*let's try turning it into a question*)
- *****Can* eagles that *fly* swim? **well-formed thought** (no EXT)

"*... that is a fine thought, but it cannot be expressed by* [*this sentence*]."

What does it mean for I-Language?

- "The Strong Minimalist Thesis (SMT) holds that language too may satisfy the **miracle creed** **at its core**." (Chomsky 2024)
- At the core: **I-Language**
  - internal: the expressions computed by Merge
  - could be a **well-formed thought** but not (directly) externalizable
  - not linearly ordered, see **Basic Property** (BP)
- **E-Language**:
  - Externalized I-Language (**EXT**), e.g. pronounced or signed or written
  - linear order imposed by the modality
  - sensorimotor system is more ancient, but EXT came after Merge
  - word order and spellout parameterized *by particular (E-)language*

return to talk about this soon!

Miracle Creed: nature maximizing simplicity

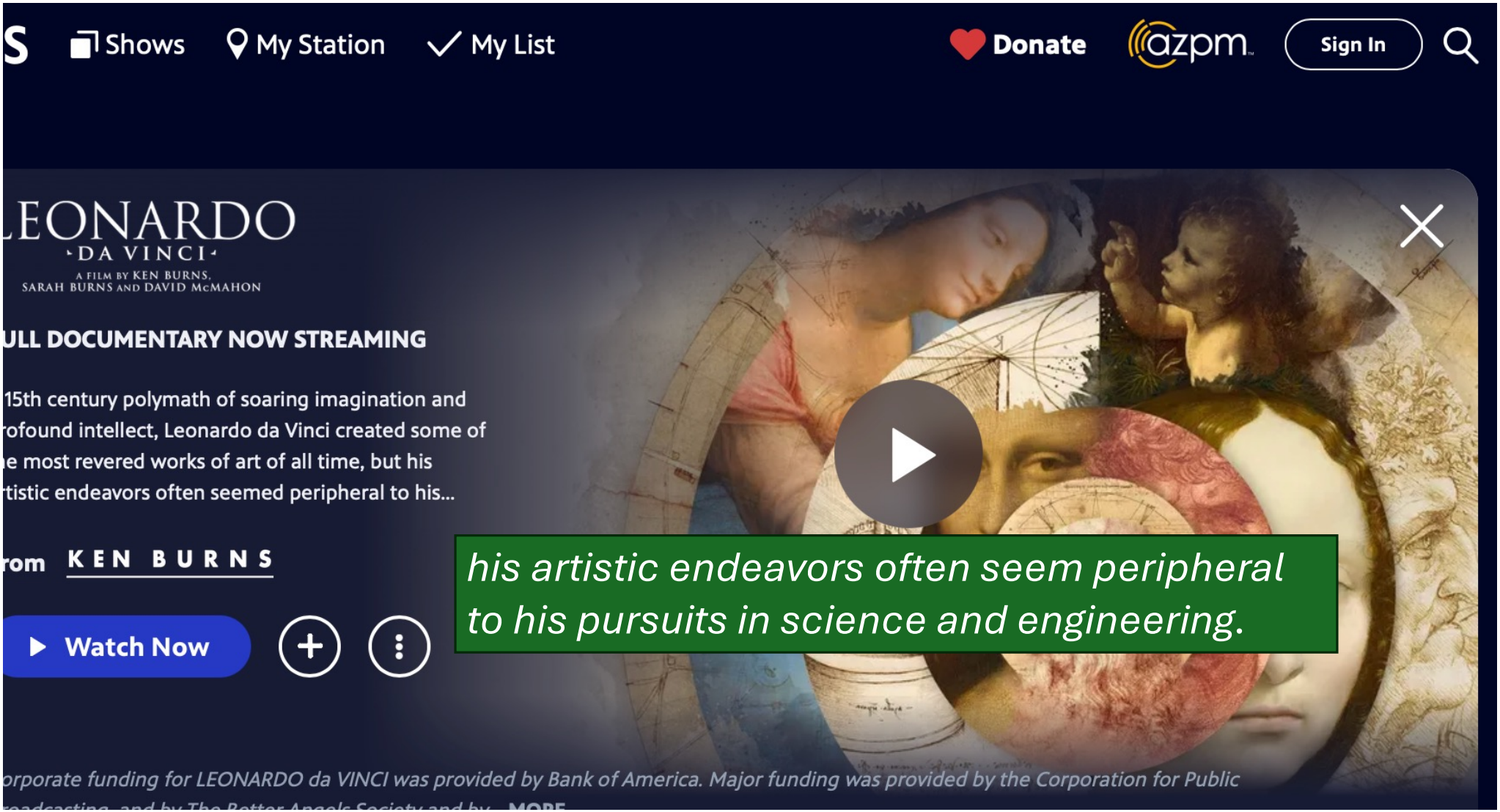
Dialogue Concerning the Two Chief World Systems (**Galileo 1632)**

- "***nature*** (*which by general agreement does not act by means of many things when it can do so by means of few*)"
  - **Context**: general discussion about motion of the planets

- *Quaderni d'anatomia IV* **(Leonardo da Vinci)**:
  - "*Every action in* ***nature*** *takes place in the shortest way possible*."
  - quoted in *Leonardo's Optics* (Argentieri, 1956)

SMT **optimal** solution:

- *Nature adapts/optimizes what it has to work with*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his artistic endeavors often seem peripheral
to his pursuits in science and engineering.
orporate funding for LEONARDO da VINCI was provided by Bank of America. Major funding was provided by the Corporation for Public

Topics

- **Part 1: Strong Minimalist Thesis** (SMT)
  - **Basic Property (BP)** of Language

Basic Property (BP) of Language

- simplest computational rule: *pick nearest (appropriate) word*

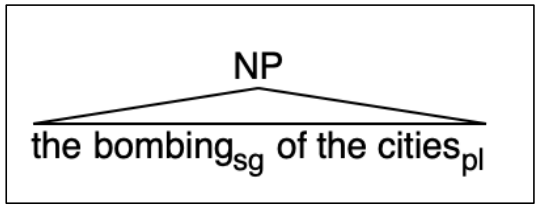
> The simplest operation is certainly within the cognitive repertoire. *A child has no problem picking the first bead on a string*. (Chomsky 2021)

- **BP: no**, simplest rule actually available:
  - *build structure, then determine nearest*
  - **not acquired**: observed in children, as early as 30 months

cognitive toolkit has linear order operations!

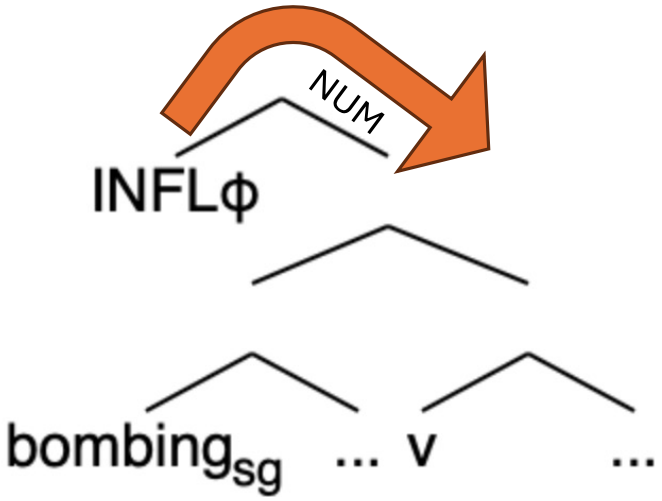
- **Number Agreement**:
  a. the bombing$_{sg}$ of the cities$_{pl}$ **was$_{sg}$** criminal
  b. * were$_{pl}$
  c. the bombings$_{pl}$ of the city$_{sg}$ **were$_{pl}$** criminal
  d. * was$_{sg}$

[pg.9, (Chomsky 2021)]



Basic Property (BP) of Language

- first build structure:
  - *the bombing of the cities*
  - {bombing$_{\text{the,[sg]}}$, (of) {cities$_{\text{the,[pl]}}$}}
- *then do* **(Minimal) Search**:
  - e.g. search for NUM
  - **Ans**: [sg]



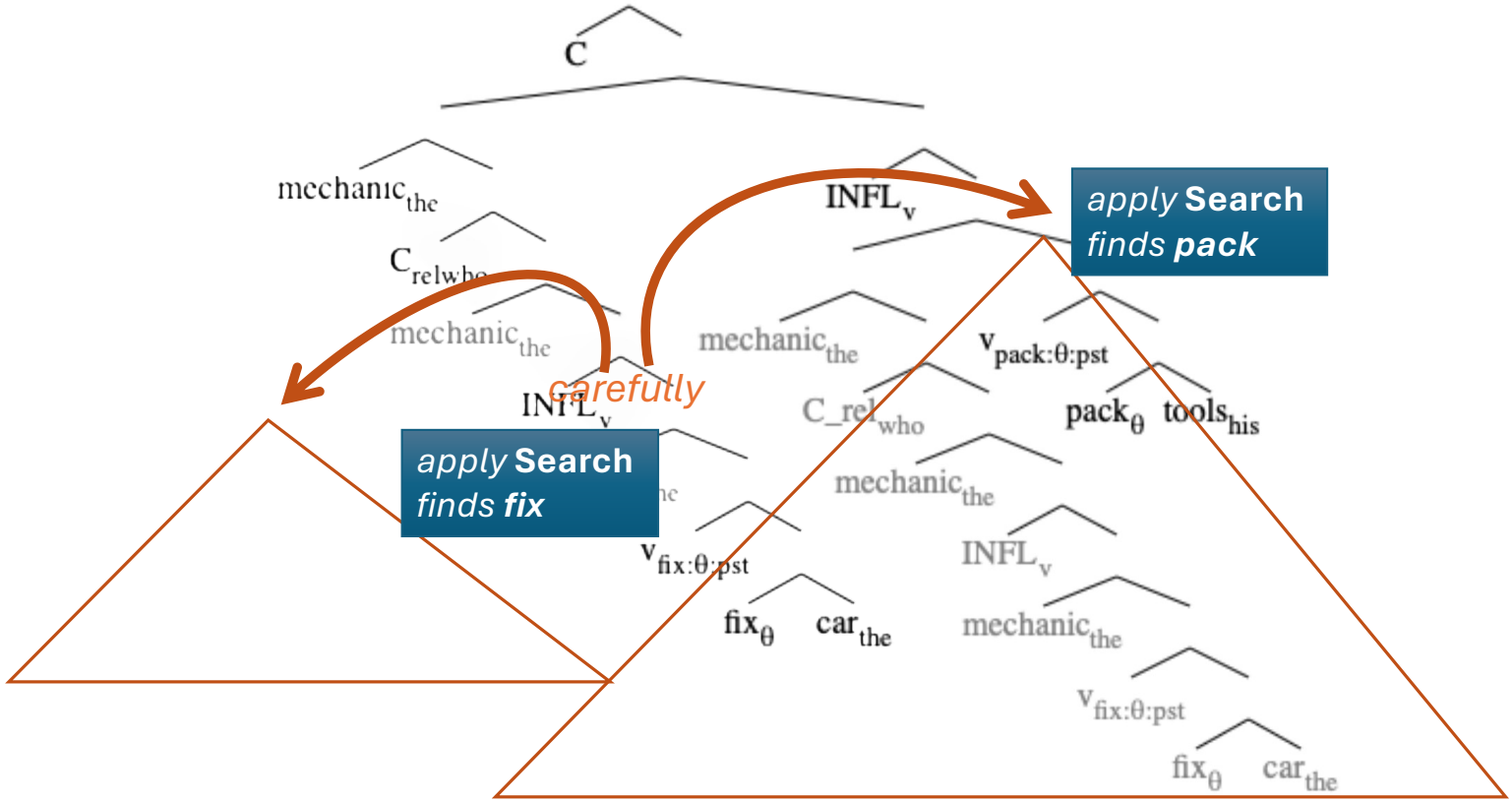
Basic Property (BP) of Language

[pg.9, (Chomsky 2021)]

- **Construal rule**:
  - "adverb *carefully* seeks a verb [to modify], but it cannot use the **simplest computation**: pick the **linearly closest** verb."
  - Below: [...] *marks linearly closest verb to the adverb*

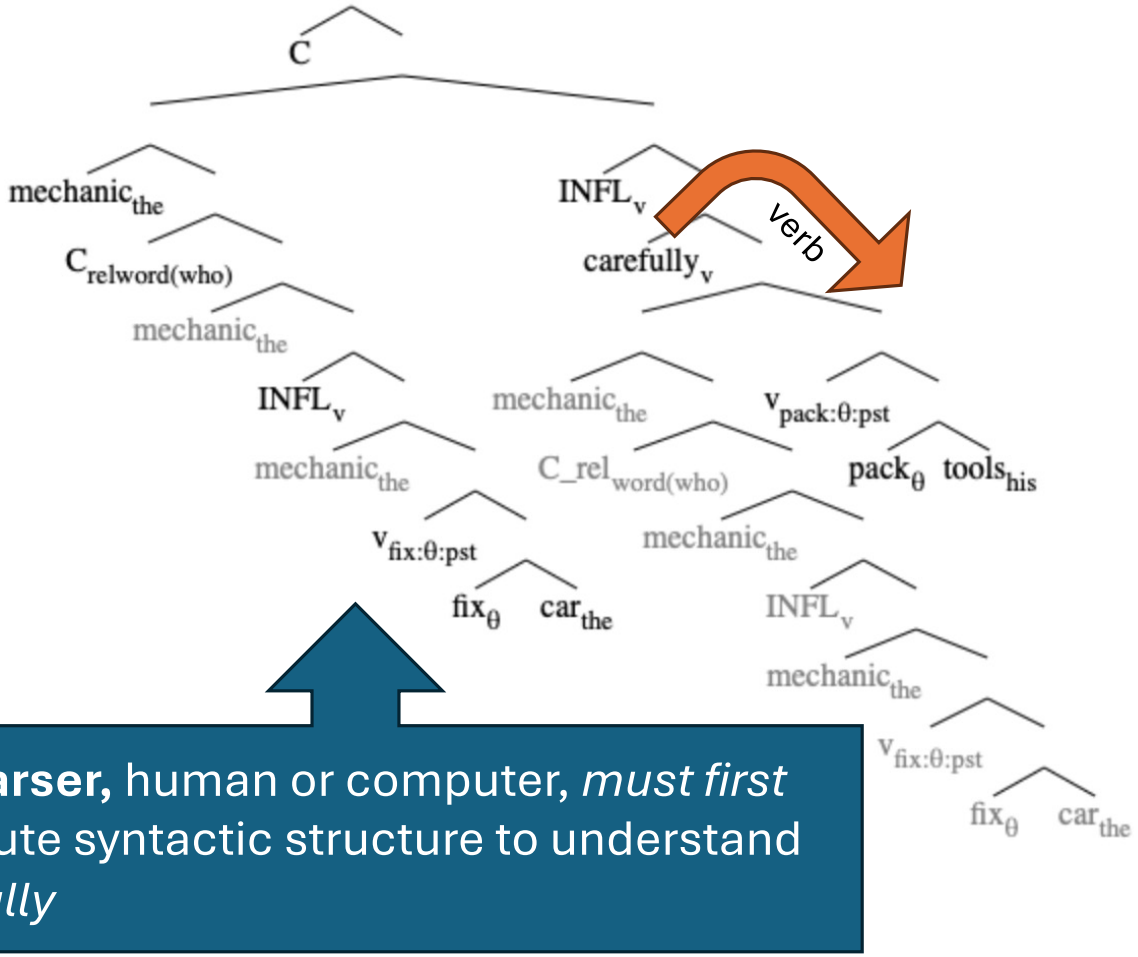
- the mechanic who *fixed* the car *carefully* [*packed*] his tools ← ANS: [*pack*] or *fix*
- *Carefully*, the mechanic who [*fixed*] the car *packed* his tools ← ANS: *pack*
- the mechanic who *fixed* the car [*packed*] his tools *carefully* ← ANS: [*pack*] ✅
- the mechanic who *carefully* [*fixed*] the car *packed* his tools ← ANS: [*fix*] ✅

Why? the mechanic who *fixed* the car *carefully packed* his tools



Search underpins relation formation

- *carefully* initiates a Search
- **Search** locates the relevant **term** (*a verb*)
- Search is **minimal**
- Simplest **structural** computation



any **parser,** human or computer, *must first* compute syntactic structure to understand *carefully*

Topics

- **Part 1: Strong Minimalist Thesis** (SMT)
  - **Basic Property (BP)** of Language
  - simplicity of **I-Language**
  - **Merge, Minimal Search and operative complexity**

Merge

- SMT says
  - simplicity of mechanism is needed (*evolutionary plausibility*)
  - computational efficiency is needed (*slow wetware*)
  - simplicity of description is possible (Einstein's *Miracle Creed*)
- What is that simple mechanism?
  - *ask what's the simplest (formal) device that permits **phrases**?*

we'll be talking about this very soon!

... a bit later

Simplest Merge

(1) External (EM)

{...} just notation, but we don't really use mathematical set theory

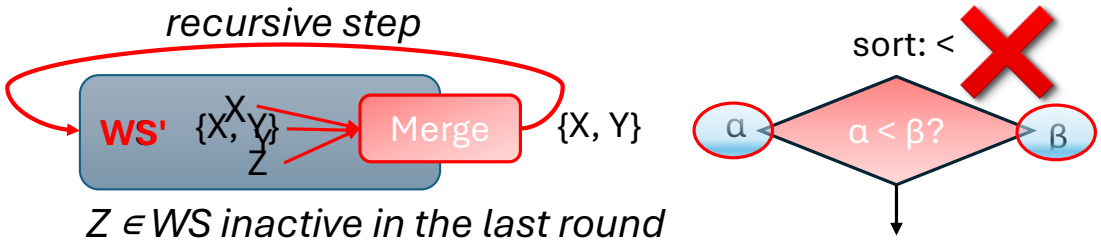
- X Y ⇒ {X, Y}
- X = {.. {..Y..}..} ⇒ {**Y**, {.. {..Y..}..}}, Y a **sub-term** of X
- assume all this happens in a **Workspace** (WS) **without history**

o/w can circumvent c-command

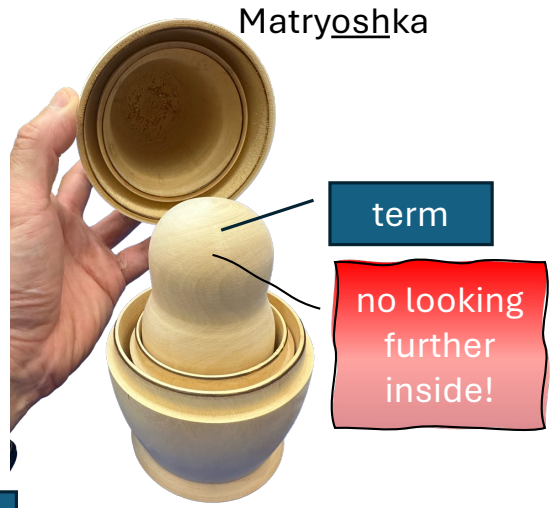
(2) Internal (IM)

Recursion

- Adopt simplest **recursive** formal device
  - i.e. *Merge feeds Merge* in the Workspace (WS)
  - not a one-time operation, *cf. Conjoin* (Progovac 2015)



Z ∈ WS inactive in the last round
Computation converges: one syntactic object



3rd Factor: all operations obey this

- (Minimal) **Search**:
  - *look in the WS or internally for a **term**, 1st thing you find, have to stop*
  - *looking ahead to Part 2: EXT adopts this layered approach*

Topics

- **Part 1: Strong Minimalist Thesis** (SMT)
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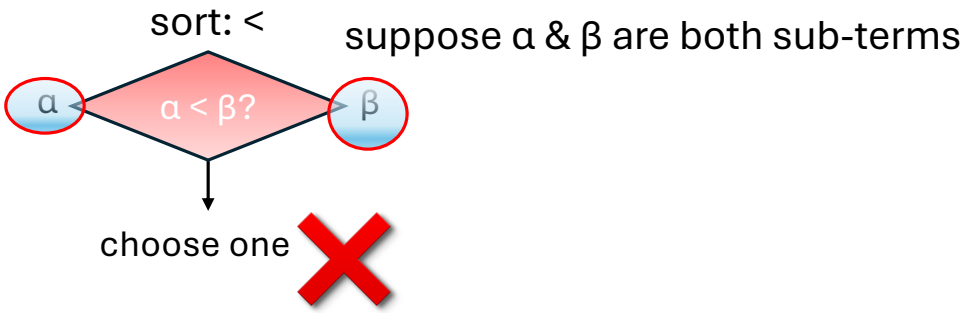
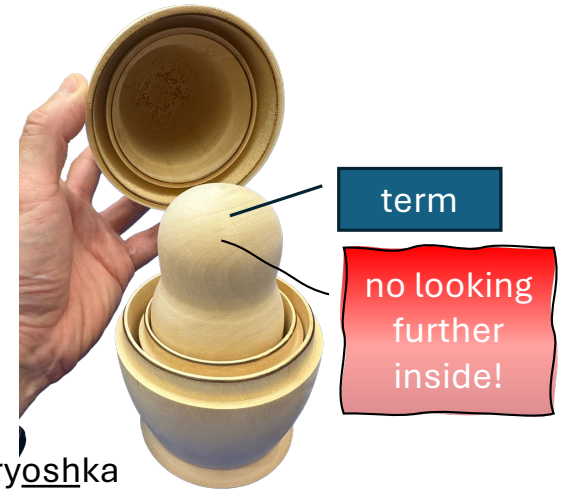
Search

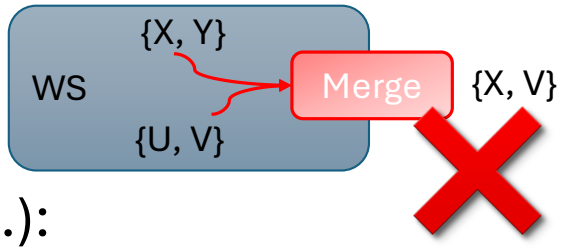
- Minimal **Search**:
  - *part of the cognitive toolkit* (First Factor)
  - subject to the Third Factor (*minimal*)
  - *look in the WS, or*
  - *look internally for a **term**, find 1st thing, have to stop*
    - *comparisons not permitted (e.g. optimality theory)*





Minimal Search (MS)

- (Chomsky p.c.):
  - **We assume that Merge like other operations observes it.**
  - **That's why only members of WS, not their terms, are eligible for [External Merge].**



- Chomsky (p.c.):
  - **Right now I don't see any reason why any operation should be exempt from MS. If so, MS can include structural identity checking -- which is its basic intuitive content.**
  - *in the toolkit available to cognitive systems*

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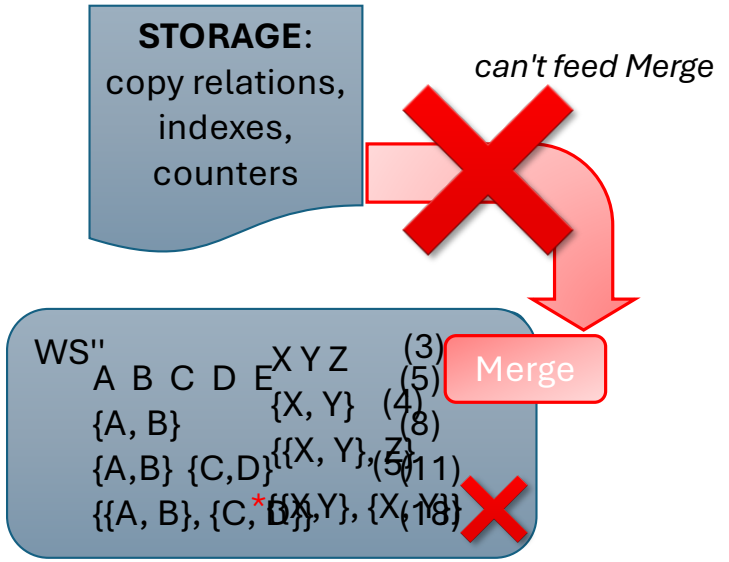
Merge is limited

- Markovian assumption:
  - no storage/counter memory
  - no WS history: WS' cannot see WS *or earlier*
    - *too powerful*: *can build anything*
  - minimize WS complexity: Minimal Yield (MY)
    - *growth can be in terms of WS item + term access*
- **Simplest (recursive) Merge**
  - *no further elaboration permitted*
  - no parallel Merge
  - no sideways Merge
  - no 3 objects at a time
  - no splicing/tuck-in operations
  - *etc*.



but see FormSet (Chomsky 2021; 2024) for UUC
John, Bill, my friends, the actor who won the Oscar …
John arrived and met Bill

FormSet

1) (a) {narrow, hallway$_a$} EM: AP θ-configuration
   (b) {long, hallway$_a$}
   (c) {dark, hallway$_a$}

- FormSet ({…}, n≥2) (Chomsky 2021):
  - ***coherent*** *collection of WS objects*

  2) {{long, hallway$_a$}, {narrow, hallway$_a$}, {dark, hallway$_a$}}

- Need a nominal to head the NP:
  - *apply same operation all members of the collection* (ATB functionality)

  3) {hallway$_a$, {{long, ~~hallway~~$_a$}, {narrow, ~~hallway~~$_a$}, {dark, ~~hallway~~$_a$}}}
  4) EXT: *a long, narrow, (and) dark hallway*

(Fong & Oishi, *to appear*))

A Note on the Determiner

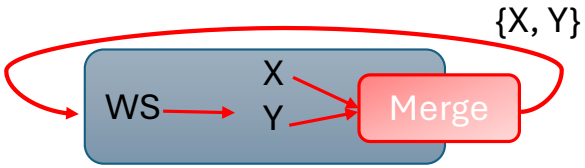
{D, N} (or <D, N> (Oishi, 2015)) if D projects

- Chomsky (p.c.):
  - **Is this External Merge?**
  - **We're just ignoring functional elements, stick them in wherever you want.**
  - **And, of course, you know there's lots of things to say about them, so why does the definite article appear before the noun?**
  - **In fact, does the definite article even apply to the noun?**
  - **Maybe the definite article's a feature of the noun phrase.**
  - **Like in Semitic, for example, it's just distributed among the elements of the noun phrase.**
- Hebrew:

  5) *ha-yeled ha-ze*
     'this child'

  - attributive adjectives must agree in definiteness; and predicative adjectives are indicated syntactically, by the lack of an article in conjunction with a definite noun.

Operative Complexity



- **Question**: now, is *simplest* Merge efficient enough for biology?
- Actually, it has horrible combinatorics
  - *not feasible for biology,*
  - *not feasible for computers*

- **Answer**: Merge has Language Specific Constraints (LSCs)
  - I-Language Merge could be feasible

return to this important idea

Topics

- **Part 1: Strong Minimalist Thesis** (SMT)
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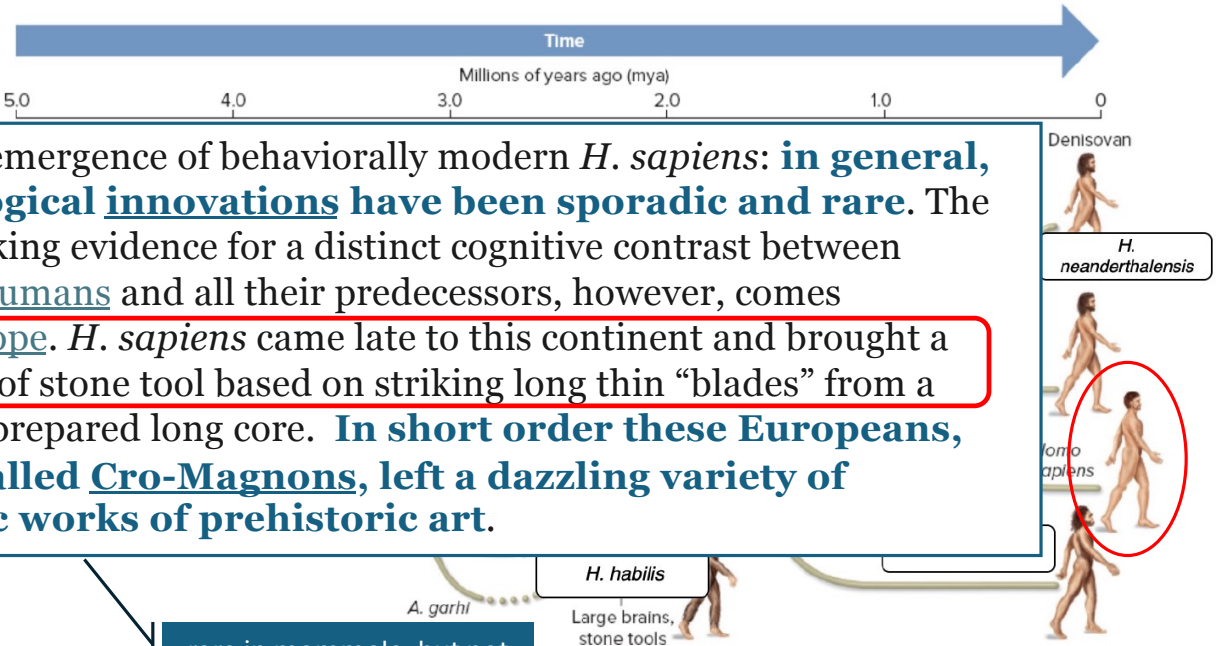
  - **Merge, Minimal Search** and **operative complexity**
  - **Evolution**
  - The **slow brain**

Evolution: *modern humans*

Language, the ultimate symbolic mental function, it is ***virtually impossible to conceive of thought*** *as we know it in its absence.*
(Tattersall 2006)

"if we are seeking a single cultural releasing factor that opened the way to **symbolic cognition**, the invention of language is the most obvious candidate." (Tattersall 2006)

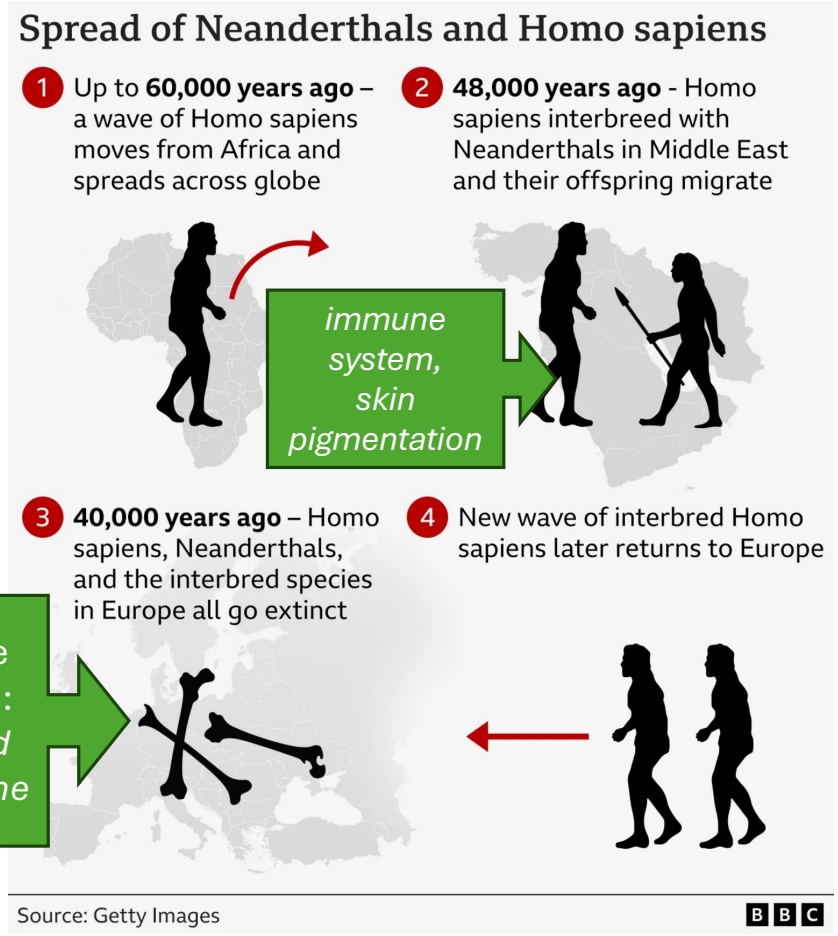


until the emergence of behaviorally modern *H. sapiens*: **in general, technological innovations have been sporadic and rare**. The most-striking evidence for a distinct cognitive contrast between modern humans and all their predecessors, however, comes from Europe. *H. sapiens* came late to this continent and brought a new kind of stone tool based on striking long thin "blades" from a carefully prepared long core. **In short order these Europeans, the so-called Cro-Magnons, left a dazzling variety of symbolic works of prehistoric art.**

rare in mammals, but not unknown for primates

Evolution: *modern humans*

- https://www.nature.com/articles/s41586-024-08420-x
  - *Ranis genomes harbor Neanderthal segments that originate from a single admixture event shared with all non-Africans that we date to ~45,000-49,000 years ago.*
- https://www.science.org/doi/10.1126/science.adq3010
  - *evidence for a single extended period of Neanderthal gene flow that occurred ~47,000 years ago and lasted for ~7000 years*

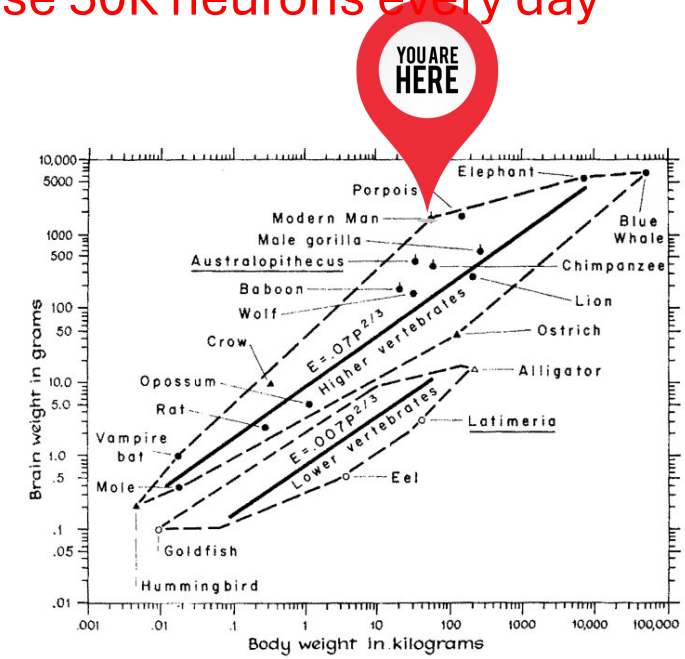


Are we special? Allometric scaling

Brain: 86 billion neurons

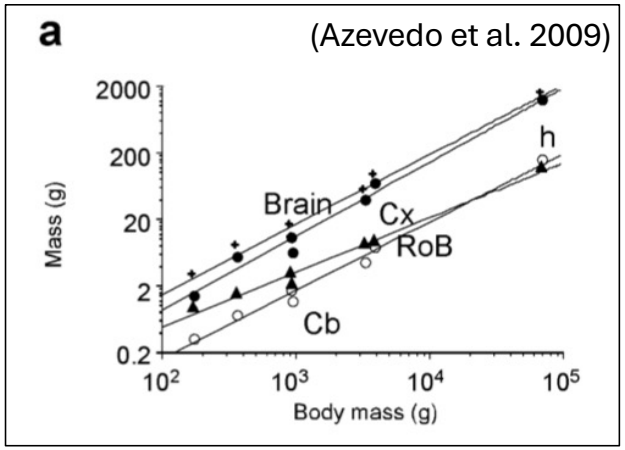
Great!

- we lose 50K neurons every day



Nah, we're not outliers!

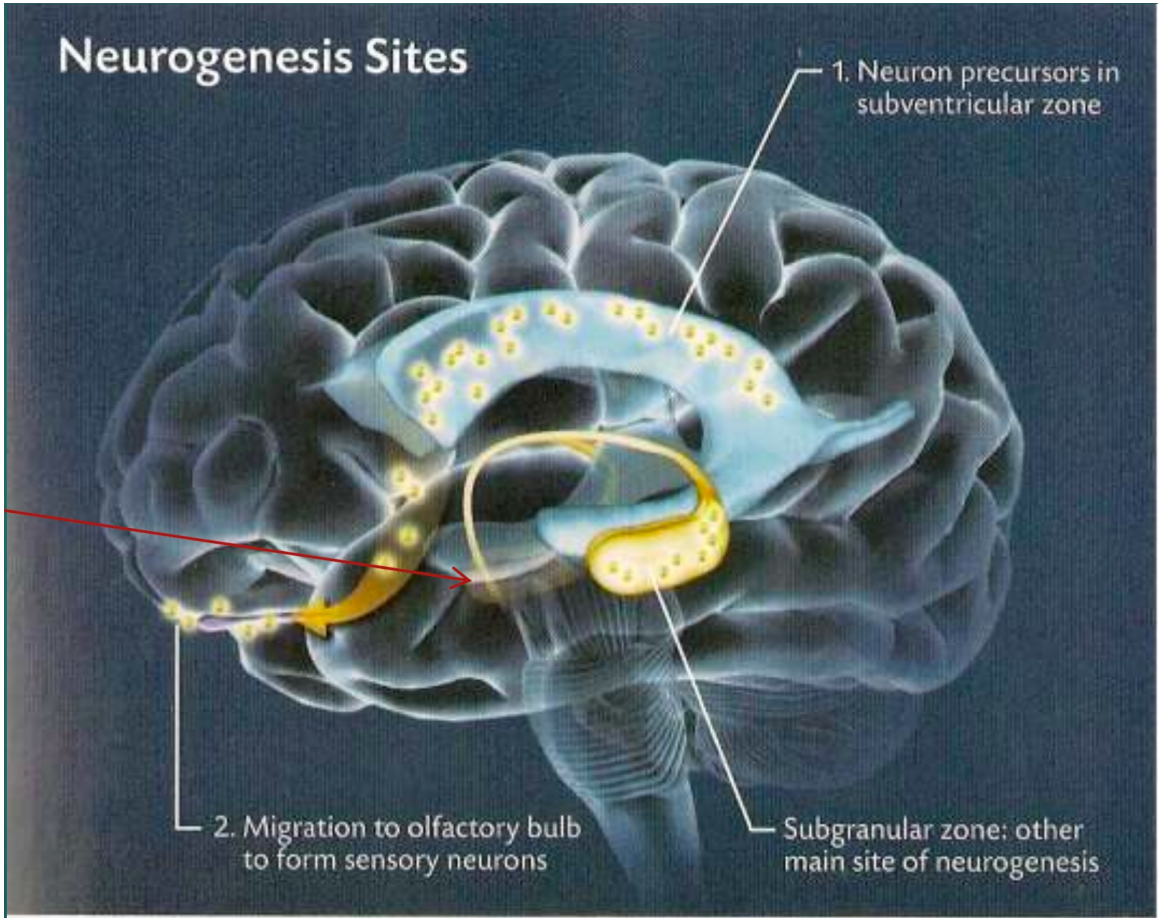
- Primate brain scaling: *uniquely human*?



Human Brain Development

Vella (2016):

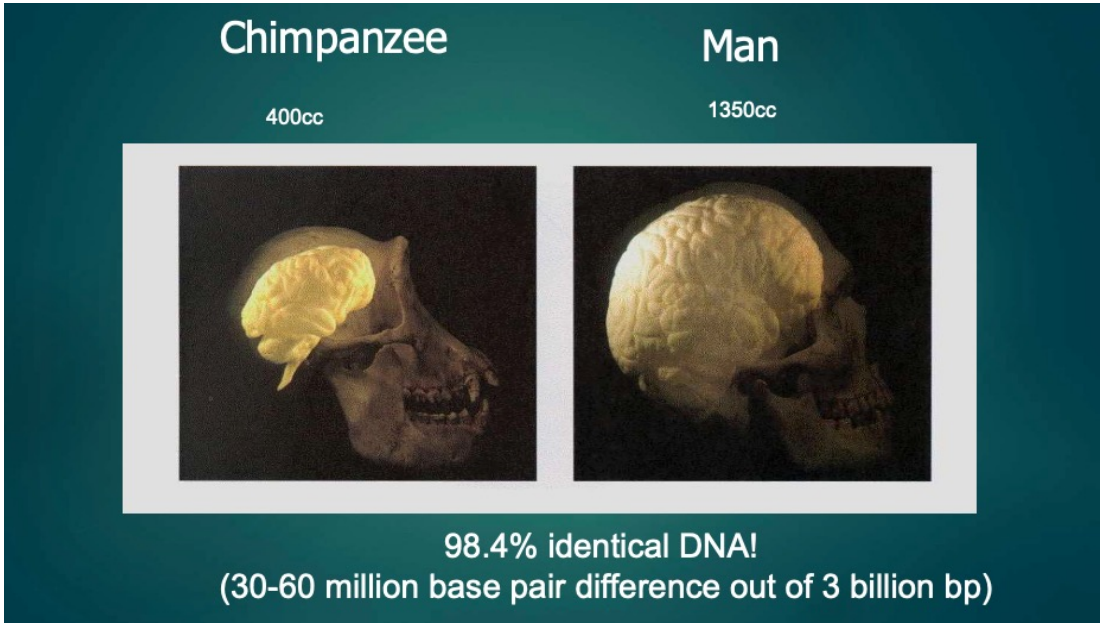
- **Perinatal neuron cell death**: Infant primates may have up to **twice the adult number of neurons**.
- Great Adolescent Pruning: Age 5-21
  - **Heavy synaptic pruning**: circuits are sculpted from the brain by **pruning** away cells and synapses.
  - Mechanisms: Programmed cell death (apoptosis), passive loss due to lack of stimulation, learning.
- 1.4K new neurons a day



Primates

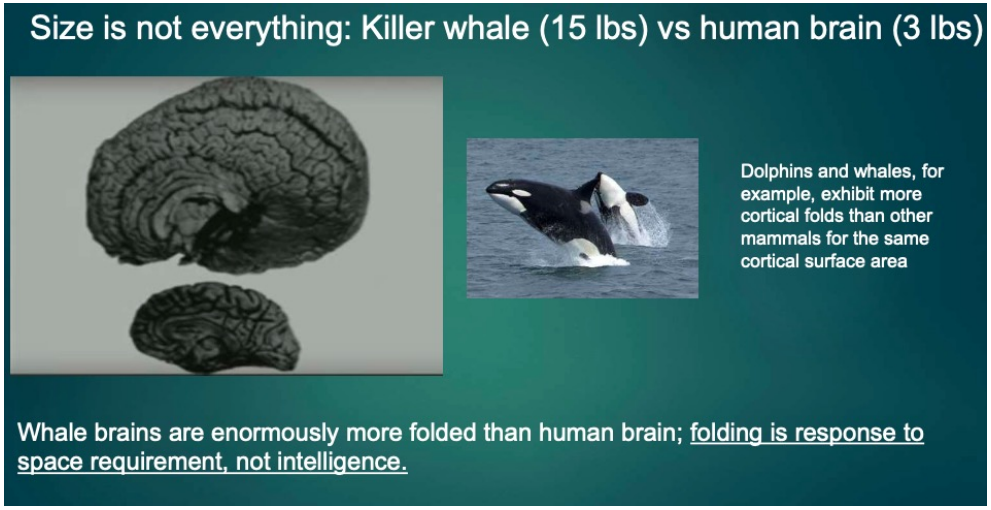
(Vella 2016)

- *Animals with large brains are rare*
- Energy cost is high (20W)
- Longer gestation
- More wiring means slower brain unless reorganized



- neuroanatomical differences: humans vs. nonhuman primates exist, e.g. ***Broca's area***

Is absolute brain size important?



Vella (2016)

[pg145. *The descent of man, and selection in relation to sex*. Darwin (1871)]

- *no one supposes that the **intellect** of any two animals or of any two men can be accurately gauged by the cubic contents of their skulls.*

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  - **Evolution**
  - The **slow brain**

Brain is slow, efficiency is important

Computational efficiency (and **bandwidth**) are important considerations for all organic systems:

- our **sensory apparatus** can generate vast amounts of data (*sensor mismatch*)
- a slow (*chemical*) brain limits what can be analyzed
- ***The War of Soups and Sparks*** (Valenstein, 2005) 19th century belief that neurons were electrically connected. *Neurophysiologists believed only electrical transmission is fast enough to activate skeletal muscles.* Mid-20th century: brain is chemical.
- neuron communication uses 50% of energy
- we (selectively) throw out/ignore almost all of the signal

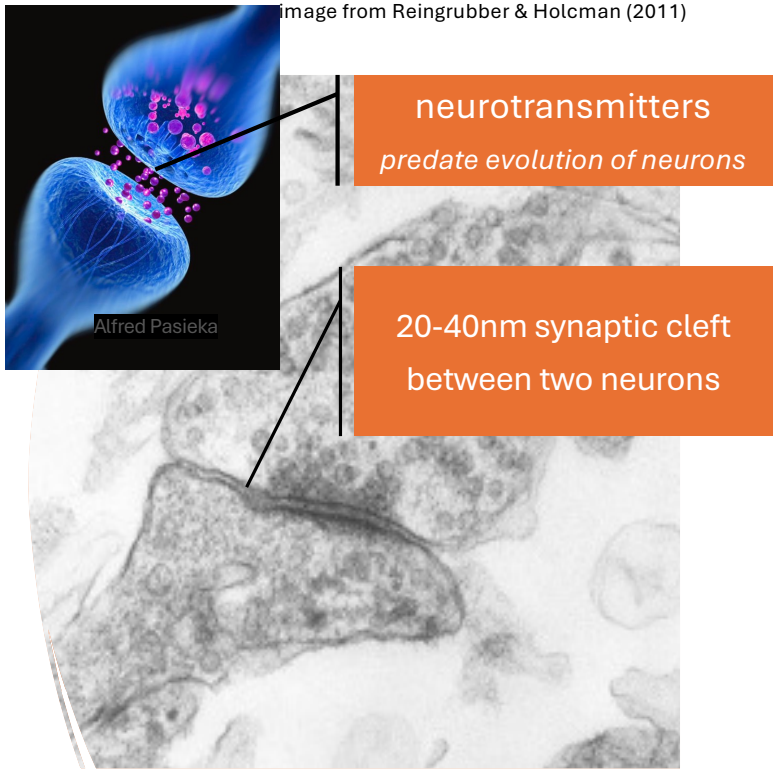
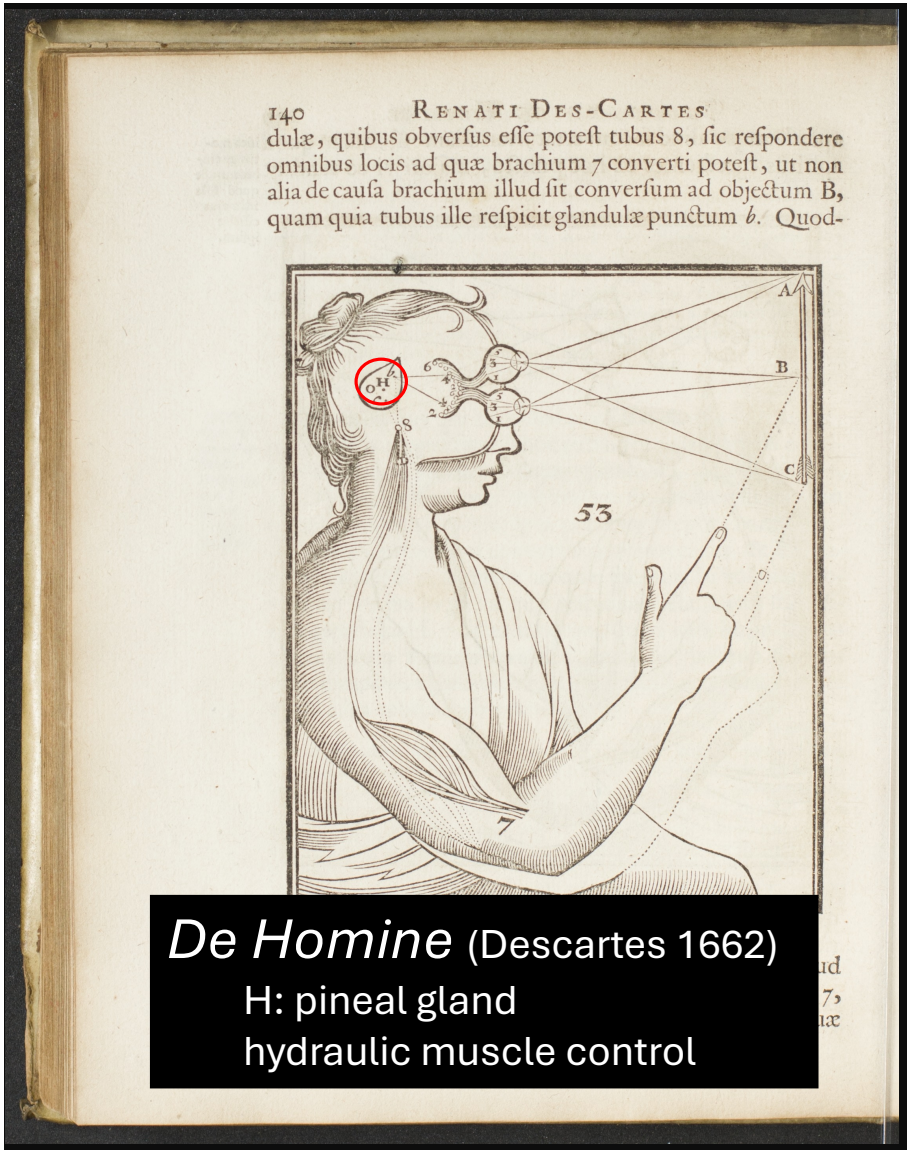


image from Reingrubber & Holcman (2011)

Earlier theories of the brain



De Homine (Descartes 1662)
H: pineal gland
hydraulic muscle control

- Leonardo da Vinci
  - ventricles (brain)
  - *imprensiva*
  - *senso comune*
  - *memoria*

  (Pevsner 2019)

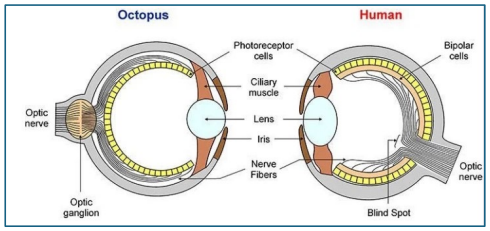
Evolution is really slow: Language is recent

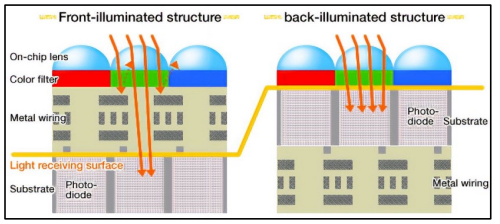
Land & Fernald (1992), *Animal Eyes* Land & Nilsson (2012)

- From the first opsin to high-resolution vision took about **170 million years** and was largely completed by the onset of the Cambrian, about 530 mya.
  - stage 1: receptors (evolved 40-65 times)
  - stage 2: optics (10 different systems)
- First brain cells (700 mya),
- First nervous system (500 mya, Cambrian). Jellyfish: eyes but no brain.
- First human-like brain (3-4 mya)
- Modern brain (1-0.2 mya)

SMT optimal solution:

- *Nature adapts/optimizes what it has to work with*
- *[Many parallels between Language and the visual system … not discussed here]*

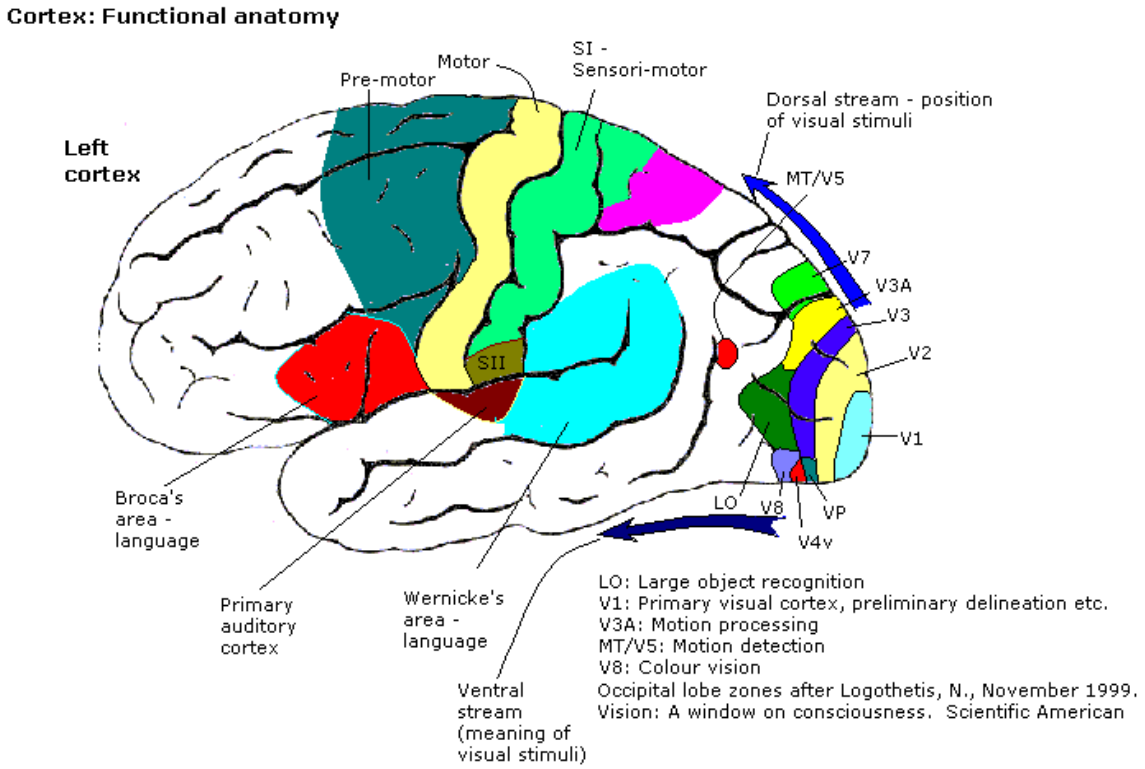




nevsemi.com

- "camera eye" (*cf. compound eye*)
- octopus: color-blind, but can re-generate eyes
- ***random***: we lost superior tetrachromatic vision 100 mya

Vision: more area, more evolved than Language?



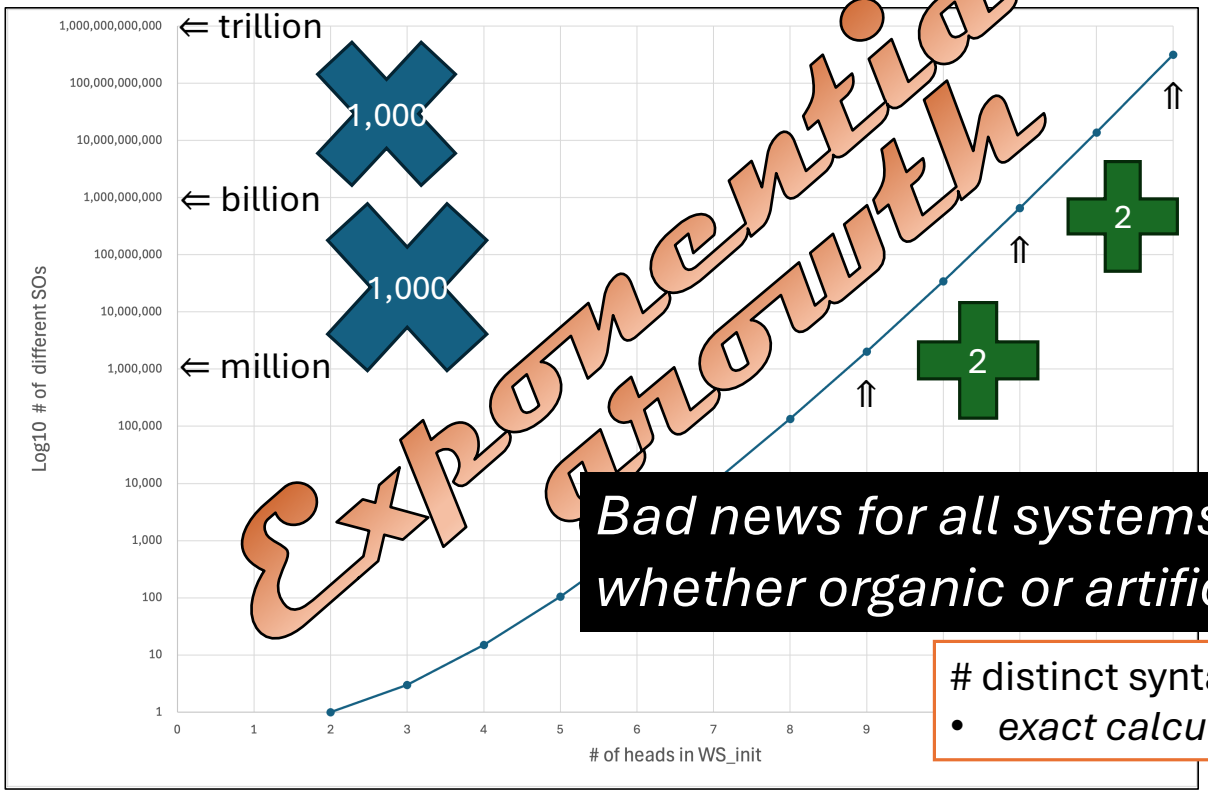
Vision developed much earlier: **Nature** had time to evolve it.

- 50% of the cortex
- V1 primary visual cortex: retinotopic map
- V2 neurons build upon the basic features detected in V1, extracting more complex visual attributes such as texture, depth, and color

Complexity of Merge

- Merge as a mathematical abstraction
  - formal complexity of Merge raises issues for biological implementation
- Merge as applied to I-Language

Summary: Free Merge is mathematically bad



Heads	#SOs
2	1
3	3
4	15
5	105
6	945
7	10,395
8	135,135
9	2,027,025
10	34,459,425
11	654,729,075
12	13,749,310,575
13	316,234,143,225

Bad news for all systems, whether organic or artificial

distinct syntactic objects for External Merge

- *exact calculation, verified by computer*

Merge Combinatorics

Consider External Merge only

- and only those cases that **converge** on a single Syntactic Object (SO)

- Given WS_{init} =
  - $h_1\ h_2$ converge on: $\{h_1, h_2\}$ (1 case, **order unimportant!** $\{h_2, h_1\}$)
  - $|\ h_1\ h_2\ |$ = 2. #(|WS|=2) = 1
  - $h_1\ h_2\ h_3$ converge on 3 cases:
    - $\{\{h_1, h_2\}, h_3\}$
    - $\{\{h_1, h_3\}, h_2\}$
    - $\{\{h_2, h_3\}, h_1\}$
  - $|\ h_1\ h_2\ h_3|$ = 3. #(|WS|=3) = 3
  - $h_1\ h_2\ h_3\ h_4$ converge on 15 cases, i.e. #(|WS|=4) = 15:
    - $\{\{\{h_1, h_2\}, h_3\}, h_4\}$ $\{\{\{h_1, h_2\}, h_4\}, h_3\}$ $\{\{h_1, h_2\}, \{h_3, h_4\}\}$
    - $\{\{\{h_1, h_3\}, h_2\}, h_4\}$ $\{\{\{h_1, h_3\}, h_4\}, h_2\}$ $\{\{h_1, h_3\}, \{h_2, h_4\}\}$
    - $\{\{\{h_1, h_4\}, h_2\}, h_3\}$ $\{\{\{h_1, h_4\}, h_3\}, h_2\}$
    - $\{\{\{h_2, h_3\}, h_1\}, h_4\}$ $\{\{\{h_2, h_3\}, h_4\}, h_1\}$ $\{\{h_2, h_3\}, \{h_1, h_4\}\}$
    - $\{\{\{h_2, h_4\}, h_1\}, h_3\}$ $\{\{\{h_2, h_4\}, h_3\}, h_1\}$
    - $\{\{\{h_3, h_4\}, h_1\}, h_2\}$ $\{\{\{h_3, h_4\}, h_2\}, h_1\}$

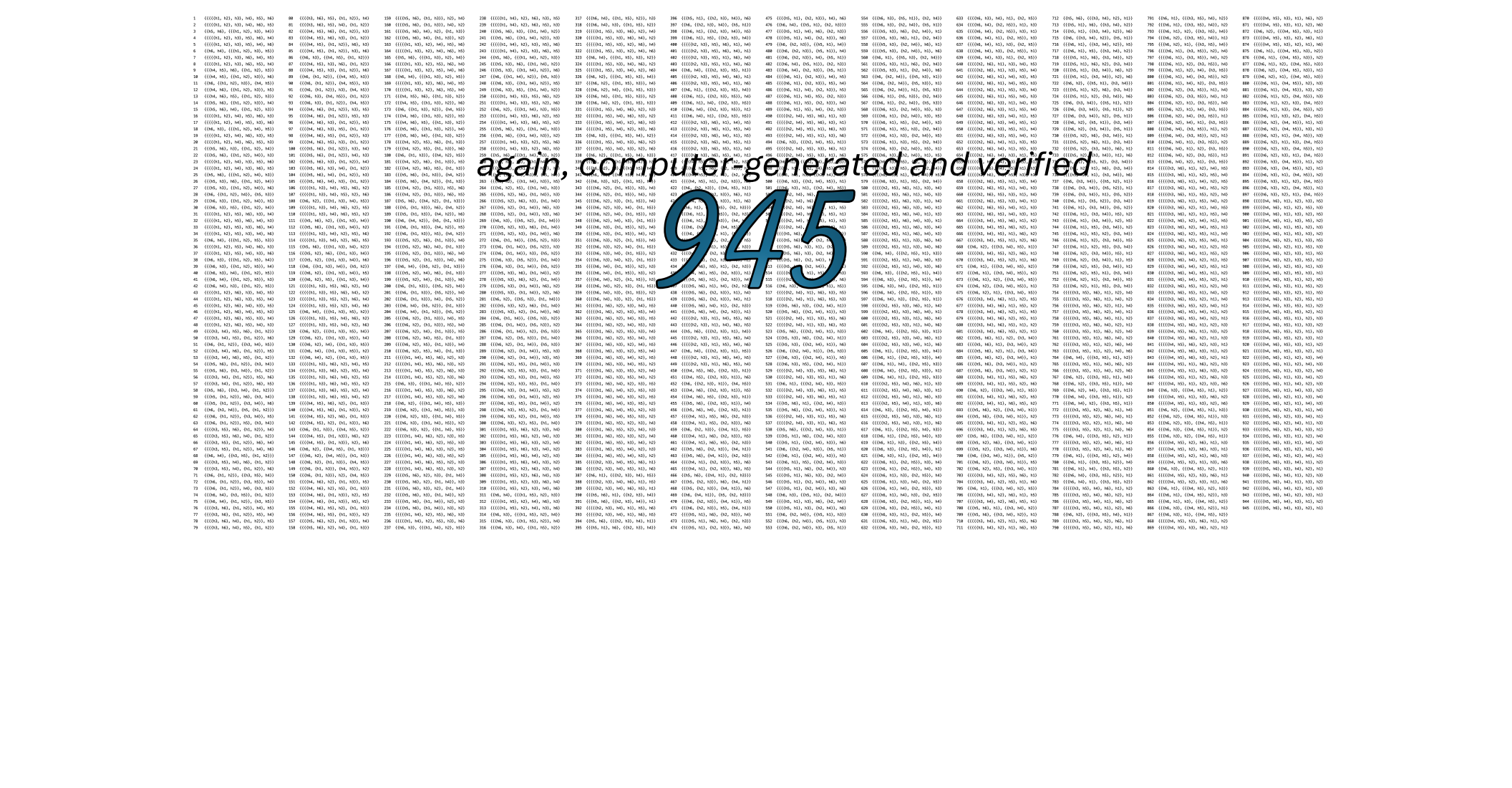
Merge Combinatorics: $WS_{init} = h_1\ h_2\ h_3\ h_4\ h_5$

a simple computer program verifies

105

1. {{{{h1, h2}, h3}, h4}, h5}
2. {{{{h1, h2}, h3}, h5}, h4}
3. {{h4, h5}, {{h1, h2}, h3}}
4. {{{{h1, h2}, h4}, h5}, h3}
5. {{{{h1, h2}, h4}, h3}, h5}
6. {{h5, h3}, {{h1, h2}, h4}}
7. {{{{h1, h2}, h5}, h3}, h4}
8. {{{{h1, h2}, h5}, h4}, h3}
9. {{{h3, h4}, h5}, {h1, h2}}
10. {{{h3, h4}, {h1, h2}}, h5}
11. {{h5, {h1, h2}}, {h3, h4}}
12. {{{h3, h5}, {h1, h2}}, h4}
13. {{{h3, h5}, h4}, {h1, h2}}
14. {{{h4, h5}, {h1, h2}}, h3}
15. {{{h4, h5}, h3}, {h1, h2}}
16. {{{{h1, h3}, h4}, h5}, h2}
17. {{{{h1, h3}, h4}, h2}, h5}
18. {{h5, h2}, {{h1, h3}, h4}}
19. {{{{h1, h3}, h5}, h2}, h4}
20. {{{{h1, h3}, h5}, h4}, h2}
21. {{{h4, h5}, h2}, {h1, h3}}
22. {{{h4, h5}, {h1, h3}}, h2}
23. {{{{h1, h3}, h2}, h4}, h5}
24. {{{{h1, h3}, h2}, h5}, h4}
25. {{h4, h5}, {{h1, h3}, h2}}
26. {{{h4, h2}, h5}, {h1, h3}}
27. {{{h4, h2}, {h1, h3}}, h5}
28. {{h5, {h1, h3}}, {h4, h2}}
29. {{{h5, h2}, {h1, h3}}, h4}
30. {{{h5, h2}, h4}, {h1, h3}}
31. {{{{h1, h4}, h5}, h2}, h3}
32. {{{{h1, h4}, h5}, h3}, h2}
33. {{{{h1, h4}, h2}, h5}, h3}
34. {{{{h1, h4}, h2}, h3}, h5}
35. {{h5, h3}, {{h1, h4}, h2}}
36. {{{{h1, h4}, h3}, h5}, h2}
37. {{{{h1, h4}, h3}, h2}, h5}
38. {{h5, h2}, {{h1, h4}, h3}}
39. {{{h5, h2}, {h1, h4}}, h3}
40. {{{h5, h2}, h3}, {h1, h4}}
41. {{{h5, h3}, {h1, h4}}, h2}
42. {{{h5, h3}, h2}, {h1, h4}}
43. {{{{h1, h5}, h2}, h3}, h4}
44. {{{{h1, h5}, h2}, h4}, h3}
45. {{{{h1, h5}, h3}, h2}, h4}
46. {{{{h1, h5}, h3}, h4}, h2}
47. {{{{h1, h5}, h4}, h2}, h3}
48. {{{{h1, h5}, h4}, h3}, h2}
49. {{{{h2, h3}, h4}, h5}, h1}
50. {{{{h2, h3}, h4}, h1}, h5}
51. {{{h5, h1}, {h2, h3}, h4}}
52. {{{{h2, h3}, h5}, h1}, h4}
53. {{{{h2, h3}, h5}, h4}, h1}
54. {{{h4, h5}, h1}, {h2, h3}}
55. {{{{h4, h5}, {h2, h3}}, h1}
56. {{{{h2, h3}, h1}, h5}, h4}
57. {{{{h2, h3}, h1}, h5}, h4}
58. {{h4, h5}, {{h2, h3}, h1}}
59. {{{h4, h1}, h5}, {h2, h3}}
60. {{{h4, h1}, {h2, h3}}, h5}
61. {{h5, {h2, h3}}, {h4, h1}}
62. {{{h5, h1}, {h2, h3}}, h4}
63. {{{h5, h1}, h4}, {h2, h3}}
64. {{{{h2, h4}, h5}, h1}, h3}
65. {{{{h2, h4}, h5}, h3}, h1}
66. {{{{h2, h4}, h1}, h5}, h3}
67. {{{{h2, h4}, h1}, h3}, h5}
68. {{h5, h3}, {{h2, h4}, h1}}
69. {{{{h2, h4}, h3}, h5}, h1}
70. {{{{h2, h4}, h3}, h1}, h5}
71. {{h5, h1}, {{h2, h4}, h3}}
72. {{{h5, h1}, {h2, h4}}, h3}
73. {{{h5, h1}, h3}, {h2, h4}}
74. {{{h5, h3}, {h2, h4}}, h1}
75. {{{h5, h3}, h1}, {h2, h4}}
76. {{{{h2, h5}, h1}, h3}, h4}
77. {{{{h2, h5}, h1}, h4}, h3}
78. {{{{h2, h5}, h3}, h1}, h4}
79. {{{{h2, h5}, h3}, h4}, h1}
80. {{{{h2, h5}, h4}, h1}, h3}
81. {{{{h2, h5}, h4}, h3}, h1}
82. {{{{h3, h4}, h5}, h1}, h2}
83. {{{{h3, h4}, h5}, h2}, h1}
84. {{{{h3, h4}, h1}, h5}, h2}
85. {{{{h3, h4}, h1}, h2}, h5}
86. {{h5, h2}, {{h3, h4}, h1}}
87. {{{{h3, h4}, h2}, h5}, h1}
88. {{{{h3, h4}, h2}, h1}, h5}
89. {{h5, h1}, {{h3, h4}, h2}}
90. {{{h5, h1}, {h3, h4}}, h2}
91. {{{h5, h1}, h2}, {h3, h4}}
92. {{{h5, h2}, {h3, h4}}, h1}
93. {{{h5, h2}, h1}, {h3, h4}}
94. {{{{h3, h5}, h1}, h2}, h4}
95. {{{{h3, h5}, h1}, h4}, h2}
96. {{{{h3, h5}, h2}, h1}, h4}
97. {{{{h3, h5}, h2}, h4}, h1}
98. {{{{h3, h5}, h4}, h1}, h2}
99. {{{{h3, h5}, h4}, h2}, h1}
100. {{{{h4, h5}, h1}, h2}, h3}
101. {{{{h4, h5}, h1}, h3}, h2}
102. {{{{h4, h5}, h2}, h1}, h3}
103. {{{{h4, h5}, h2}, h3}, h1}
104. {{{{h4, h5}, h3}, h1}, h2}
105. {{{{h4, h5}, h3}, h2}, h1}

Merge Combinatorics: $WS_{init} = h_1\, h_2\, h_3\, h_4\, h_5\, h_6$



Merge Combinatorics: $WS_{init} = h_1\ h_2\ h_3\ h_4\ h_5\ h_6\ h_7\ h_8\ h_9$

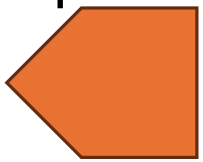
Top row (transposed), *n*=9, *k*=x-axis pair:

9	2027025							
Pair (y,x)	2	3	4	5	6	7	8	9
1	135135	135135	124740	103950	75600	45360	20160	5040
2		135135	124740	103950	75600	45360	20160	5040
3			124740	103950	75600	45360	20160	5040
4				103950	75600	45360	20160	5040
5					75600	45360	20160	5040
6						45360	20160	5040
7							20160	5040
8								5040

- $\{h_1, h_2\}$ #c(|WS|=n-1) = 135135
- $\{h_1, h_3\}$ #c(|WS|=n-1)
- $\{h_1, h_4\}$ #c(|WS|=n-1) – #c(|WS|=n-2) h_2, h_3
- $\{h_1, h_5\}$ #c(|WS|=n-1) – $_{k-2}C_2$ #c(|WS|=n-2) $h_2 \sim h_4$
- $\{h_1, h_6\}$ – $_{k-2}C_2$ #c(|WS|=n-2) $h_2 \sim h_5$ + $_{k-2}C_2$ #c(|WS|=n-3)/2 $\{h_2, h_3\}\{h_4, h_5\}$
- $\{h_1, h_7\}$ – $_{k-2}C_2$ #c(|WS|=n-2) $h_2 \sim h_6$ + $_{k-2}C_2$ #c(|WS|=n-3) $_{k-4}C_2$ /2 $\{h_2, h_3\}\{h_4, h_5\}$
- $\{h_1, h_8\}$ – $_{k-2}C_2$ #c(|WS|=n-2) $h_2 \sim h_7$ + $_{k-2}C_2$ #c(|WS|=n-3) $_{k-4}C_2$ /2 $\{h_2, h_3\}\{h_4, h_5\}$ – $_{k-4}C_2$ #c(|WS|=n-4) $\{h_2, h_3\}\{h_2, h_3\}\{h_6, h_7\}$
- $\{h_1, h_9\}$ (n-2)! = 5040 $h_2 \sim h$

Computational Complexity of Merge

- Merge as a mathematical abstraction
  - not feasible, e.g. as a generate-and-test model
  - biologically implausible
  - in fact, implausible for any real computational system
- Merge as applied to I-Language
  - **Free Merge**: *see also* (Ginsburg 2024)
    - https://bioling.psychopen.eu/index.php/bioling/article/view/14015



Computational Complexity of Merge

- Merge as a mathematical abstraction
  - not feasible, e.g. as a generate-and-test model
- Merge as applied to I-Language
  - Language **Organ** Specific constraints
    - limit the complexity of Merge
  - **LSC**, e.g. (Chomsky 2021)
  - Theta theory (θ-roles and predicate heads)
  - functional selection (verbal projection: INFL, v, neg)
  - other 3rd Factor considerations, e.g. Laws of Nature (optimization) & computational efficiency

I-Language Merge: θ-driven

- Chomsky (p.c.):
  - **Theta positions are detectable everywhere**
  - Conversation goes:
    - Well, there are no marking for IM (Internal Merge) vs. EM (External Merge).
    - INT reads the computed structure and determines how to interpret identical inscriptions.
    - **That's true, but it doesn't mean that IM can't observe theta theory (and duality …), crashing and hence cancelling the preferred derivation.**
- (Chomsky 2024):
  - [T] All relations and structure-building operations (SBO) are **thought-related**, with semantic properties interpreted at CI.
- Merge is θ-aware & θ-driven:
  - (External) Merge builds θ-configurations efficiently
  - *i.e as early and quickly as possible*

I-Language Merge: selection-driven

[pg.132, (Chomsky 2000)], *also* (Richards 2007)

- (53) *Properties of the probe/selector α must be satisfied before new elements of the lexical subarray are accessed to drive further operations*.
- i.e. *probing must be done at head Merge time*

- Example:
  - head INFL triggers (Internal) Search for a θ-relevant item
    - *pronounced at its left edge as the surface subject in English*
    - $\{INFL_{\phi}, \{v_{pres}, \{arrive, train_a\}\}\} \Rightarrow \{train_a \{INFL_{\phi}, \{v_{pres}, \{arrive, \sout{train}_a\}\}\}\}$
    - $\{INFL_{\phi}, \{John, \{v_{past}, \{meet, Mary\}\}\}\} \Rightarrow \{John, \{INFL_{\phi}, \{\sout{John}, \{v_{past}, \{meet, Mary\}\}\}\}\}$
  - [Interesting question: *there*-insertion]

Communication and Thought

- **Language** organ is designed to construct thoughts efficiently
- **Language** is not designed for efficient communication
- *If that makes expressions harder to process and even makes some thoughts impossible to express without circumlocution, too bad. Nature doesn't care.* [pg.11, (Chomsky 2021)]
  - **EXT** cannot have come before Merge.
    - The modern doctrine that language may have evolved from animal communication seems quite untenable. [pg.10, Chomsky GK (2021)]

a current research topic for me!

It makes no sense to say that *some system evolved for X*
"the spine evolved for keeping us upright," or "language evolved for communication"

Perception and Parsing

- *Isn't it a mystery that we can parse externalized language at all?*
  - No help from SMT *(thought optimized*)
  - Only Merge builds structures (**BP**)
  - Not enough time for Nature to tinker with language
  - Not enough time to evolve new systems or mechanisms, e.g. *a phrase structure parsing algorithm*

Parsing vs. Internal Thought

- Operative Complexity less for Internal Thought
  - *Language is optimized for thought, not communication*
- No **Phases**
  - Chomsky *MI* (2000) assumes WS's are pre-partitioned:

(26) the demonstration that glaciers are receding showed that global warming must be taken seriously

The prefinal phases of the derivation are the syntactic objects corresponding to (27a–c).[55]

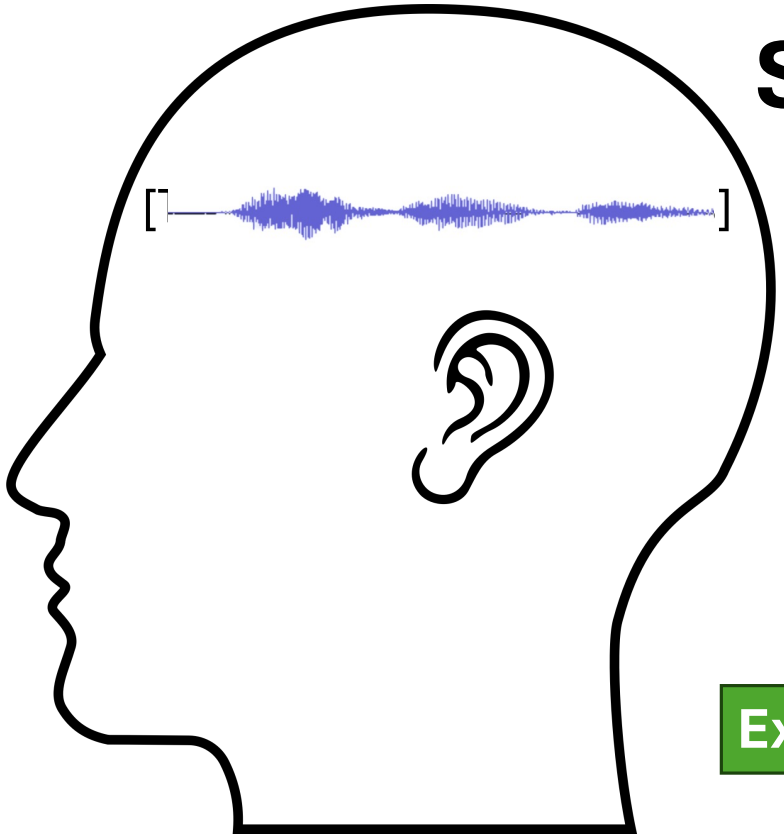
(27) a. $P_1 = [_{CP}$ that global warming must be taken seriously]
b. $P_2 = [_{CP}$ that glaciers are receding]
c. $P_3 = [_{vP}$ [the demonstration P_2 [show P_1]]]

For each new phase, a subarray provides the lexical material required and the operations proceed in the manner already sketched, with P_1/P_2

Sub-arrays reduce operative complexity

Communication and Thought

- Communicative efficiency is always sacrificed
  - The most serious cases involve deletion of copies in accord with computational efficiency, leading to some of the **hardest parsing problems**. [pg.10, fn.12, (Chomsky 2021)]
    - *see solutions in the SMT Parser …*
- "*Note that statistical information is irrelevant to I-language as a matter of principle, though as has always been assumed in the generative enterprise (see Chomsky 1957), it can be highly relevant to processing and acquisition*."



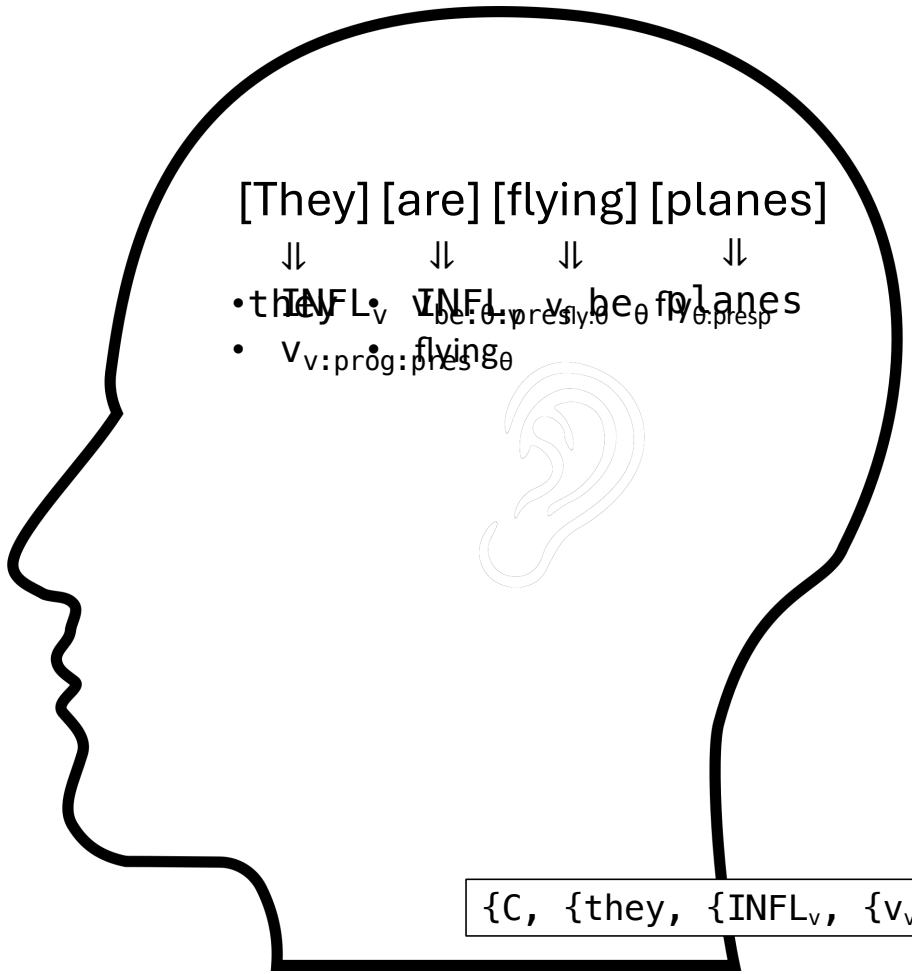
SMT Parser: *how it works*

[pg.118, Chomsky (1956)]

this sentence will have two phrase structures assigned to it; it can be analyzed as "they - are - flying planes" or "they - are flying - planes." And in fact, this sentence is ambiguous in just this way; we can understand it as meaning that "those specks on the horizon - are - flying planes" or "those pilots - are flying - planes."

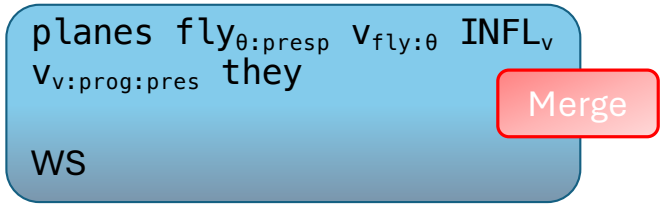
- ***they*** – *are* – *flying planes*
- ***they*** – *are flying* – *planes*

Examples: `sandiway.arizona.edu/smtparser`



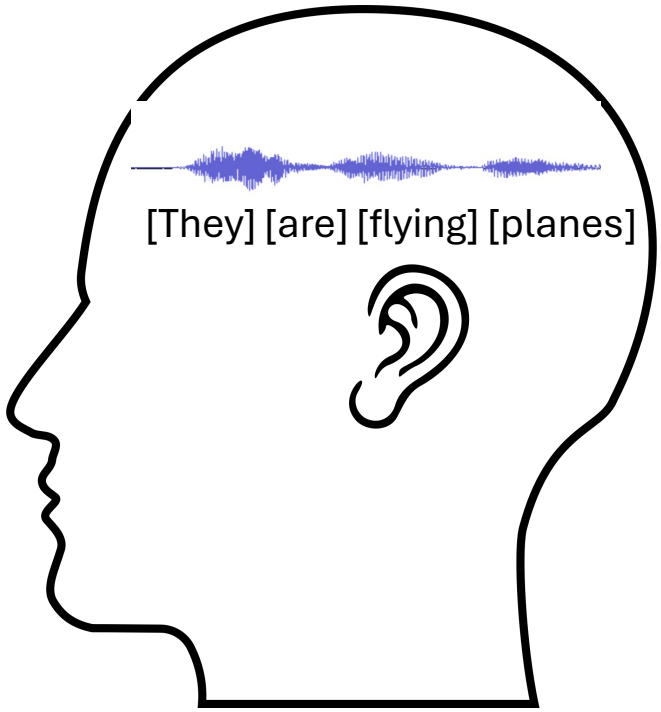
How it works

- **Parsing**:
  - recognize a word from the input signal
  - look it up in **LEX**
  - heads go in an Initial Workspace (WS_{init})



{C, {they, {INFL$_v$, {v$_{v:prog:pres}$, {they, {v$_{fly:\theta}$, {fly$_{\theta:presp}$, planes}}}}}}}

- Merge fires!



How it works

Two workspaces (WS_{init})

1. planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_{v}$ $v_{v:prog:pres}$ they
2. planes $flying_{\theta}$ be_{θ} $v_{be:\theta:pres}$ $INFL_{v}$ they

- *could be more …*

[They] [are] [flying] [planes]

- **Derivation:**

1. planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{v:prog:pres}$ they
2. {$fly_{\theta:presp}$, planes} $v_{fly:\theta}$ $INFL_v$ $v_{v:prog:pres}$ they
3. {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}} $INFL_v$ $v_{v:prog:pres}$ they
4. {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}} $INFL_v$ $v_{v:prog:pres}$
5. {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}}} $INFL_v$
6. {$INFL_v$, {$v_{v:prog:pres}$, {**they**, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}}}}
7. {**they**, {$INFL_v$, {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}}}}}
8. {**C**, {they, {$INFL_v$, {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}$_7$
9. {C, {they, {$INFL_v$, {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}$_7$
10. they 3pl pres. be flying planes
11. they are flying planes

θ-configuration

Merge output: *converged*

FormCopy

Linear Spellout

[They] [are] [flying] [planes]

- **Derivation:**

1. planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{v:prog:pres}$ they
2. {$fly_{\theta:presp}$, planes} $v_{fly:\theta}$ $INFL_v$ $v_{v:prog:pres}$ they
3. {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}} $INFL_v$ $v_{v:prog:pres}$ they
4. {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}} $INFL_v$ $v_{v:prog:pres}$
5. {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}}} $INFL_v$
6. {$INFL_v$, {$v_{v:prog:pres}$, {**they**, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}}}}
7. {**they**, {$INFL_v$, {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}}}}}}
8. {**C**, {they, {$INFL_v$, {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}$_7$
9. {C, {they, {$INFL_v$, {$v_{v:prog:pres}$, {they, {$v_{fly:\theta}$, {$fly_{\theta:presp}$, planes}$_7$
10. they 3pl pres. be flying planes
11. they are flying planes

θ-configuration

Merge output: *converged*

FormCopy

Linear Spellout

How it works

[pg.118, Chomsky (1956)]

- *they – are – flying planes*
- *they – are flying – planes*

Compare the EXT output with what you originally heard

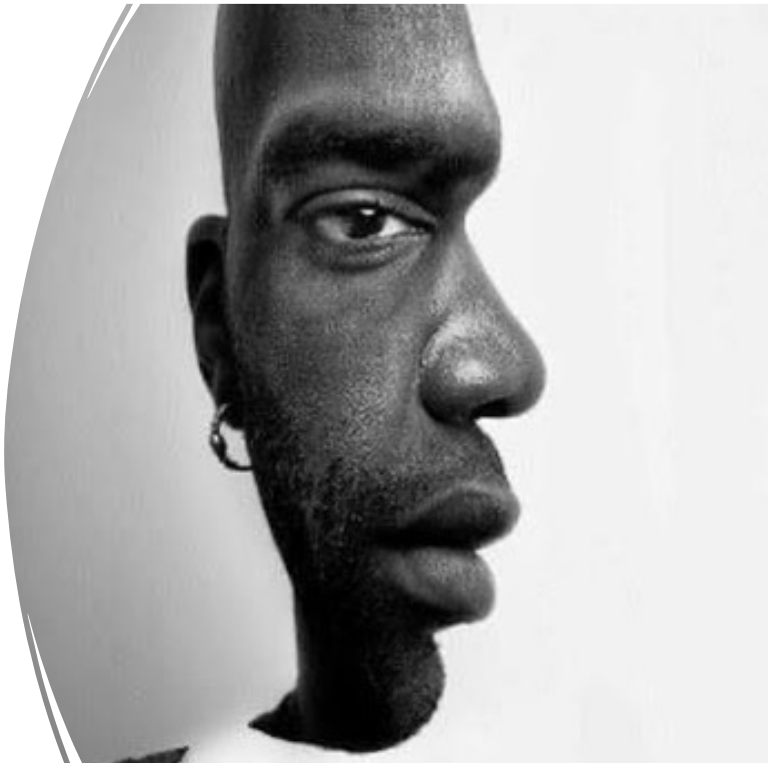
Note: the visual system can also exhibit parsing ambiguity

1. {C, {they, {INFL$_v$, {v$_{v:prog:pres}$, {they, {v$_{fly:\theta}$, {fly$_{\theta:presp}$, planes}$_7$
   they 3pl pres. be flying planes
   they are flying planes
2. {C, {they, {INFL$_v$, {they, {v$_{be:\theta:pres}$, {be$_\theta$, {{flying$_\theta$, planes}, planes}$_8$
   they 3pl pres. be flying planes
   they are flying planes

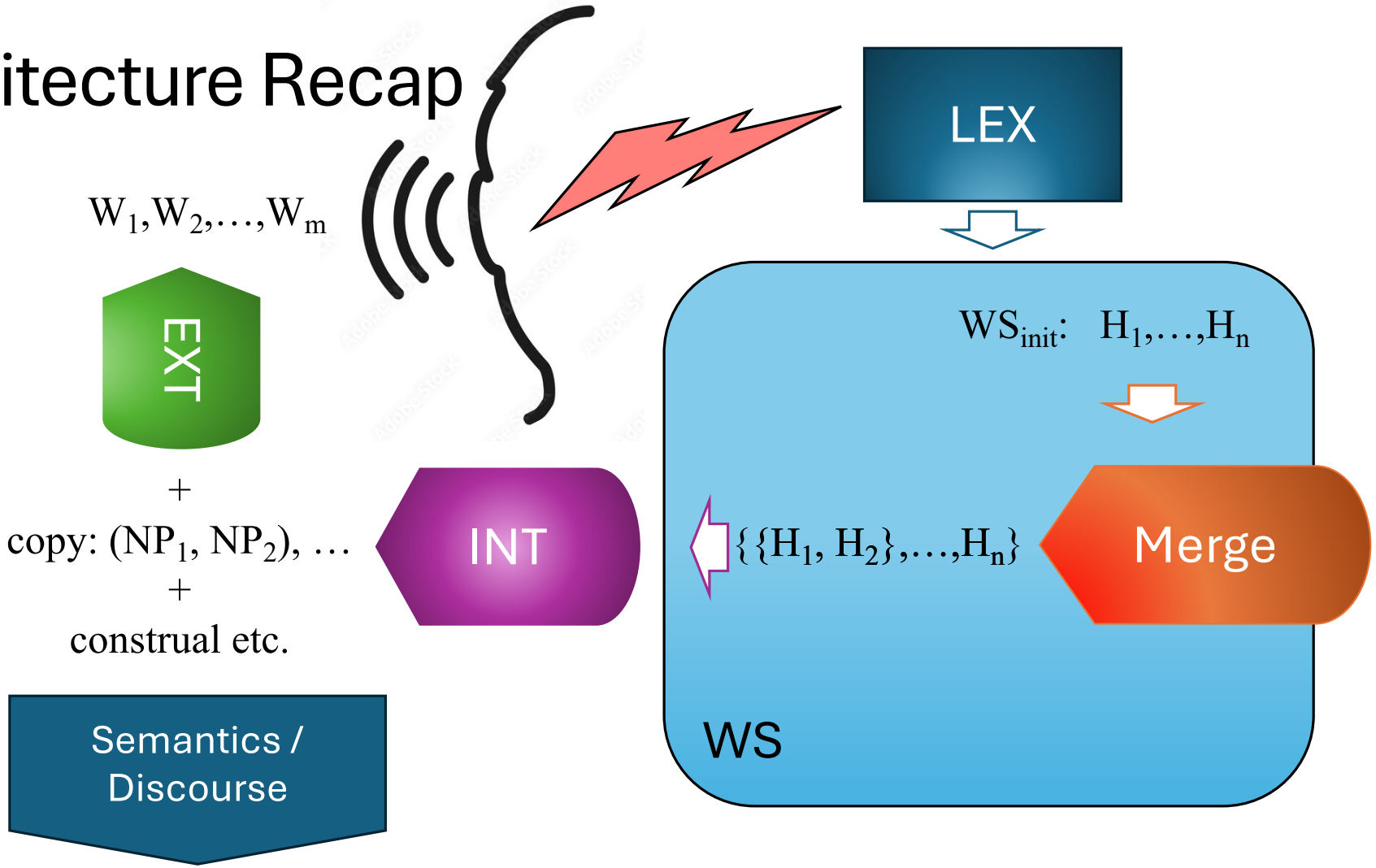
Ambiguity

- They are flying planes
- The mechanic who fixed the car *carefully* packed his tools

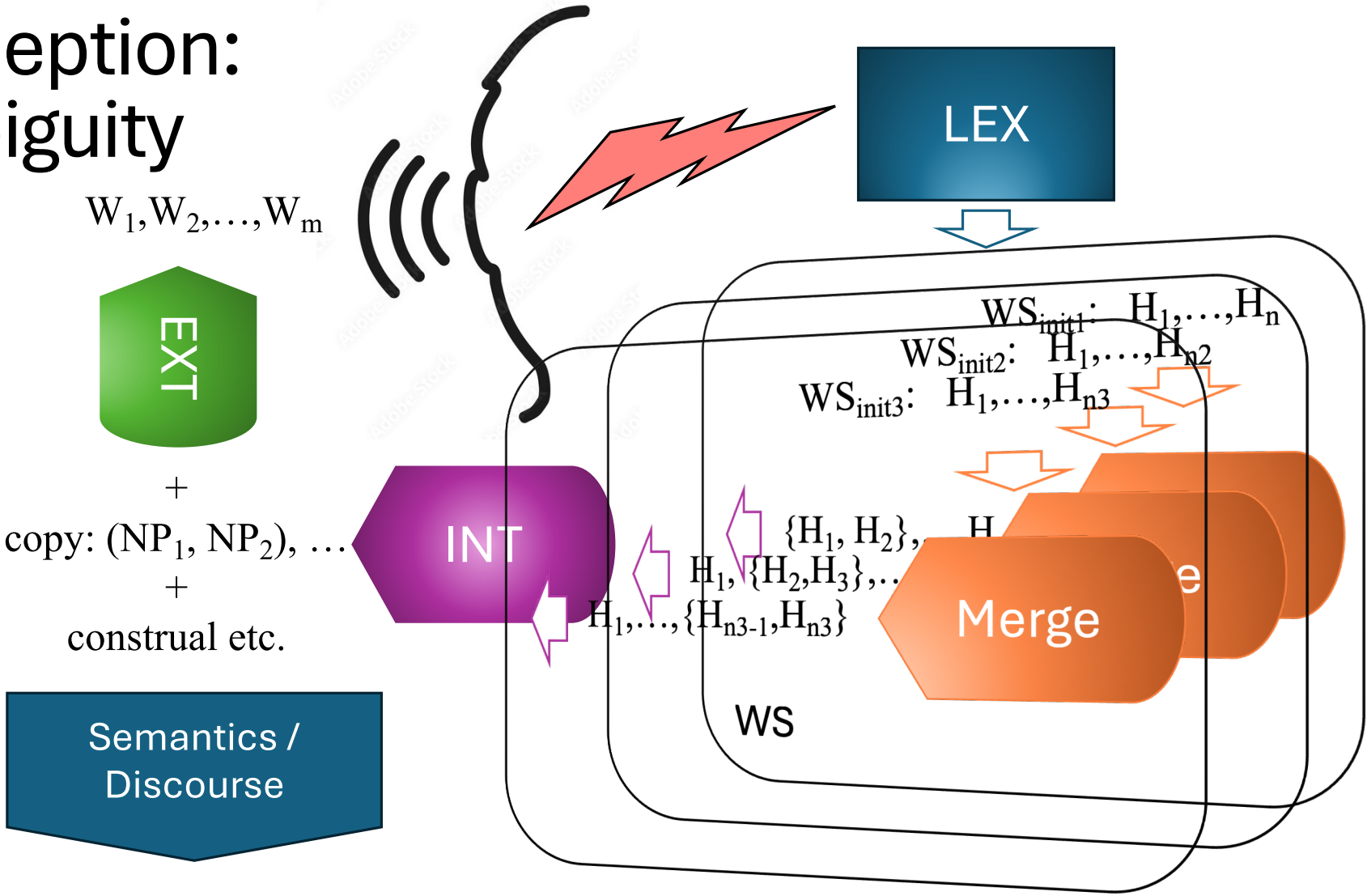
- Visual ambiguity



Architecture Recap



Perception: ambiguity



SMT Parser

sandiway.arizona.edu/smtparser/flying_planes.html

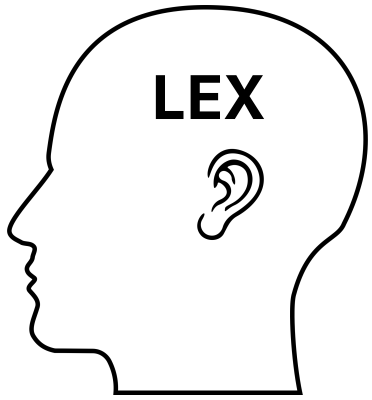
Hand-built LEX

Words: they are flying planes

- **Initial WS 1:** planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 2:** planes $flying_{\theta}$ $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 3:** planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 4:** planes $flying_{\theta}$ be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 5:** planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{v:prog:pres}$ they
- **Initial WS 6:** planes $flying_{\theta}$ $v_{v:prog:pres}$ they
- **Initial WS 7:** planes $flying_{\theta}$ $v_{v:pass:pres}$ they

how many entries come to mind?

context, experience

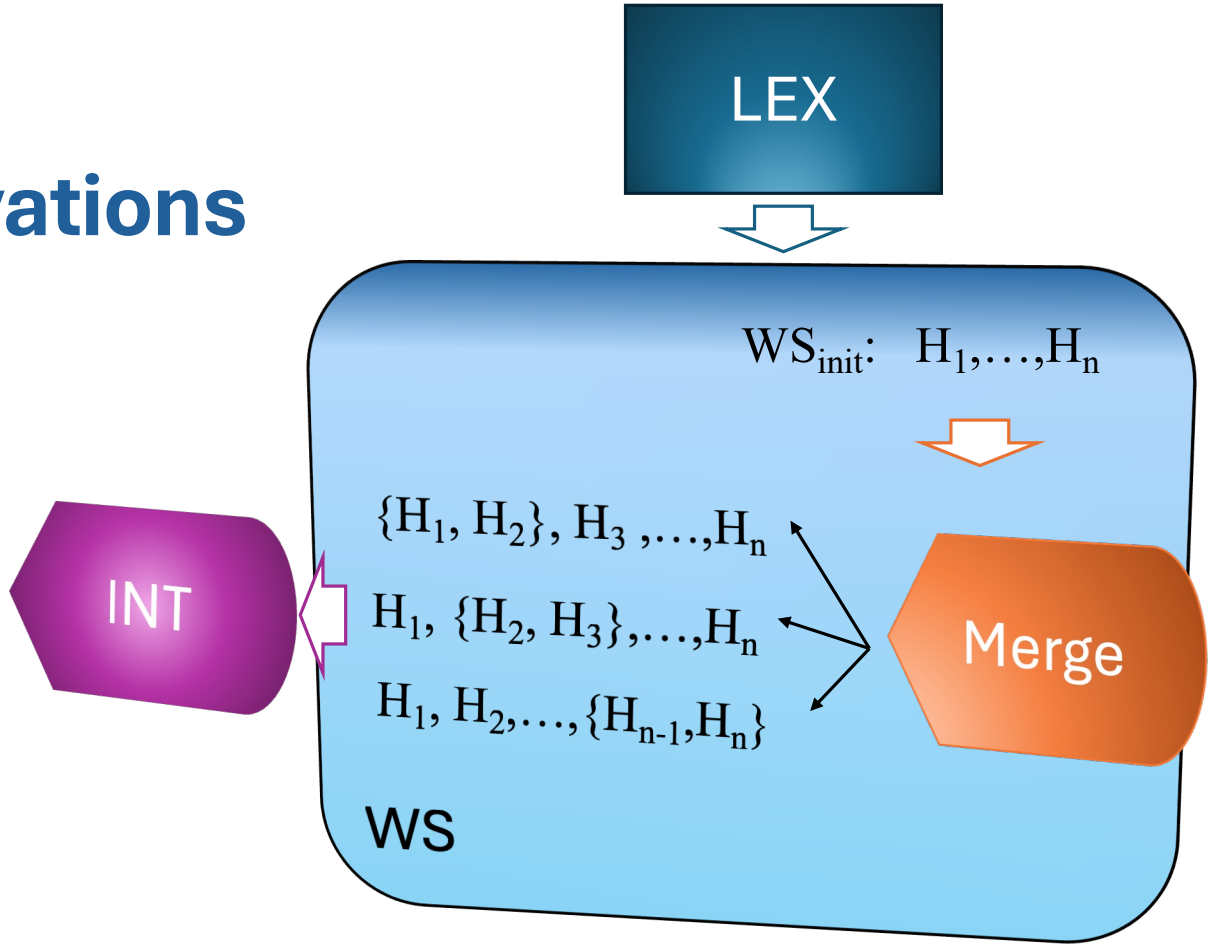


WordNet LEX (nltk)

Words: they are flying planes

- **Initial WS 1:** planes flying are they
- **Initial WS 2:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ flying are they
- **Initial WS 3:** planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ are they
- **Initial WS 4:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ are they
- **Initial WS 5:** planes $flying_{\theta}$ are they
- **Initial WS 6:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ $flying_{\theta}$ are they
- **Initial WS 7:** planes flying $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 8:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ flying $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 9:** planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 10:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 11:** planes $flying_{\theta}$ $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 12:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ $flying_{\theta}$ $v_{pred:pres}$ $INFL_v$ they
- **Initial WS 13:** planes flying be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 14:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ flying be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 15:** planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 16:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 17:** planes $flying_{\theta}$ be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 18:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ $flying_{\theta}$ be_{θ} $v_{be:\theta:pres}$ $INFL_v$ they
- **Initial WS 19:** planes flying $v_{v:prog:pres}$ they
- **Initial WS 20:** planes $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{v:prog:pres}$ they
- **Initial WS 21:** $plane_{\theta}$ $v_{plane:\theta:pres}$ $INFL_{v:3sg}$ $fly_{\theta:presp}$ $v_{fly:\theta}$ $INFL_v$ $v_{v:prog:pres}$ they
- **Initial WS 22:** planes $flying_{\theta}$ $v_{v:prog:pres}$ they
- **Initial WS 23:** planes flying $v_{v:pass:pres}$ they
- **Initial WS 24:** planes $flying_{\theta}$ $v_{v:pass:pres}$ they

One WS_{init}
multiple derivations



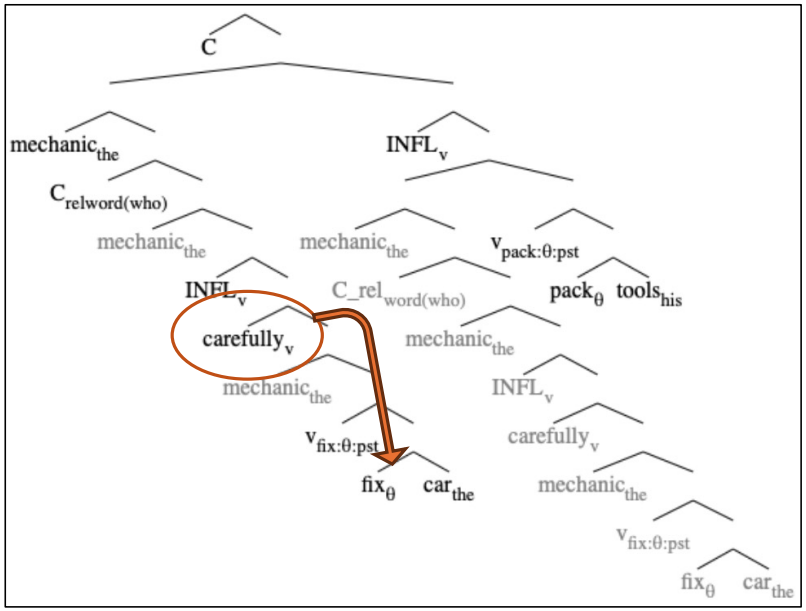
SMT Parser

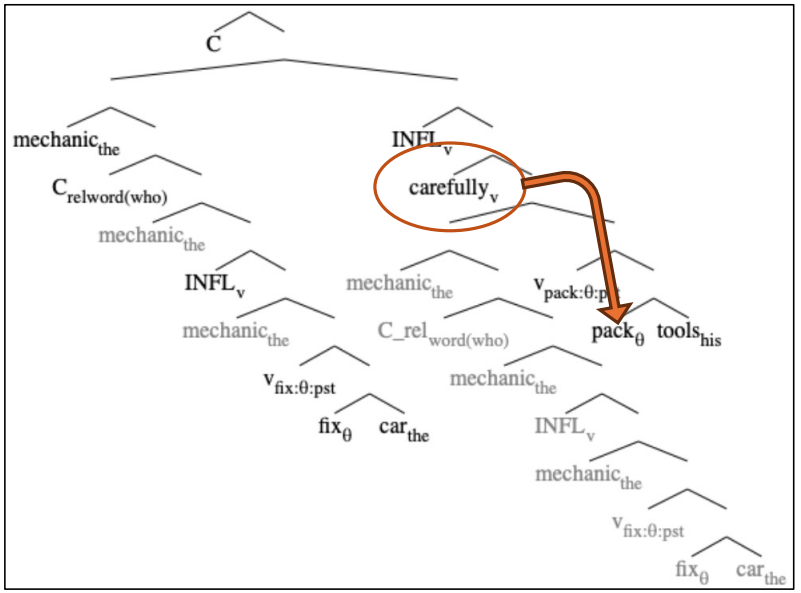
Similar sentence:
Birds that fly instinctively swim

- the mechanic who *fixed* the car *carefully packed* his tools

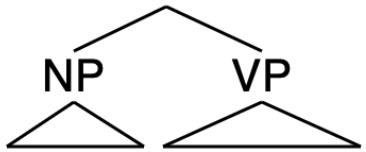
Question: *one WS_{init} or two?*

one WS_{init}: $\texttt{tools}_{\texttt{his}}$ $\texttt{pack}_{\theta}$ $\texttt{v}_{\texttt{pack:θ:pst}}$ $\texttt{INFL}_{\texttt{v}}$ $\texttt{carefully}_{\texttt{v}}$ $\texttt{car}_{\texttt{the}}$ $\texttt{fix}_{\theta}$ $\texttt{v}_{\texttt{fix:θ:pst}}$ $\texttt{INFL}_{\texttt{v}}$ $\texttt{C}_{\texttt{relword(who)}}$ $\texttt{mechanic}_{\texttt{the}}$





WS Parallelism



Repetitions exist in I-language because derivation is in parallel. Thus in an NP–VP structure, NP and VP are generated in parallel, with no interaction, and they might draw independently from the lexicon yielding structurally identical objects that are not copies, as in *John saw John*, with two independent occurrences of *John*. This is not a logical necessity. Evolution might have taken a different course, taking all identical inscriptions to be copies.

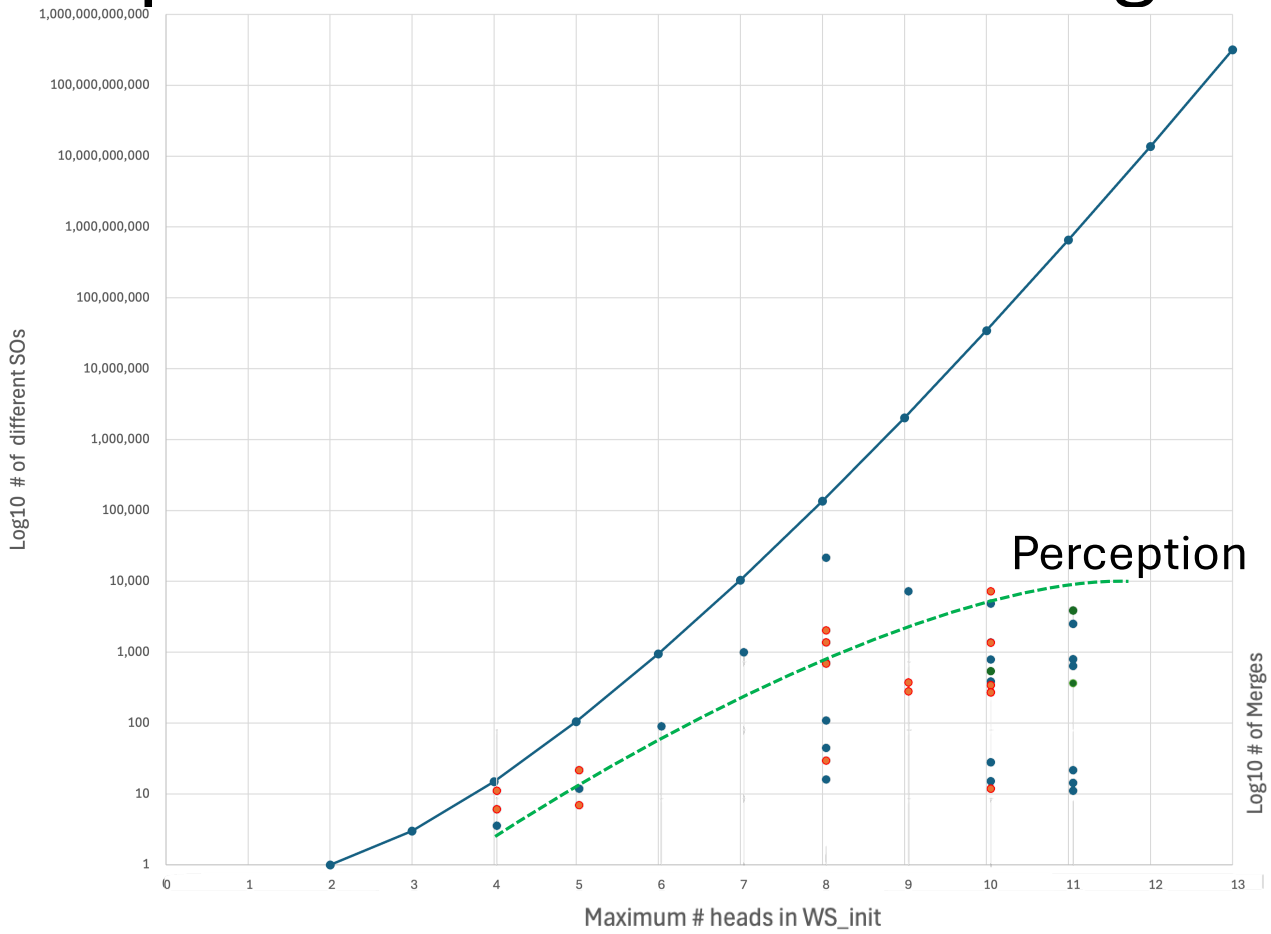
(Chomsky 2021)

English Language Jokes

- Many jokes are based on the human parser reflexively computing 2 parses …
- **As I handed my dad his 50th birthday card,**
- **he looked at me with tears in his eyes and said,**
- **"You know, one would've been enough."**

- *chasing people on a bicycle*

Computation: did we tame Merge?



Data:

61 examples on
`sandiway.arizona.edu/smtparser/`

- grammatical
- ungrammatical
- multigrammatical

- verbal head clustering

Theta theory in the WS

- θ-Balancing

Repetitions and Workspace θ-Balancing

- Theta Theory informs and drives WS convergence:
  - for a derivation to converge, the number of θ-seekers and θ-relevant items must converge and balance out, i.e. arguments and θ-seekers must match up (with nothing left over in the WS).
- Example:
  - John wants to win
  - {C, {John, {$INFL_{v:\theta}$, {~~John~~, {$v_{want:\theta}$, {$want_{INFL}$, {~~John~~, {$INFL_{v:\theta}$, {~~John~~, {$v_{win:\theta}$, win}}}}}}}}}}
- (**Inner Thought**) balanced WS_{init}:
  - $INFL_v$ $v_{win:\theta}$ win $INFL_v$ $v_{want:\theta}$ want 2×John
- (**Perception**) unbalanced WS_{init}:
  - C $INFL_{v:\theta}$ $v_{want:\theta}$ $want_{INFL}$ EA $INFL_{v:\theta}$ $v_{win:\theta}$ win (θ-*seekers*: $v_{want:\theta}$+ $v_{win:\theta}$; θ-*relevant*: EA)

Replicate Existing θ-relevant item

Talk Outline

- **Part 1: Background assumptions**
  - **Strong Minimalist Thesis** (SMT)
  - the simplicity of **I-Language**
  - **Basic Property (BP) of Language**
  - **Merge** and **operative complexity**
  - The **slow brain**
  - **Evolution**
  - Examples of derivations
- **Part 2: there-insertion**
  - Should ***there*-insertion** be part of I-Language?
  - Reasons yes and no
  - A radical proposal

Is *there*-insertion part of I-Language?

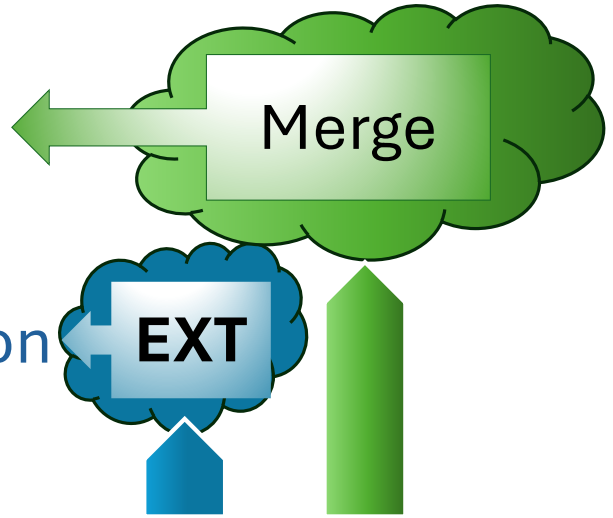
- Reasons no:
  - **Language variation**
    1. not all Germanic languages permit *there*-insertion
    2. for those that do, there is variation across verb types
    3. with **unaccusatives** generally, but with **unergatives** in Dutch, not English
    4. no **TEC** in English, Norwegian, but **transitive expletives** (**TEC**) in Dutch and Icelandic
    5. dialectal variation in acceptability
    6. many languages have no (overt) expletives at all
  - *there* is not θ-relevant (*not part of* θ-configurations)
- Reasons yes:
  - associated with edge of INFL (*surface subject*)
  - affects meaning: associate obeys a definiteness restriction
  - similar existential "constructions" exists in languages without overt *there*

Should *there*-insertion belong to EXT?

- Big Picture
  - I-Language is (ideally) invariant across languages
  - **EXT**: locus of language variation (*experience*)
- Wordform (*experience*):
  - *there* (English), *Það* (Icelandic), *er* (Dutch), *haber* (Spanish), *il* (French)
    - *share form with an existing item, e.g. a pronominal, sometimes morphology*
      - *a "bolt-on"* (*extra*)?
      - *possible competition* (e.g. Spanish *haber*, *not discussed here*)
  - *there* (externalized nominal definiteness feature) (Fujita, p.c.)
  - none (Chinese)
- Verb types (*experience* & *underlying conceptual system*):
  - transitives (TEC), unergatives, unaccusatives, reflexives, etc.
  - implications for L2 acquisition

3Factors (Chomsky 2005)

- *Three factors enter into growth of language for an individual*:
  1. Near-uniform genetic endowment
  2. Experience, which leads to variation
  3. Principles not specific to the faculty of language



there-insertion and I-Language mechanisms

- **Merge** head INFL and vP
  1. INFL triggers *internal* **Minimal Search** for θ-relevant term α
  2. construct {α, {INFL, vP}}
- **Examples**:
  - $\{INFL_{\phi}, \{v_{pst}, \{arise, storm_a\}\}\} \Rightarrow \{storm_a, \{INFL_{\phi}, \{v_{pst}, \{arise, storm_a\}\}\}\}$
  - $\{INFL_{\phi}, \{John, \{v_{pst}, \{meet, ...\}\}\}\} \Rightarrow \{John, \{INFL_{\phi}, \{John, \{v_{pst}, \{meet, ...\}\}\}\}\}$
- Is *there* in the Workspace (WS)?
  1. does INFL have the option to trigger *external* **Search** for *there*?
  2. construct {*there*, {INFL, vP}}
  3. how does *there* enter WS_{init}? Under what circumstances?

there-insertion and I-Language mechanisms

- Let's say it's an option, i.e.
  a) INFL triggers *internal* **Search** for θ-relevant term α, *or*
  b) INFL triggers *external* **Search** for EXPL
  - Suppose *there* ∈ WS_{init},
    WS won't converge unless option b) is exercised or preferred.
  - Suppose *there* ∉ WS_{init}, having options is fine.
- Then, what about **Transitive Expletive Constructions** (TEC)?
  - EXPL … EA … IA… $V_{tr.}$
  - need two subject positions, are both a) and b) simultaneously taken?
  - generally, we assume a single surface subject position

Return to something simpler later …

English / Spanish

- **Inside Verbals**, widely studied since (Milsark 1974) for English
  - *there* appear with existential verbs, e.g. forms of *be,* unaccusative *arise*, *appear*, *develop* or *happen*.
  - *a policeman is here / there is a policeman here*
  - *a storm arose in the desert / there arose a storm in the desert*
  - *a little girl danced / *there danced a little girl* (*unergative)
- Spanish:
  - *un policía está aquí / hay un policía aquí* (Alex Tubens, p.c.)
  - *surgió una tormenta / *había surgido una tormenta* (*had arose a storm*)
  - una niña bailó / *había* bailado una niña (as perfective: ok)
  - *impersonal verb hay/había/habrá* (*there-is/was/will.be*)
  - *haber is also "to have"* (*auxiliary and main verb*)
  - *allí hubo un asesinato* / there was a murder there (past: *hubo*/*había*)

Definiteness restriction

- For **inside verbals** only:
  - there arrived a high-ranking government official (at the courthouse)
  - *there arrived the president of the United States (at the courthouse)
- **Outside verbals** (oblig. PP NP):
  - *admit unergatives* (*normally disallowed, *there walked NP*)
  - there walked into the courthouse a high-ranking government official
  - there walked into the courthouse the president of the United States
- List context definites and inside verbals:
  - There were some people, the police, and the dog captured on the security camera

Forms of auxiliary *be*

- Existential *be*:
  - *the/some police* are in the building
  - *there* are *some police* in the building / *there is *the police* in the building
- Progressive *be*:
  - a/the dog was barking
  - *there* was *a dog* barking / **there* was *the dog* barking
- Passive *be*:
  - a/the demonstrator was caught
  - *there* was a demonstrator caught / **there* was *the demonstrator* caught
  - *there was caught *a*/*the demonstrator*
- Dutch passive (Reinhart & Siloni 2004):
  - *er* werd een kind gewassen (passivized transitive *wash*)
  - *there* was a child washed
  - **er* *werd zich gewassen* (reflexive *wash*)
  - *there* was SELF washed
  - **er* *werd gegroeid* (unaccusative *grow*)
  - *there* was grown

IA raises to edge of PRT (Sobin 2014)

er needs to find an associate?
but impersonal passive permitted:
er werd gedanst
there was danced

Transitive Expletive Constructions (TEC)

- Dutch (Koster & Zwart 2000):
  - *Er* heeft iemand een huis gekocht
  - *There* has someone a house bought (* in English and Mainland Scandinavian)
- Icelandic:
  - Einhverjir útlendingar keyptu gamla húsið
  - Some foreigners bought old house.the
  - *Það* keyptu einhverjir útlendingar gamla húsið (TEC)
  - *There* bought some foreigners old house.the
- (Spanish)
  - Unos extranjeros compraron la vieja casa
  - Some.m foreigners.m bought the.f old.f house.f
  - Unos extranjeros *habían* comprado la vieja casa (no TEC, competition?)
  - Some.m foreigners.m *had*.3pl.past bought the.f old.f house.f

French

(Reinhart & Siloni 2004)

- Unaccusative:
  - *Il* est arrivé trois filles
  - *there* is arrived three girls
- Reflexive verb (*se dénoncér*):
  - *Il* s'est dénoncé trois mille hommes ce mois-ci
  - *there* SE is denounced three thousand men this month-here
  - '*three thousand men denounced themselves this month*'
- *TEC:
  - **Il* les a dénoncés trois mille hommes ce mois-ci
  - *there* them$_{cl}$ has denounced three thousand men this month-here

Spanish:
- tres niñas llegaron
- llegaron tres niñas
- *han llegado tres niñas (but ok as perfective)
- *habian llegado tres niñas

Existentials without *there*-insertion

- Mandarin Chinese (Huang 1987) (Wu 2020):
  - 老师 来了
  - laoshi lai-le
  - '*the teacher came*'
  - 来了一个老师
  - lai-le yige laoshi (VS order)
  - '*there came a teacher*'
- Unergatives:
  - 客人 笑了
  - keren xiao-le
  - 'The guest laughed'
  - *笑了 客人
  - xiao-le keren (*VS order)
  - 'There laughed a guest'
- 跑 (*escape*):
  - 监狱里 跑了 一个 犯人 (VS order)
  - (jianyu-li) pao-le yige fanren
  - prison-in escape-PF one-CL prisoner
  - '*there escaped a prisoner*'
- definiteness restriction:
  - *监狱里 跑了 他/那个人 (*VS order)
  - (jianyu-li) pao-le ta/neige ren
  - prison-in escape-PF he/that person
  - '*there escaped him/that person*'

Proposal #1: a doubled constituent

- [Space reserved for Oishi-sensei]

Proposal #2: INFL is like C_Q

- Suppose INFL is a probe similar to interrogative C_Q:
  - C_Q triggers *internal* **Search** for *wh*-term
  - C_Q may induce language-particular spellout at EXT
- C_Q and Box example (*see appendix*):
  - *Who does Mary like*?
  - {Mary, {$v_{like:\theta:pres:box(who)}$, {$like_\theta$, *who*}}}
  - {C_Q, {Mary, {$INFL_{v:3sg}$, {~~Mary~~, {$v_{like:\theta:pres:box(who)}$, {$like_\theta$, *who*}}}}}}
  - EXT:who
  - who [ϕ,tns] Mary 3sg pres like
  - who does Mary like
  - **Remarks**:
    - no Internal Merge to C_Q, and
    - EXT of C_QP (English): spell *who* at left edge of phrase

(θ-configuration for *like*; Phase head v)

~~*who*~~

Proposal #2: INFL is like C_Q

- **Merge** head INFL and vP
  1. INFL triggers *internal* **Search** for θ-relevant term α
  2. no Internal Merge, i.e. do not construct {α, {INFL, vP}}
  3. at EXT, spell either EXPL or α at the (left) edge of INFL
  - Remarks:
    - INFL has no options in syntax (*less WS complexity*)
    - solves associate ϕ-feature surface subject problem (*Agreement*)
    - *answers Q*: how does *there* enter WS_{init}? It's not there. (*Smaller WS*)
    - (value of) EXPL determined by particular language (*experience*)

Proposal #2: INFL is like C_Q

- Example (*English unaccusative*):
  - *a storm arose* / *there arose a storm* (*in the desert*)
  - $\{arise_\theta, storm_a\}$
  - $\{v_{pst}, \{arise_\theta, storm_a\}\}$ — a θ-configuration
  - $\{INFL_\phi, \{v_{pst}, \{arise_\theta, storm_a\}\}\}$ — (INFL ϕ-features probe)
  - $\{C, \{INFL_{3sg}, \{v_{pst}, \{arise_\theta, storm_a\}\}\}\}$ — Phase, **timing**: probe here instead …
  - **EXT** (layered):
    - C
    - $\{INFL_{3sg}, \{v_{pst}, \{arise_\theta, \sout{storm_a}\}\}\}$ pronounce *storm*$_a$ @ left edge of phrase
      - … *a storm arose*
    - $\{INFL_{3sg}, \{v_{pst}, \{arise_\theta, storm_a\}\}\}$ pronounce *there* @ left edge of phrase
    - *3sg* + *pst*
      - $\{arise_\theta, storm_a\}$
        - pronounce 3sg + pst + *arise* ⇒ *arose*
        - pronounce *storm*$_a$
    - *there arose a storm*

TEC

- TEC languages are V2 languages (*not all V2 languages permit TEC*)
- Example (Ásgrímur 2011):
  - *Það* keyptu einhverjir útlendingar gamla húsið (Icelandic)
  - *there* bought some foreigners old house.the
  - 'Some foreigners bought the old house'
  - {foreigners$_{some}$, {{{{old, ~~house~~$_{the}$}, house$_{the}$,}, buy $_{\theta}$}, v$_{buy:\theta}$}} = vP a θ-config.
  - {C_{V2}, {INFL $_{\phi}$, vP}} (C_{V2} root phenomenon; EXT requirements)
  - **EXT:**
    - C_{V2} ❶ pronounce *Það* **or** nearest θ-relevant term @ left (or PP, adverb)
    - C_{V2} ❷ then pronounce nearest available verb here
    - C_{V2}-INFL $_{\phi}$ are a pair/work in tandem
    - Note: INFL $_{\phi}$ closest to highest verb in vP (*Agreement computed*)

Definiteness restriction

- Much prior work, e.g. summarized in (McNally 1997), on existentials
- **Assume**:
  - **where and how** you pronounce **matters** for focus/topic/new-old information
  - considerable scope for language variation (*generally*)
  - *there* signals new information (*discourse*) for all languages that have it
- Example:
  - the storm$_{old}$ arose / a storm$_{new}$ arose
  - **there* arose the storm$_{old}$
  - *there* arose a storm$_{new}$ / (several) storms$_{new}$ (*bare plurals too*)
- Note: same restriction applies to TEC
  - *there* bought some foreigners$_{new}$ old house.the

Definiteness restriction

- Chinese (Huang 1987):
  - 老师　来了
  - laoshi lai-PERF
  - '*the teacher came*'
- VS order:
  - 来了　　一个 老师
  - lai-PERF yige　laoshi
  - '*there came a teacher*'

old information

- {C, {INFL $_{\phi}$, {v_{PERF}, {来, teacher}}}}
- pronounce老师 @ left edge of phrase
- teacher PERF come

new information
*那个老师
that teacher

- {C, {INFL $_{\phi}$, {v_{PERF}, {来, teacher}}}}
- pronounce *EXPL* @ left edge of phrase
- in Chinese, EXPL is non-overt
- **BUT** still signals new information! 一个老师$_{new}$

Information

- Speculations:
  - information across a dialogue involves a **Memory** component
  - **EXT** cues **Memory**
  - **Memory** also subject to the **Third Factor**, etc.

    Search:
    - old information: e.g. **Minimal Search** existing Memory for participants
    - new information: don't search
    - *there is a man*$_{new}$ *in the room*
    - *it was Timmy*$_{participant}$ *who borrowed the pencil* (*not me*$_{speaker}$)
      - **Clefting***: contrast with someone else* (*in* ***Memory***)
    - Negation (e.g. *wasn't*): presupposition

Language Variation and Verb Classes

- *there*-insertion across languages
  - unaccusatives generally permitted
  - unergatives
    - * *there danced a little girl*
    - **había* bailado una niña (Spanish: ok as perfective)
    - *er dantse iemand* (Dutch)
    - *il* s'est dénoncé trois mille hommes ce mois-ci (French)
      - reflexives are **unergative**-like verbs according to (Reinhart & Siloni 2004)
    - **er werd zich gewassen* (Dutch: reflexive *wash*)
- L2 *there* acquisition is affected by L1
  - psycholinguistic experiments, e.g. (Wu 2020), (White et al. 2012)

Conclusions

- A simplification of I-Language is always welcome
  - *reduce operative complexity*
  - for all languages, INFL behaves like C_Q
  - INFL triggers a simple operation:
    - *internal* **Search** for a θ-relevant term α ← the "associate"
- Externalization:
  - ***EXT*** *cannot have come before Merge* (Chomsky).
  - *need a theory of how this works*
    - simplest possible mechanism: EXT ***peels off*** the syntactic object a layer at a time
    - at each phrase, the head may spell something (it found) on the left edge (resp. right)
    - language-particular effects must be simple and learnable, e.g. identity of EXPL,
    - e.g. phrase-phrase order rules