The Strong Minimalist Thesis (SMT):

an introduction

Sandiway Fong

University of Arizona

sandiway.arizona.edu

Abbreviations/Glossary

Slides!

Kyoto University, Dec 6th 2025

Topics

Not today:

- **(Yesterday) *Generative AI* vs. *Generative Linguistics***

T

Subject Verb Agreement and Attention

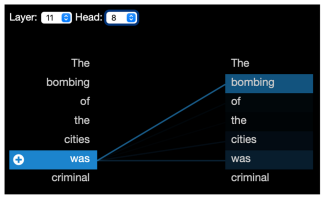
Example (Chomsky 2021):

- The *bombing* of the *cities was* criminal

Adapted:

- The *indiscriminate bombing*$_3$ of the *cities was*$_7$ criminal
- The *indiscriminate bombing*$_3$ of the *ancient and modern cities*$_9$ *was* criminal
- * The *indiscriminate bombing*$_3$ of the *ancient and modern cities*$_9$ *were* criminal
- The *indiscriminate bombing*$_3$ of the *cities that we couldn't possibly have predicted was*$_{13}$ criminal

- GPT-2 small (12 levels; 12 heads)



Adverb-Verb Construal and Attention

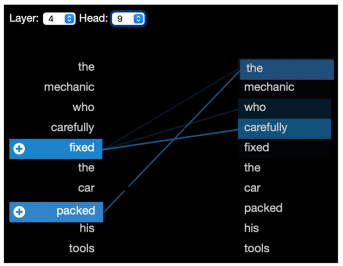
- The mechanic who *carefully* ***fixed*** the car *packed* his tools
- The mechanic who ***fixed*** the car *carefully* ***packed*** his tools
- *Carefully*, the mechanic who *fixed* the car ***packed*** his tools

adapted from (Chomsky 2021)

5.3.2 Dependency Relations

Figure 8 shows the dependency alignment scores (Eq. 4) broken out by layer. Attention aligns with dependency relations most strongly in the middle layers, consistent with recent syntactic probing analyses (Liu et al., 2019; Tenney et al., 2019).

Figure 8: Proportion of attention that is aligned with dependency relations, aggregated by layer. The orange line shows the baseline proportion of token pairs that share a dependency relationship, independent of attention.



Topics

Not today:

- **(Yesterday) *Generative AI*** *vs.* ***Generative Linguistics***

Today:

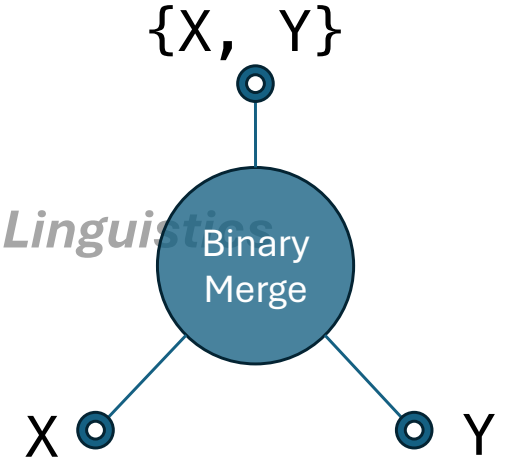
- **SMT: *A General Introduction***

Tomorrow:

- **In detail:** *theory, data and derivations* (handout)

Not covered:

- **FormSet :** 2025 paper with M. Oishi
- **SMT Parser:** a computational model of parsing



Tomorrow (*in-depth*): handout

9. a. drink a beer/some beer/beer[7]
   b. drink a barrel ?(of beer)

Secondary predication in the form of the *resultative dry*$_\theta$ imposes an additional constraint that the IA must also be interpretable as a *container* (as well as a *liquid*), as in (10a-c).

10. a. drink a *barrel* (of beer) *dry*
    b. ??drink a *beer*/some *beer dry*
    c. *drink *beer dry*

Note that the ungrammaticality of (10b-c) is improved when the *container* is adjectivally specified, as in (11a-b).

11. a. drink a large/huge beer *dry*
    b. drink some large/huge beer *dry*

To summarize, θ-Merge does not do θ-role assignment (nor could it due to maximal simplicity). INT must read the I-Language structure computed by Merge and configurationally figure out any semantic constraints that come with the argument-taking heads. (See also discussion of the constraints on *flaw* in examples (18b-c) below.)

The clausal domain

After the completion of θ-Merge, we switch from the propositional domain to the clausal domain by introducing (clausal) heads INFL and C. We assume INFL has ϕ-properties, indicated below as INFL$_\phi$. ϕ triggers a (Minimal) Search for a θ-argument, which may induce verbal Agreement and also be spelled out as a subject at the edge of INFL$_\phi$. In the case of English, the subject may be spelled out at the left edge of INFL. Both Agreement and subject spellout are part of EXT downstream from Merge.

Side note on Minimal Search (MS)

Minimal Search (**MS**) is the only search operation available to I-Language. Search is always targeted, e.g. for a θ-relevant item (or θ-argument). In this account, we assume that search is θ-aware, i.e. it has configurational information that allows it to distinguish between arguments and non-arguments.

Given SMT, search is also *maximally simple and efficient*. It must terminate as soon as the first matching item is found in the c-command domain. Additionally, search may not be resumed, nor should it ever find *equidistant* candidates (and make a comparison between them, selecting one).

[7] *Beer* vs. *wine*: **drink a wine* but *drink some wine/wine*. In my dialect (at least), *drink a beer dry* is marginal, but *drink a wine dry* is sharply ungrammatical.

In the case of WS 4 above, we obtain clausal configuration (12) with IA marked as IA$_\phi$:

12. {C, {INFL$_\phi$, {v, {R, {P$_\theta$, IA$_\phi$}}}}} ϕ-relation (INFL$_\phi$, IA$_\phi$)

Note we use the marking IA$_\phi$ here for notational convenience only. Technically what is computed and appears at INT is the ϕ-relation (INFL$_\phi$, IA$_\phi$). Recall also that Merge has no structural storage facilities, and cannot affect, i.e. transform/modify/mark, its inputs.

For WS 1 and WS 2 above, we compute the clausal domain ϕ-relations (INFL$_\phi$, EA$_\phi$) and (INFL$_\phi$, IA$_\phi$), respectively:

13. {C, {INFL$_\phi$, {EA$_\phi$, {v$_\theta$, {R$_\theta$, IA}}}}} ϕ-relation (INFL$_\phi$, EA$_\phi$)
14. {C, {INFL$_\phi$, {v, {R$_\theta$, IA$_\phi$}}}} (*cf.* (7) *above*)

Note in (13), EA is ϕ-marked, and IA is not considered, as required by search. Once an argument has established a ϕ-relation with INFL, it may be spelled out at the edge of INFL at EXT. EXT is subject to (language) variation and there may be flexibility in spell out. For example, in English, the ϕ-marked argument may be spelled out at the left edge, as in (15a) and (15c) below; not spelled out at all, as in (15b), instead deploying a pleonastic substitute *there*; or spelled out at the right edge, as in (15d).

15. a. He$_\phi$ repairs$_\phi$ the car (left edge of INFL; EA agreement)
    b. There have$_\phi$ arrived many soldiers$_\phi$ (no spellout; IA agreement)
    c. Many soldiers$_\phi$ have$_\phi$ arrived (left edge of INFL; IA agreement)
    d. We should do this again, said$_\phi$ John$_\phi$ (right edge of INFL: quotative inversion)

In addition to a pleonastic substitute, a PP phrases can also be EXT'ed at the left edge of INFL in cases of *Locative Inversion* (LI), as in (16a):

16. a. In the distance stands$_\phi$ a mountain range$_\phi$ (LI)
    b. There stands$_\phi$ a mountain range$_\phi$ in the distance (no spellout; IA agreement)
    c. A mountain range$_\phi$ stands$_\phi$ in the distance (left edge of INFL)
    d. In the distance, there stands$_\phi$ a mountain range$_\phi$ (topicalization: cf. (10b))
    e. In the distance, a mountain range$_\phi$ stands$_\phi$ (topicalization: cf. (10c))

Under the simplest hypothesis, (16a-c) share the same clausal configuration, something like (17a). Similarly, (16d-e) share clausal configuration (17b), assuming the introduction of a Topic head (TOP) into the WS.

17. a. {C, {{INFL$_\phi$, {v, {R$_\theta$, *a mountain range*$_\phi$}}}, *in the distance*}}
    b. {TOP, {C, {{INFL$_\phi$, {v, {R$_\theta$, *a mountain range*$_\phi$}}}}, *in the distance*}}

Topics

Not today:

- **(Yesterday) *Gene***

Today:

- **SMT: *A General I***

Tomorrow:

- **In detail:** *theory,*

Not covered:

- **FormSet :** 2025 p
- **SMT Parser:** a co

GK paper: Chomsky (2021)

With this much background, consider one of the more complex sequences, pairing unaccusative and transitive, keeping to essentials:

(39) John arrived and met Bill.

The first step is to form the two independent objects $\{_1\ v, \{arrive, John_1\}\}$ and $\{_2\ John_2, \{v^*, \{meet, Bill\}\}\}$ of (40a) (*John arrived* and *John met Bill*) in the normal way, satisfying Θ-Theory. The next step is to construct the *set* (40b):

(40) a. $\{_1\ v, \{arrive,\ John_1\}\}, \{_2\ John_2, \{v^*, \{meet, Bill\}\}\}$
b. $\{\{_1\ v, \{arrive,\ John_1\}\}, \{_2\ John_2, \{v^*, \{meet, Bill\}\}\}\}$

Application of Merge, introducing & and INFL, yields (41):

(41) $INFL, \{\&, \{\{_1\ v, \{arrive,\ John_1\}\}, \{_2\ John_2, \{v^*, \{meet, Bill\}\}\}\}\}$

Since we so far have only sets, extraction is possible, so either of the occurrences of *John* can be raised to SPEC–INFL, yielding (42), which is converted to (43) by merging C and then applying FSQ:[51]

(42) $John_3, \{INFL, \{\&, \{\{_1\ v, \{arrive,\ John_1\}\}, \{_2\ John_2, \{v^*, \{meet, Bill\}\}\}\}\}\}$
(43) $C, \{John_3, \{INFL, <\&, \{_1\ v, \{arrive,\ John_1\}\}, \{_2\ John_2, \{v^*, \{meet, Bill\}\}\}>\}\}$

Topics

sandiway.arizona.edu/smtparser

Not today:

- **(Yesterday)**

Today:

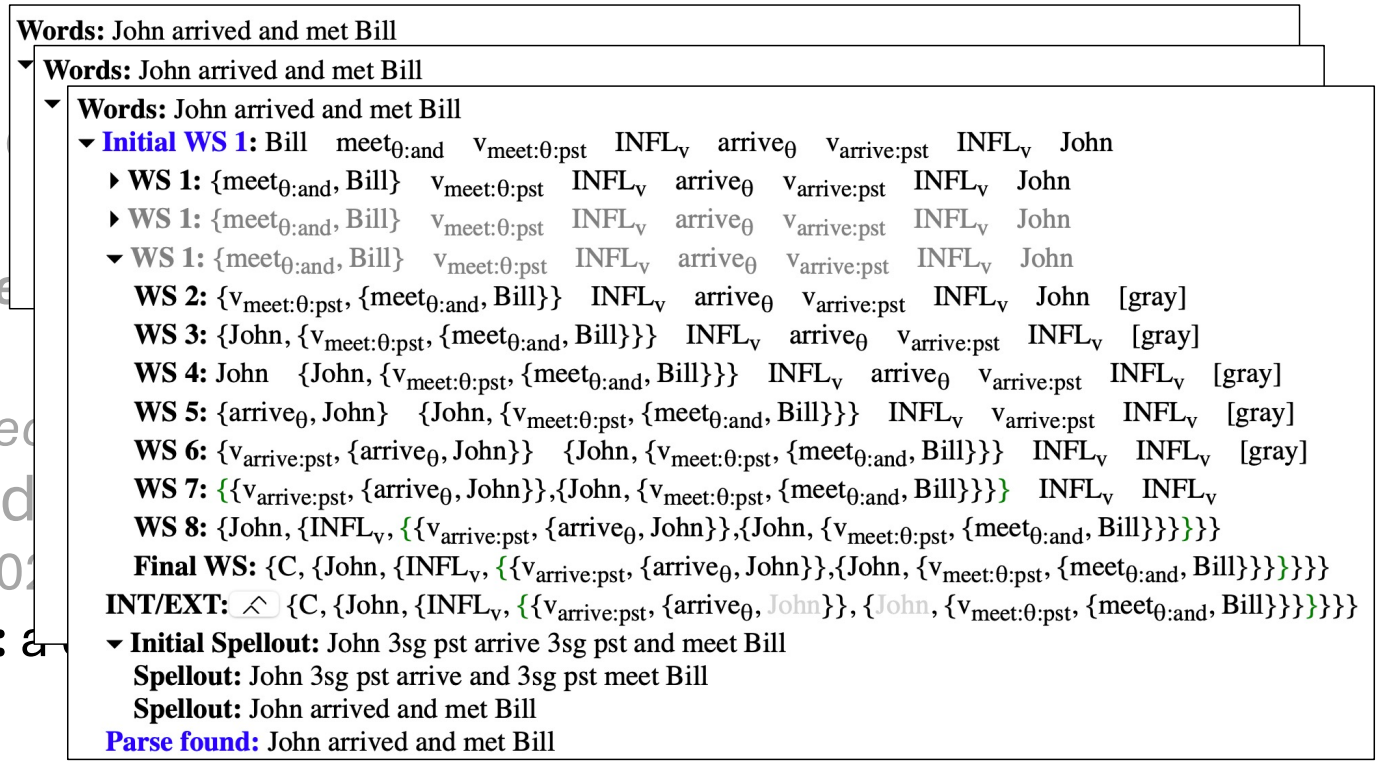
- **SMT:** ***A Gene***

Tomorrow:

- **In detail:** *theo*

Not covered

- **FormSet :** 20
- **SMT Parser:** a



Topics

Not today:
- **(Yesterday) *Gen***

Today:
- **SMT: *A General***

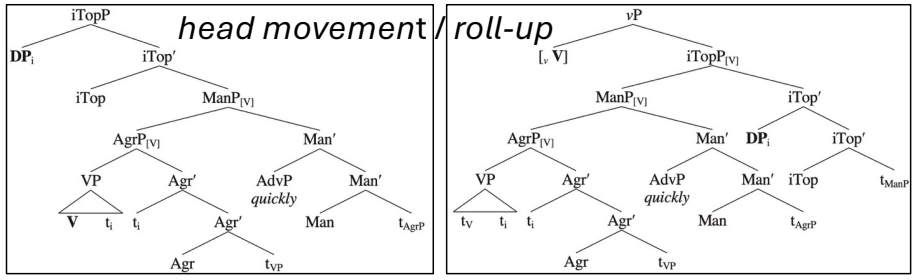
Tomorrow:
- **In detail:** *theory,*

Not covered:
- **FormSet :** 2025
- **SMT Parser:** a co

PSG parsing algorithms:
- Cocke–Younger–Kasami (CKY) algorithm, Sakai (1961)
- LR(*k*) parsing, (D)PDA discovery, Knuth (1965)
- Earley algorithm, Earley (1968)

banned!

Key Research Questions:
- How to *parse* (efficiently) if we only have **Merge**?
- How does **Externalization (EXT)** work?
  - *how do we learn and encode word order variation?*
  - *Merge does not encode linear order, cf. trees*



Object Shift (**OS**) *takes 6 moves. Pearson* (*2000*). *Do we really want this?*

Topics

Not today:

- **(Yesterday) *Gen***

Today:

- **SMT: *A General***

Tomorrow:

- **In detail:** *theory,*

Not covered:

- **FormSet :** 2025 p
- **SMT Parser:** a co

Key Research Questions:

- How to *parse* (efficiently) if we only have **Merge**?
- How does **Externalization** work?
- **M-gaps**: *unpronounced θ-items* (*perception problem*)
- A/A-bar segregation: **IM** *and the* **Box**

Examples: `sandiway.arizona.edu/smtparser`

Acknowledgements:

- *Alex Tubens* (*UA linguistics grad. student*)
- Spanish (NSF collaboration with *Hilton Alers-Valentín*, University of Puerto Rico at Mayaguez)

Today's Topics

Biolinguistics perspective (1974)

- **Motivation for the SMT**
  - (recent) human evolution
  - slow brain (*a bottleneck*), but excellent sensors
- **Organ: Language Faculty (FL)** ☜ **Theory: Universal Grammar (UG)**
  - Design: *must be* (*very*) *simple* (*Miracle Creed*)
  - Third Factor: *must be efficient* (1st factor: *genetic*; 2nd: *experience*)
  - Workspace (WS): *(only) scratchpad*
  - WS Merge
  - Markovian Assumption: *no access to computational history*
  - Difference between a 3rd Factor Design Principle and a Constraint
  - Minimal Search (MS)
  - Duality of Semantics: *Internal/External Merge division of labor*
  - Copy/Repetition Problem
  - …

Recent Human Evolution

- Explosion of symbolic works in the fossil record
  - *coincides with the appearance of modern humans* (200-300 tya)
  - … 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**. (Tattersall in *Encyclopaedia Britannica*)

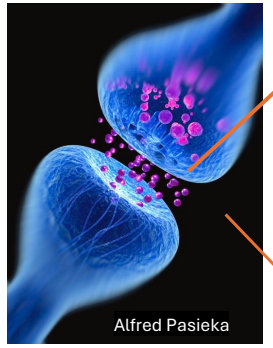
    Last Updated: Aug. 29, 2025
  - *we can fashion tools that amplify these inherent abilities that we have to spectacular magnitudes, e.g. wrt. locomotion, computation, medicine*

Slow Brain Bottleneck

- 3rd Factor (*computational efficiency*)
- Sensor/brain mismatch
  - slow brain limits what sensory inputs can be analyzed
  - mid-20th C: chemical neural communication, not electrical
    - *The War of Soups and Sparks* (Valenstein, 2005)
- Example: can we "see" a single photon?
  - *Adaptation: **neural filters** only allow a signal to pass to the brain to trigger a conscious response when at least 5-9 arrive within < 100 ms.* (Gibbs 1996)
  - **Yes** (Tinsley *et al*. 2016) vs. **No** ~5-7 (Hecht, Schlaer & Pirenne 1942)
  - *Single photon priming effect* (peak ~3.5 secs)

neurotransmitters

predates evolution of neurons



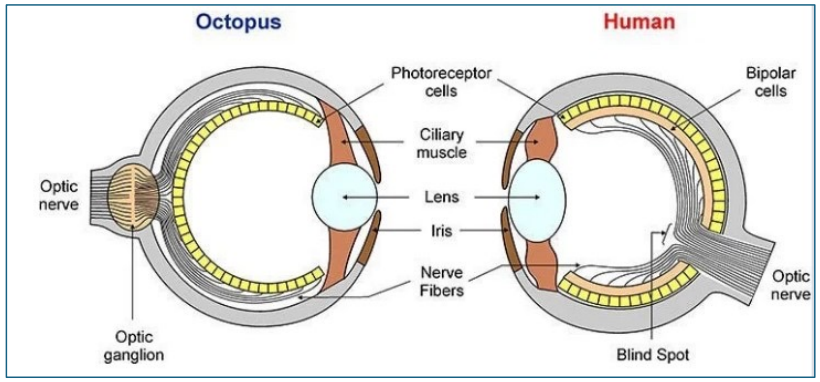
20-40nm synaptic cleft between two neurons

Recent Human Evolution

- (Berwick & Chomsky 2016)
  - *Vocal learning and production aspect of* [***EXT***] *is not human-specific* (ancient)
- (Chomsky 2021)
  - Language/thought, **I-Language**, an authentic species property (recent)
  - *Our closest relatives, otherwise intelligent apes, cannot begin to grasp the most elementary rudiments of language even with intensive training. They have about the same auditory system as humans, but acquire nothing from the sounds that lead a human infant, almost reflexively, to develop complex systems for constructing and expressing thought.*
- Basic structure of I-Language should be simple (**Merge**):
  - *the result of some […] small rewiring of the brain […] and has not changed […] since.*
- Modern human ~20K protein coding genes (*1.5% human genome*)
  - Neanderthal/Modern human Y-chromosome divergence ~588 tya (Mendez *et al*. 2016)
  - 14,042 regions of archaic DNA (Neanderthal/Denisovans) (Weiss et al. 2021)
  - *407 […] drove differential expression between the modern and archaic alleles*

Motivation for the SMT

- *Nature adapts/optimizes what it has to work with …*
- Disruptive event: *new entity/functionality* (**I-Language**)
- Reconstruction: *put together a simplest system new/old*



- Example of convergent evolution

- 750-570 mya: **LCA**
- 530 mya: high-res camera eyes (*re-invented many times*) (Land & Fernald 1992) (Land & Nilsson 2012)
- 500 mya: first nervous system
- 100 mya: we lost tetrachromatic vision (*cone cells*)
- 3-4 mya: first human-like brain
- 1-0.2 mya: modern brain
- octopus: "colorblind" (only 1 type of photoreceptor), but employ color (*camouflage*)

SMT

- Structures of **I-Language** are generated by the *simplest operations*
  - simplicity of mechanism is needed (*evolutionary plausibility*)
  - computational efficiency is needed (*slow brain*)
  - simplicity is possible? (*Miracle Creed*)
- Not part of core I-Language:
  - language variation/parameterization, e.g. *word order*
  - acquisition: e.g. *words, variation in word order, surface subject*
- I-Language/E-Language divide:
  - could have a **well-formed thought** but not (directly) externalizable
- **Strong**: *all linguistic phenomena can be accounted for*

Miracle Creed

LLMs: *GPT-4 1,760 billion parameters*
(G. Holz, cited in Wikipedia) GPT-5?

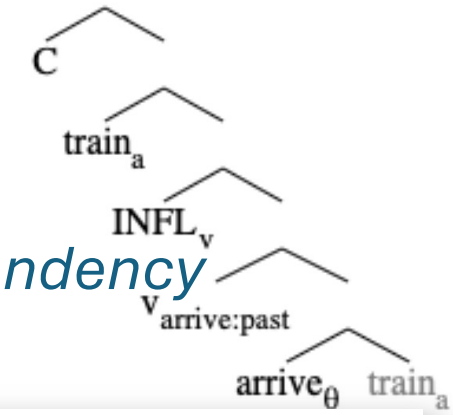
APRIL 1, 1950 | 20 MIN READ

On the Generalized Theory of Gravitation

how pure a "positivist" he may fancy himself. The metaphysicist believes that the logically simple is also the real. The tamed metaphysicist believes that not all that is logically simple is embodied in experienced reality, but that the totality of all sensory experience can be "comprehended" on the basis of a conceptual system built on premises of great simplicity. The skeptic will say that this is a "miracle creed." Admittedly so, but it is a miracle creed which has been borne out to an amazing extent by the development of science.

A. Einstein in *Scientific American* Vol. 182 No. 4 (1950)

(Simplest) Merge



- **Basic Property** of I-Language: *structural dependency*
  - *not linear order!* (surprising: *even simpler*)
- **SMT**:
  - what is the simplest mechanism that results in structure?
- (Mathematical) **Merge**:
  - two items X and Y (*binary*)
  - create {X, Y} (set: *no order*)
  - **recurse**: *Merge can feed Merge* (**WS**)
  - no embellishments!

INT/EXT: ⩤ {C, {$train_a$, {$INFL_v$, {$v_{arrive:past}$, {$arrive_\theta$, train:a_a}}}}}

(Marcoli et al. 2025)

banned!

non-recursive precursors?
- Core-Merge (Fujita 2014)
- Conjoin (Progovac 2015)

(Simplest) Merge

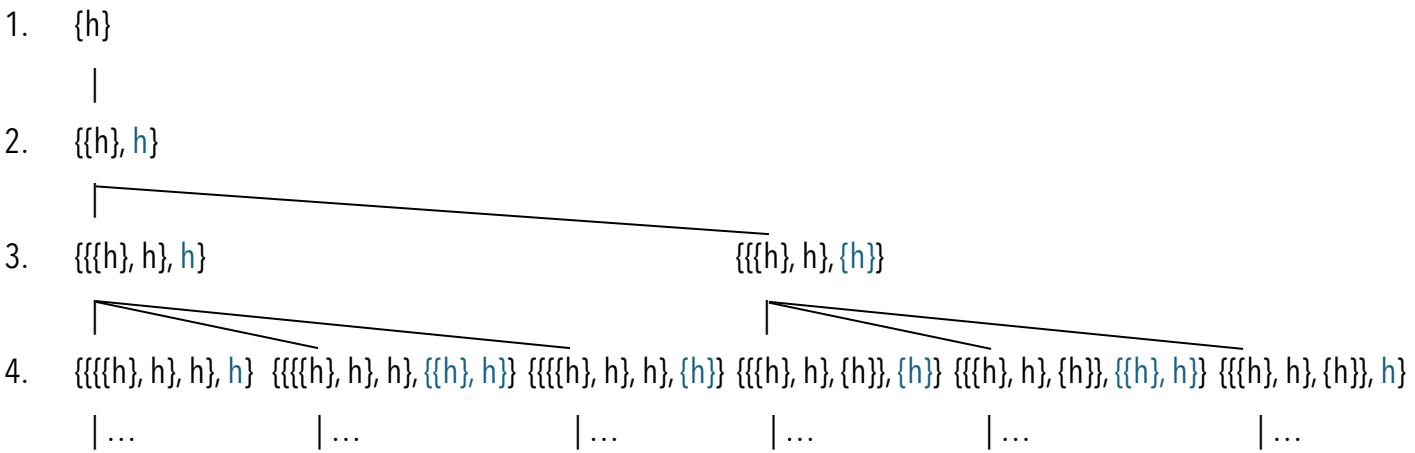
- Nature makes **Merge** available for cognition
- Natural Numbers ($\mathbb{N}$)
  - lexicon (**LEX**): h (*lexical item*: **LI**, a head h)
  - Workspace (**WS**): {h} (*suppose WS items: sets*)
  - **Merge**: {h} h
    - select WS item *X* and *Y*, a (sub-)**term of** *X*
    - create {X, Y} {{h}, h}

Internal Merge (IM)
"*simplest case*"

  - WS': {{h}, h} (*WS': state of WS after 1 Merge*)
  - WS'': {{{h}, h}, h} (h *a term of* {{h}, h} in WS')
    or {{{h}, h}, {h}} ({h} *a term of* {{h}, h} in WS')
    or {{{h_1}, h_2}, h_1} (h *a term of* {{h}, h} in WS')

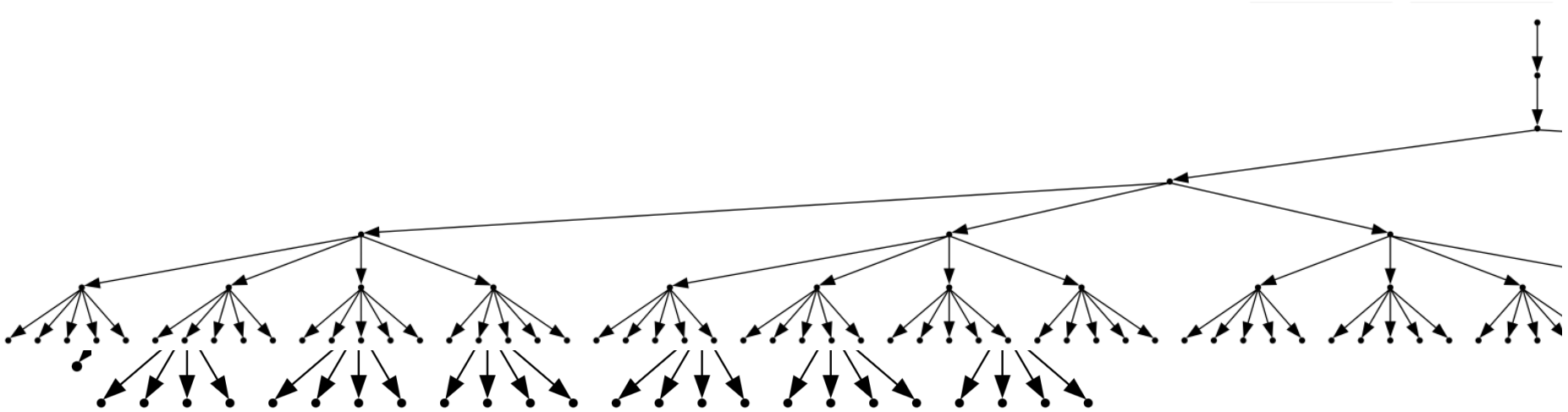
Workspace (WS)

- **IM WS** computation (*ignoring duplicates*):



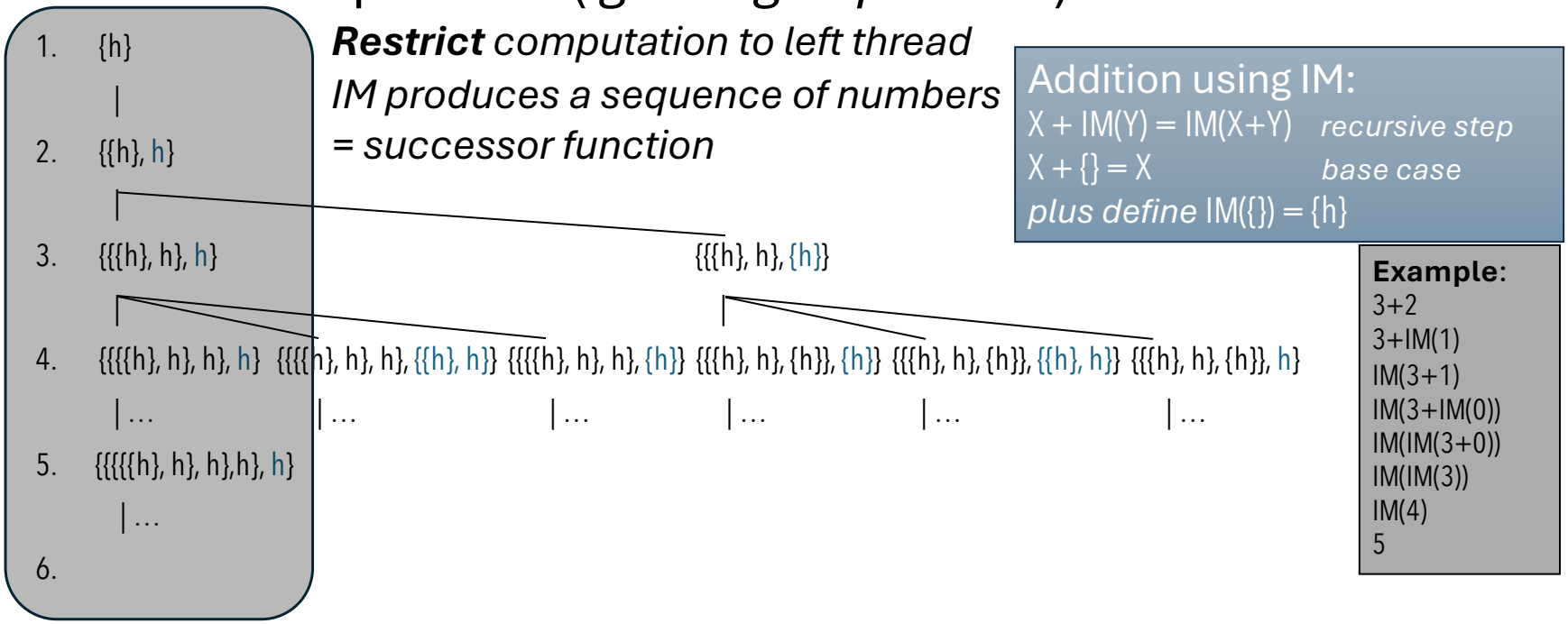
Workspace (WS)

- **IM WS** computation space (*zoomed out*)



Workspace (WS)

- **IM WS** computation (*ignoring duplicates*):

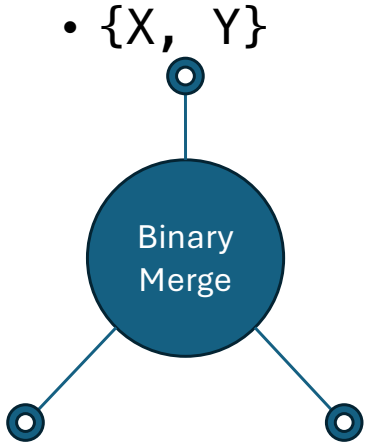


Workspace (WS)

- **EM** is more complex than **IM** (Chomsky)
- *but required by* **FL** *for thought construction*

- For I-Language
  - **LEX** contains (> 1) heads
  - **IM** is basic, *term-of* is the simplest relation
- Need also some θ-configurations:
  - {v, {R, IA_θ}} *unaccusative*
  - {EA_θ, {v, {R, IA_θ}} *transitive*
  - {EA_θ, {v, R}} *unergative*
  - assume v & R are heads (**LEX**)
  - EA & IA could be complex objects
  - *External Merge* (**EM**), brings *sister-of* relation

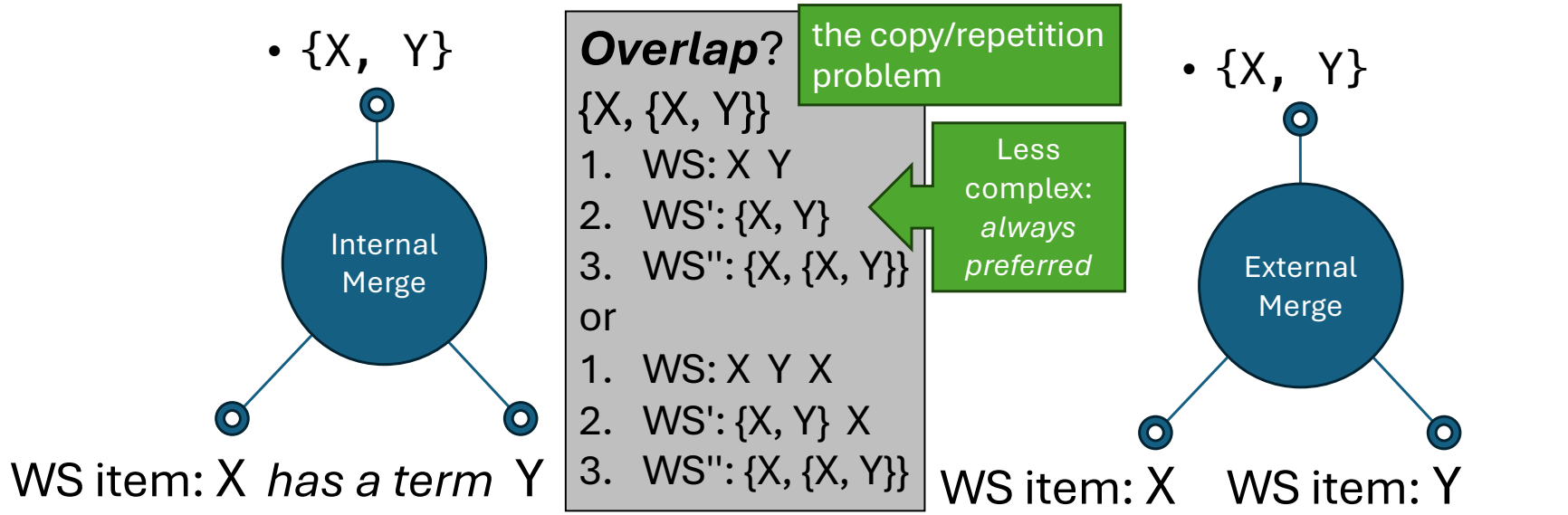
known to **INT**



Note: *assume* X *&* Y *are distinct, i.e. can't draw the same item twice*

Duality of Semantics

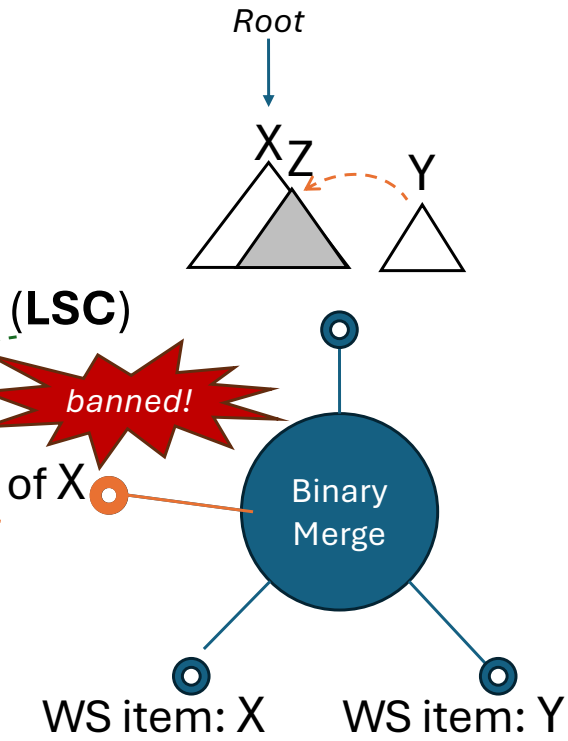
Earlier theory: $\{X_i, \{t_i, Y\}\}$ vs. $\{X, \{X, Y\}\}$



- IM for discourse/information functions
- EM for θ-configurations

Consequences

- **Merge** customized for I-Language use
  - **Duality**: *Language* (*Faculty*)-*Specific Condition* (**LSC**)
  - Minimal Search (**LSC**)
- **Design Principles**: *baked/designed-in*
  - ***Extension Condition*** (*root-only*)
    - *no tuck-in / splicing / no verbal head movement*
  - ***Non-Tampering Condition*** (**NTC**)
    - *deletion / turning something into a trace*
  - ***Inclusiveness*** (*no invention during derivation*)
    - *coindexation / γ-mark / assign a feature*
- **Merge** builds θ-configurations (*propositional domain*)
  - then transitions to the *clausal domain* via $INFL_{\phi}$
  - then adds heads like C/C_Q, Topic, Focus *etc*. (*probe with language-particular spellout **EXT***)



Consequences 2

- No circumvention of these principles
  - e.g. **Inclusiveness** bans indexing
  - work-around: insert *pre-indexed* heads, e.g. X_i X_i, into the WS
- Requires memory/marking:
  - *Principle of Minimal Compliance* (**PMC**) (Richards 1998)

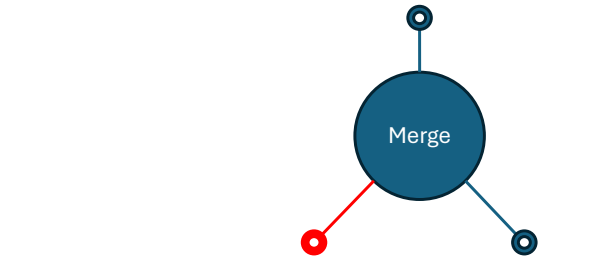
> For any dependency D that obeys constraint C, any elements that are relevant for determining whether D obeys C can be ignored for the rest of the derivation for purposes of determining whether any other dependency D′ obeys C.

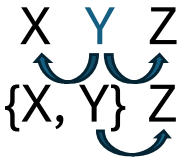
Consequences 3

- **Idea**: check off something, it's exempt (motivation: *economy*)
- **SMT Problem**: need to mark something as exempt
  - *requires memory*
- Example (Richards 1998):
  - Dutch: *all anaphors with a clausemate binder must be zichzelf*
  - **Henk* wees *zich* aan mij toe *(*Henk*, *zich*)
  - *Henk* wees mij aan *zichzelf* toe (*Henk*, *zichzelf*)
  - *Henk* wees *zich* aan *zichzelf* toe (*Henk*, *zichzelf*) mark *Henk*, then ignore violation *(*Henk*, *zich*), also a timing issue
  - **Key**: *toe-wees* = 3.sg.past of *toewijzen* (assign), separable prefix *toe-*

Consequences 4

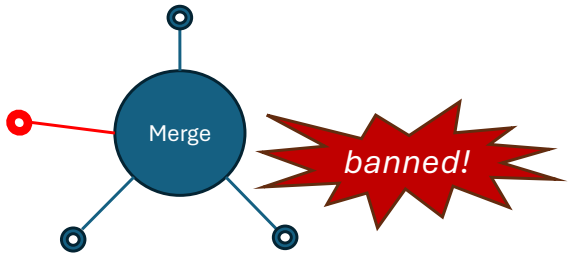
- Plain Merge means:
  - *no feature movement / inheritance*
  - *no memory devices/scratchpads*
  - *no WS history:* ***Markovian Assumption***
- More complex forms of Merge:
  - *useful perhaps, but also out!*
  - parallel Merge, sideways Merge
- *Minimal Yield* (**MY**) is a **design principle**
  - *not a* ***filter*** *on Merge output*





*{X, Y} {Z, Y}

violates Minimal Search



Markovian Assumption

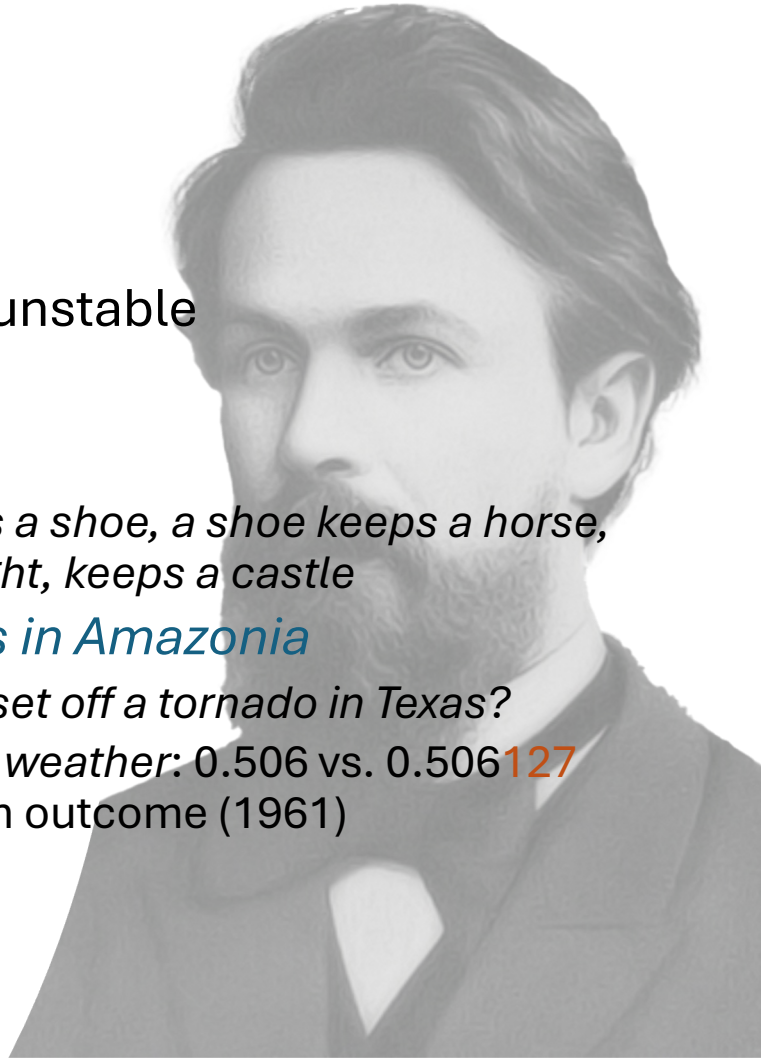
- **Independence:**
  - *each event is independent*
- **Markovian Assumption**:
  - *the future depends only on the present* (*not the deep past*)
- **Markov** (1913), *translated by Morris Halle*:
  - *Eugene Onegin*, in Russian (chapter 1 + 16 stanzas of chapter 2)
  - 20,000 characters; vowels: 8638, consonants: 11362

Probability	vowel	consonant
vowel	0.128	0.663
consonant	0.872	0.337

Strong bias in favor of alternation

Markovian Assumption

- Non-Markovian processes are complex/unstable
- Examples (Hayes 2013):
  - *kingdoms are lost for want of a nail*
  - 13th C poet: *the wise tell us that a nail keeps a shoe, a shoe keeps a horse, a horse keeps a knight, a knight, who can fight, keeps a castle*
  - *hurricanes are spawned by butterflies in Amazonia*
  - *Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?*
  - E.N. Lorenz (Chaos theory mathematician). *weather:* 0.506 vs. 0.506127 resulted in a completely different simulation outcome (1961)



Minimal Search (MS)

Chomsky (2021) (3) d. carefully, the mechanic who fixed the car packed his tools

- Examples of structural relations (*all must obey MS*):
  - an adverb must **find** a verb to modify
    - *but cannot use the simplest computation: pick linearly closest verb*
  - $INFL_{\phi}$ must **find** θ-relevant item (*with ϕ for* **EXT**) (*Agree*)
    - θ-relevant item: *EA for transitives, IA for unaccusatives*
- Merge must also obey MS
- Formulate the **find** operation:
  - **IM** brings the *term-of* relation
  - **EM** brings the *sister-of* relation
  - **c-command** = *sister-of* + *term-of* (**Phase**-local; related: **WS** partitioning)
  - No embellishments!

Minimal Search (MS) 2

- **Search**: *look for something, e.g. an identical inscription*
  - in **structure**: *for free* ***c-command*** (basic: *sister-of* + *term-of*)
  - in **WS**: *for free member-of* (*but not inside*)
- **MS**:
  - *1st thing you find, you have to* ***stop*** (**3rd Factor**)
  - *How to know we pick A or B?* **Answer**: *you never get to see B*
- **Minimal Yield (MY):**
  - *Merge should not explode the WS search space* (**Design Principle**)
- **Contrast with sorting** (*finding optimal*):
  - sort requires comparisons
  - compare candidates
  - must find/generate (multiple) candidates (**3rd Factor**)
  - *no optimality-theoretic accounts?*

On Minimal Search (MS)

- Rules out *equidistance* (Chomsky 1995)
- 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.*

FormSet

(Chomsky 2021:31)

- *unbounded unstructured sequences* (**UUS**)

John, Bill, my friends, the actor who won the Oscar, … ran, danced, took a vacation (*respectively*)

- FormSet ({…}):

8) (a) S_1 = {John, Bill, my friends, the actor who won the Oscar}
   (b) S_2 = {ran, danced, took a vacation}

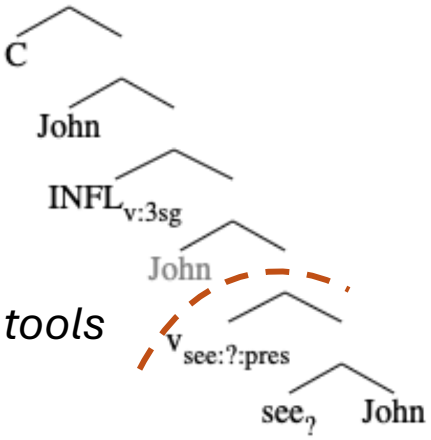
- *Other examples:*
  - John lived on a farm *and* with his family
  - John arrived *and* met Bill (*derivation on earlier slide*)
  - when *and* where did you see her? (Williams 1978)
  - which book did John buy *and* read?
  - the student who lives here who studies English whom I know
  - the politician is greedy *and* a charlatan (adjectival)
  - the long, dark *and* narrow hallway

SMT and FormSet

- *suppose FormSet is generally available to cognition*
  - *grouping given similarity* (*part of the toolkit*)
- **Simplest** conditions: (Design Principles)
  - members must be a *coherent* of set of syntactic objects
    - *but be easily computable, e.g.* ***±substantive, ±predicative***
  - members must obey some *parallelism* requirement for **INT**
  - members must *integrate identically* with Merge syntax (ATB effects)
- **Note**:
  - n = 2: {X, Y} *not same as binary Merge* {X, Y} *due to different conditions*
  - *n = 1? not available for* ***I-Language****, cf. arithmetic (Merge)*

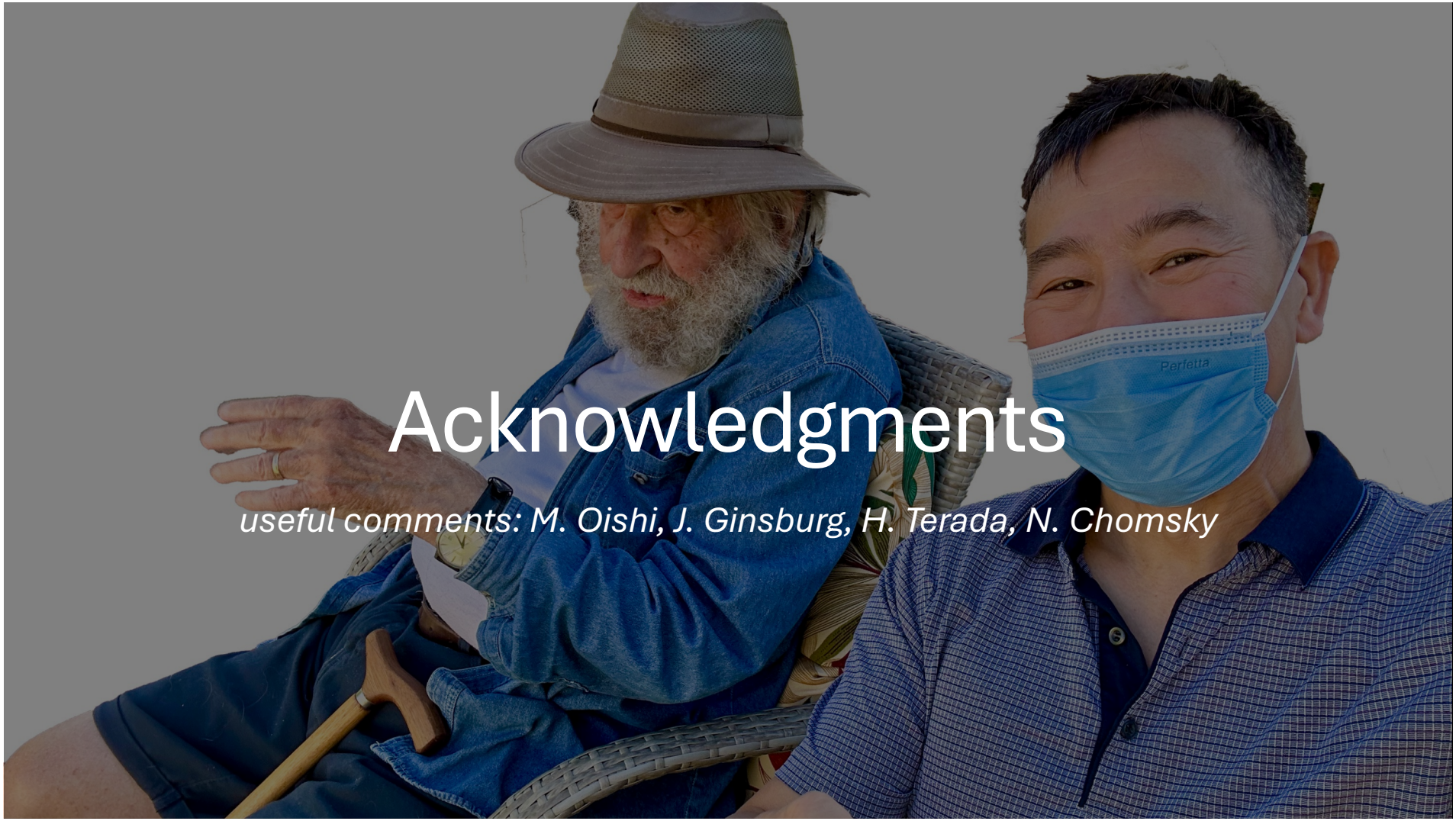
Workspace (WS) 2

Economy of **EXT**:
in English, pronounce only the highest copy



- **WS** *Partitions* and **Phases**:
  - **John likes* means the EA is in a higher Phase than the IA
  - *the nice mechanic who fixed the car carefully packed his tools*
  - WS_1: C_{rel} v fix $_{PAST}$ car who carefully ➲ $C_{rel}P$
  - WS_2: C v pack $_{PAST}$ tools he mechanic nice
  - or
  - WS_1: C_{rel} v fix $_{PAST}$ car who ➲ $C_{rel}P$
  - WS_2: C v pack $_{PAST}$ tools he mechanic nice carefully
- Note {XP**,** YP} *generally* requires WS partitioning:
  - (**EA**) *the nice mechanic* (who …) = XP
  - EM inserts EA into matrix θ-config. {EA, {v_{PAST}, {pack, {he, tools}}}}

YP



Acknowledgments

useful comments: M. Oishi, J. Ginsburg, H. Terada, N. Chomsky

Appendices

Sections:

- **Abbreviations/Glossary**
- Biology
- Combinatorics and Computation
- Structural Ambiguity
- Thought and Externalization
- Thought vs. Communication
- Syntax
- Mathematical Set Theory

ABBREVIATIONS/GLOSSARY

1. {} Empty set
2. {…} Non-empty set made by Merge
3. {…} set made by FormSet
4. **<** Precedes (in time)
5. **1st Factor** genetic, see Third Factor
6. **2nd Factor** experience, see Third Factor
7. **3rd Factor** see Third Factor
8. **Agree** Agreement (a relation)
9. **Box** see MC
10. **c-command** a relation built on sister-of and term-of (set)
11. **CKY** Cocke-Younger-Kasami
12. **copy** non-independent occurrence of phrase/head, see repetition
13. **DPDA** Deterministic PushDown Automata
14. **E-Language** Externalized language
15. **EA** External Argument
16. **EM** External Merge
17. **EXT** Externalization
18. **FL** Language Faculty (organ: biology)
19. **GK** (Chomsky 2021) in *Gengo Kenkyu* (LSJ journal)
20. **GPT** Generalized Pre-trained Transformer
21. **head** smallest unit (atom) in I-Language computation
22. **I-Language** contrast with E-Language
23. **IA** Internal Argument
24. **IM** Internal Merge
25. **INFL** Inflection (a head)
26. **LEX** Lexicon (heads & idiom chunks)
27. **OS** Object Shift
28. **INT** Interpretation
29. **LCA** Last Common Ancestor
30. **LI** Lexical Item from LEX
31. **LLM** Large Language Model
32. **LR** Left-to-Right
33. **LSC** Language-Specific Condition
34. **M-gap** Markovian gap see GK
35. **MC** *The Miracle Creed and SMT* (Chomsky 2024)
36. **ms**. millisecond
37. **MS** Minimal Search
38. **MY** Minimal Yield
39. **mya** Million Years Ago
40. ℕ Natural numbers 0,1,2…
41. **nm** nanometer
42. **NTC** Non-Tampering Condition
43. **PAST** Past tense
44. **PDA** PushDown Automata
45. **ϕ** phi-features, e.g. Person, Number, (grammatical) Gender
46. **phrase** structure formed by Merge, cf. head
47. **occurrence** in structure, a phrase or head may occur 1,2,3… times, see also copy and repetition
48. **sister** sister-of (a relation: set)
49. **SMT** Strong Minimalist Thesis
50. **structure** (I-Language) structure formed by Merge
51. **R** Root (a head)
52. **Root** highest node (tree)
53. **repetition** independent occurrence (of phrase/head)
54. **term** term-of (a relation: set)
55. **θ** Theta (as in Theta Theory)
56. **Third Factor** see *Three Factors in Language Design* (Chomsky 2005)
57. **tya** Thousand Years Ago
58. **UG** Universal Grammar (a theory)
59. **UUS** Unbounded Unstructured Sequences
60. **v** "little v" (a head)
61. **WS** Workspace

(Fong **SMT** UA *Synsalon* talk Sept 24th 2025)