A Tier-Based Model of Syntactic Agreement

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1 Introduction

■ Some (paradoxical) properties of agreement ■

Usually...	but...
Applies over a distance	Subject to blockers
Blockers are predictable	Vary across dependencies/languages
Targets the closest visible DP	Which DPs are visible varies
Probe c-commands goal	Sometimes reversed
One probe ↔ one goal	Sometimes many-to-one

■ Overview ■

Main claim: Agreement patterns are **tier-based strictly local (TSL)**, mirroring findings on movement (Graf 2022b) and case (Hanson 2023b).[1]

Why this matters:

- Limits structural configurations
- Defines parameters for variation
- Provides a unified model of locality restrictions
- Shows parallels within/across domains
- Derives typology from issues of efficient computation

■ Roadmap ■

1. What is a TSL pattern?
2. A TSL model of agreement
3. Consequences for locality
4. Typological variation
5. Parallels with phonology
6. Strengths and limitations of the model

[1] This is an informal presentation of an analysis done in the framework of MG derivation trees, recast in terms of mainstream Minimalism. See Hanson (2023a) for a more formal presentation (available at `https://www.kennethhanson.net/files/hanson-nyubb2023-agreement-slides.pdf`).

2 TSL patterns

■ What is a TSL pattern? ■

1. Ignore the irrelevant items and treat the rest as if adjacent
2. All constraints must be stated within a fixed-size moving window

Example: Vowel harmony

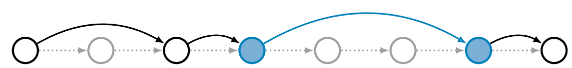
i/u/o obey front-back harmony, *e* is transparent/neutral, *a* is opaque

All elements: k, b, l, i, **e**, u, o, **a**
Tier elements: i, u, o, **a**
Invisible elements: k, b, l, **e**
Constraints: *iu, *io, *oi, *ui

Word	Tier	
kubulo	uuo	✓
kibilo	iio	✗
kubelo	uo	✓
kibelo	io	✗
kubalo	uao	✓
kibalo	iao	✓

■ More about TSL ■

- Originally defined to model phonological patterns (Heinz et al. 2011)
- Argued to be relevant in syntax as well (Graf 2022a)
- Inspired by but distinct from autosegmental phonology (Goldsmith 1976)
- Special relational structure (tier successor) with very weak constraint logic (banned substrings) (Lambert et al. 2021)
- By hypothesis, we only need a window of size two (McMullin 2016)



TSL string model with constraint window of size two

See Appendix A.1 for another example and a formal definition.

3 A TSL Model of Agreement

■ Setup ■

Assumptions:

- Bare phrase structure, feature-driven selection, movement, ...
- Agreement between elements with initially unvalued features (probes) and elements which provide those values (goals)[2]

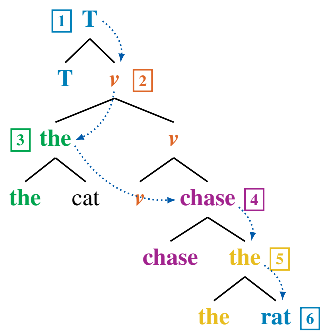
Question: What are the possible arrangements of probes and goals for agreement?

Answer: They are TSL constraints on the search path of the probe.

[2] I use the term **agreement** rather than **Agree** to indicate that we are not presupposing a particular version of the Agree operation, nor dealing with other phenomena that are sometimes subsumed under Agree.

■ The search path ■

ex. ‘The cat chases the rats.’



The search path follows the **derivational command (d-command)** relation (Graf and Shafiei 2019).

- Head < Spec < Comp
- d-command order ≈ height of XP
  ≈ order of last merge
  ≈ reverse order of selection
- Projections of a head are not distinguished.
- At each branching point, follow the complement spine (Graf and De Santo 2019).

See Appendix A.2 for how this works using derivation trees.

■ The TSL analysis ■

General principle: a probe must be immediately followed by its goal on a tier projected from the search path (and vice versa).

Notation: $p\phi$ = probe $g\phi$ = actual goal ϕ = other potential goal

Example: (canonical) subject-verb agreement

Tier elements:	All agreeing elements (T/D) and blockers (C)
Constraints:	$*\mathrm{T}_{[p\phi]} \cdot \mathrm{D}_{[\phi]}$, $*\mathrm{T}_{[p\phi]} \cdot \mathrm{C}$, $*\mathrm{D} \cdot \mathrm{D}_{[g\phi]}$, $*\mathrm{D}_{[g\phi]} \cdot \mathrm{D}_{[g\phi]}$, ...

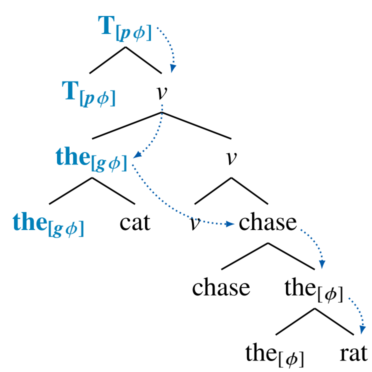
■ The TSL analysis – example ■

ex. The cat **chases** the rats.

Path: $\mathbf{T}_{[p\phi]} \cdot v \cdot \mathbf{D}_{[g\phi]} \cdot \mathrm{V} \cdot \mathrm{D}_{[\phi]} \cdot \mathrm{N}$

Tier: $\mathbf{T}_{[p\phi]} \cdot \mathbf{D}_{[g\phi]} \cdot \mathrm{D}_{[\phi]}$

Violations: n/a



For simplicity, we substitute most items with their category labels.

4 Consequences for locality

■ Consequences for locality ■

- **Minimality:** if another potential goal intervenes on the tier, agreement is blocked.
- **Invisibility:** if a DP is omitted from the tier, long-distance agreement is possible.
  - e.g. agreement across *there*, case-sensitive agreement
- **Blocking:** if a non-agreeing element intervenes on the tier, agreement is blocked.
  - e.g. probe horizons (Keine 2019), defective intervention

■ Minimality ■

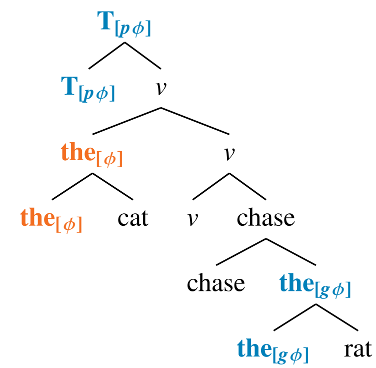
If another potential goal intervenes on the tier, agreement is blocked.

ex. * The cat **chase** the rats.

Path: $\mathbf{T}_{[p\phi]} \cdot v \cdot \mathbf{D}_{[\phi]} \cdot \mathrm{V} \cdot \mathbf{D}_{[g\phi]} \cdot \mathrm{N}$

Tier: $\mathbf{T}_{[p\phi]} \cdot \mathbf{D}_{[\phi]} \cdot \mathbf{D}_{[g\phi]}$

Violations: $*\mathrm{T}_{[p\phi]} \cdot \mathrm{D}_{[\phi]}$, $*\mathrm{D}_{[\phi]} \cdot \mathrm{D}_{[g\phi]}$



■ Invisibility ■

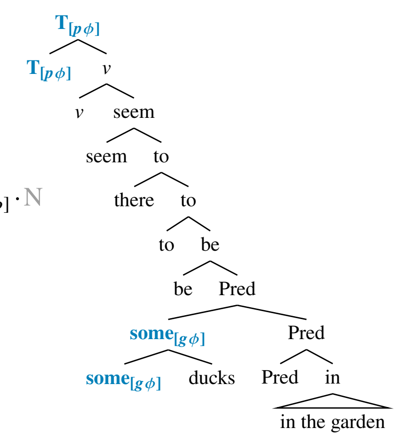
If a DP is omitted from the tier, long-distance agreement is possible.

ex. There **seem** to be some ducks in the garden.

Path: $\mathbf{T}_{[p\phi]} \cdot v \cdot \mathrm{V} \cdot \mathrm{T} \cdot \mathrm{there} \cdot v \cdot \mathbf{D}_{[g\phi]} \cdot \mathrm{P} \cdot \mathrm{D}_{[\phi]} \cdot \mathrm{N}$

Tier: $\mathbf{T}_{[p\phi]} \cdot \mathbf{D}_{[g\phi]} \cdot \mathrm{D}_{[\phi]}$

Violations: n/a



We can handle optional default agreement in several ways. Ask me if you are interested.

■ Blocking ■

If a non-agreeing element is projected on the tier, agreement is blocked.

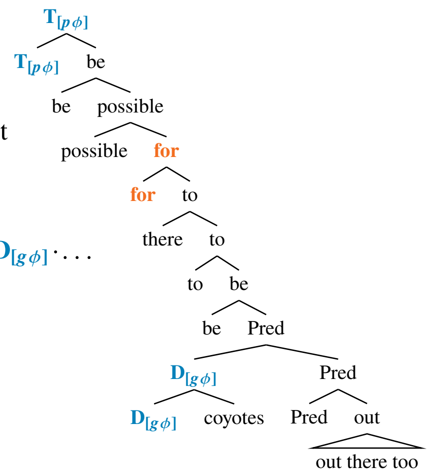
ex. * It **are** possible for there to be coyotes out there too.

cf. It **is** possible. . .

Path: $\mathbf{T}_{[p\,\phi]} \cdot v \cdot \mathrm{V} \cdot \mathbf{C} \cdot \mathrm{T} \cdot \text{there} \cdot v \cdot \text{Pred} \cdot \mathbf{D}_{[g\,\phi]} \cdot \ldots$

Tier: $\mathbf{T}_{[p\,\phi]} \cdot \mathbf{C} \cdot \mathbf{D}_{[g\,\phi]}$

Violations: $*\mathrm{T}_{[p\,\phi]} \cdot \mathrm{C}$, $*\mathrm{C} \cdot \mathrm{D}_{[g\,\phi]}$



Assume for the sake of demonstration that expletive “it” is inserted late and does not agree.

■ Locality – summary ■

Locality phenomena derive from TSL with a window of size two, a.k.a. **TSL-2**.

- Minimality: closer potential goal intervenes

$$\mathrm{T}_{[p\,\phi]} \ldots \mathbf{D}_{[\phi]} \ldots \mathrm{D}_{[g\,\phi]}$$

- Invisibility: hypothetical goal does not appear on tier

$$\mathrm{T}_{[p\,\phi]} \ldots \text{there} \ldots \mathrm{D}_{[g\,\phi]}$$

- Blocking: some non-agreeing element intervenes on the tier

$$\mathrm{T}_{[p\,\phi]} \ldots \mathbf{C} \ldots \mathrm{D}_{[g\,\phi]}$$

■ Importance of the finite window ■

- Neither tiers nor the finite window alone are adequate.
  - Tiers allow long-distance dependencies to be treated as if local.
  - The finite constraint window limits the power of the system.
  - Together, they create the right type of relativized locality.

See Appendix A.3 and Appendix A.4 for details.

5 Typological variation

■ Parameters for variation ■

The parameters for TSL-2 (tier elements and constraints) correspond neatly to variation in long-distance dependencies.

- Visibility — which elements are relevant and which are ignored?
  - Case-sensitive agreement (cf. Bobaljik 2008; Preminger 2014)
- Iteration — if you allow AB and BB, then you get ABB, ABBB, etc.
  - Case/gender/number concord
- Directionality — do we ban AB or BA?
  - Upward/downward agreement (cf. Chomsky 2000; Zeijlstra 2012)

■ Case-sensitive agreement ■

In Hindi, the verb agrees with the closest *nominative* argument, which may not be the subject.

(1) Hindi verbal agreement ignores ergatives (Mahajan 1990)

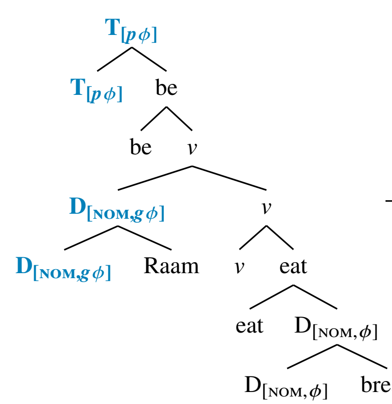
a. Raam roTii khaataa thaa.
Raam.M.NOM bread.F.NOM eat.IPFV.M be.PST.M
‘Raam ate bread (habitually).’

b. Raam-ne roTii khaayii.
Raam.M-ERG bread.F.NOM eat.PFV.F
‘Raam ate bread.’

Analysis: Project D only if nominative. Tier constraints are unchanged.

■ Case-sensitive agreement (2) ■

‘Raam ate bread (habitually).’ (Nominative subject, subject agrees)



$\rightarrow \mathbf{T}_{[p\,\phi]} \cdot \text{be} \cdot v \cdot \mathbf{D}_{[\text{NOM},g\,\phi]} \cdot \text{eat} \cdot \mathrm{D}_{[\text{NOM},\phi]} \cdot \text{bread}$

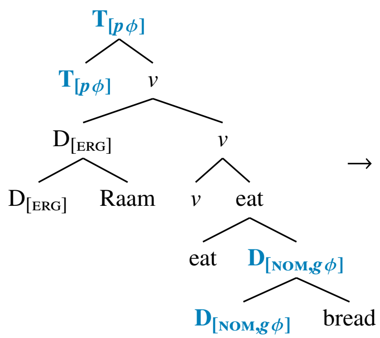
$\downarrow$

$\mathbf{T}_{[p\,\phi]} \cdot \mathbf{D}_{[\text{NOM},g\,\phi]} \cdot \mathrm{D}_{[\text{NOM},\phi]}$

We ignore agreement on the non-finite verb for simplicity. Concord will be discussed later.

■ Case-sensitive agreement (3) ■

'Raam ate bread.'   (Ergative subject, object agrees)



$$\rightarrow\ T_{[p\phi]} \cdot v \cdot D_{[\text{ERG}]} \cdot \text{eat} \cdot D_{[\text{NOM},g\phi]} \cdot \text{bread}$$

$$\downarrow$$

$$T_{[p\phi]} \cdot D_{[\text{NOM},g\phi]}$$

■ Ergative ≠ Invisible ■

Ergatives are not invisible in Nepali (though datives are).

(2) Agreement with ergative in Nepali (Coon and Parker 2019)

a. Maile yas pasal-mā patrikaā kin-ē.
   1SG.ERG DEM store-LOC newspaper.ABS buy-1SG
   'I bought the newspaper in this store.'

b. Ma thag-ī-ē.
   1SG.ABS cheat-PASS-1SG
   'I was cheated.'

No problem! We project $D_{[\text{NOM}]}$ and $D_{[\text{ERG}]}$ but not $D_{[\text{DAT}]}$.

■ Formal vs substantive constraints ■

- Case visibility hierarchy (Bobaljik 2008): Nom > Acc/Erg > Obliques
- We can encode the attested patterns in a TSL-2 grammar, but the implicational hierarchy itself requires a separate explanation.

■ Concord in the DP ■

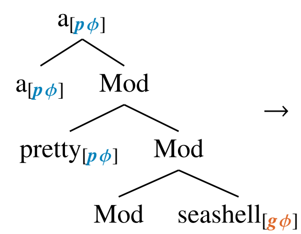
To allow for iterated agreement, just permit $p\phi \cdot p\phi$.

(3) Gender concord in German
   Ich habe [eine hübsche Muschel] gefunden.
   I have [a.F pretty.F seashell.F] found
   'I found a pretty seashell.'

Analysis: Ignore Mod on the tier, permit $D_{[p\phi]} \cdot A_{[p\phi]}$ and $A_{[p\phi]} \cdot A_{[p\phi]}$.

■ Concord in the DP (2) ■

Analysis: Ignore Mod on the tier, permit $D_{[p\phi]} \cdot A_{[p\phi]}$ and $A_{[p\phi]} \cdot A_{[p\phi]}$.



$$\rightarrow\ D_{[p\phi]} \cdot \text{Mod} \cdot A_{[p\phi]} \cdot N_{[g\phi]}$$

$$\downarrow$$

$$D_{[p\phi]} \cdot A_{[p\phi]} \cdot N_{[g\phi]}$$

The Mod head is not crucial. If direct adjunction is used, then the pattern is local: the tier contains everything.

■ Upward agreement ■

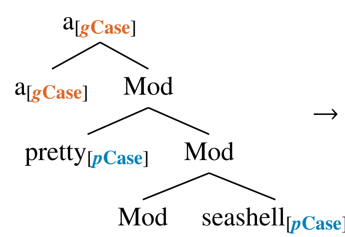
If the constraints are mirrored, then the direction of agreement is reversed.

(4) Case concord in German
   Ich habe [eine hübsche Muschel] gefunden.
   I have [a.ACC pretty.ACC seashell.ACC] found

Analysis: allow $D_{[g\text{Case}]} \cdot A_{[p\text{Case}]}$ instead of $D_{[p\text{Case}]} \cdot A_{[g\text{Case}]}$, etc.

■ Upward agreement (2) ■

Analysis: allow $D_{[g\text{Case}]} \cdot A_{[p\text{Case}]}$ instead of $D_{[p\text{Case}]} \cdot A_{[g\text{Case}]}$, etc.



$$\rightarrow\ D_{[g\text{Case}]} \cdot \text{Mod} \cdot A_{[p\text{Case}]} \cdot N_{[p\text{Case}]}$$

$$\downarrow$$

$$D_{[g\text{Case}]} \cdot A_{[p\text{Case}]} \cdot N_{[p\text{Case}]}$$

We can handle definiteness agreement on the adjective (ignored here) in the same way.

■ What does it mean to probe upward? ■

- In the MG derivation tree formalism (Graf and Shafiei 2019), we have a static representation of the entire derivation, so there is no problem.
- In a bottom-up Minimalist derivation, it is not obvious what it means for a probe to search upward. Some possibilities:
  - Let valued features search downward for unvalued features (Adger 2003)
  - Replace the search metaphor with the sliding window metaphor

■ Typological variation – summary ■

Example	Tier Elements	Tier Constraints
(Canonical) subject-verb agreement	All T/D/C	Strict pairing of $p\phi$ and $g\phi$
Case-sensitive agreement	All T/C D only if right case	(as above)
Concord within DP	All D/Adj/N	Allow sequential $p\phi$
Upward agreement	(as above)	Swap order of $p\phi/g\phi$

■ Parallels with phonology ■

Parameter	ϕ-agreement	Vowel harmony
Participants	Probe and most DPs	Most vowels
Invisible	Non-DPs, some DPs	Consonants, some vowels
Blockers	Finite C, some DPs	Some vowels
Directionality	Downward/upward	Progressive/regressive
Chaining	Concord/no concord	Spreading/"icy targets"

See McMullin (2016) and McMullin and Hansson (2016) regarding long-distance harmony.

■ What else is TSL? ■

Phenomenon	One line summary
Defective intervention*	Some DPs project even if they are never $g\phi$
Probe horizons (Keine 2019)	V/*v*/T/C project even if they are never $p\phi$
A′-agreement (Van Urk 2015)*	Only project DPs with a certain A′ feature
Omnivorous number	Only project DPs with [PL], not [SG]
Upward C agr. (Diercks 2013)*	C probes up, only project DPs that EPP-move
Default agreement*	Allow lone $p\phi$ under limited circumstances
Interaction/Satisfaction (Deal 2015)*	Allow multiple $g\phi$ under limited circumstances
Independent subfeatures of ϕ	Each probe gets its own tier/constraints

Also: many movement (Graf 2022b) and case patterns (Vu et al. 2019; Hanson 2023b), though these analyses use a different tier-based model.

*See Hanson (2023a) and Hanson (2024a) for details.

■ What *isn't* TSL? ■

Not all linguistic patterns are TSL. Of those that are not, most appear to be SS-TSL (structure-sensitive TSL). These include:

- Some long-distance harmony (De Santo and Graf 2019; Graf and Mayer 2018)
- Some tone patterns (e.g. unbounded tone plateauing)
- Some binding rules (Graf and Shafiei 2019)

6 Strengths and limitations of the model

■ Advantages of the model ■

- Clear separation of concerns:
  - Structural representation
  - Computations over said structure
  - Substance of elements of structure
- Insights:
  - Agreement is especially similar to harmony as both involve feature matching; the same seems to be true of movement
  - If case is different, this is plausibly because it involves different kinds of constraints (e.g. dependent case)

■ Limitations of the model ■

Puzzles for the path-based approach:

- What to do about violations of c-command (e.g. sub-command)?
- How to handle exceptions to the complement spine generalization?

What the TSL model (alone) does not tell us:

- Why does case matter for ϕ-agreement? Why should nominatives always be visible, ergatives sometimes visible, and datives usually invisible?
- Why do probes seem to look downward more often than upward?
- How do children identify the visible elements and constraints for each dependency? (see Hanson 2024b; Belth 2023)

7 Conclusion

■ Summary ■

- Agreement patterns in syntax are largely TSL with a window size of 2.
- If we vary the tier projection and constraints slightly, we can account for a wide range of variation across languages and constructions.
- This variation is similar to other linguistic phenomena, especially phonological harmony.
- Most of the logical possibilities of the model are realized within a single phenomenon — this is not necessarily expected!

■ Some open questions ■

- Do we ever need a window size larger than 2?

- Are there patterns that are not TSL under any reasonable analysis?
- How far can we take the parallel with harmony in phonology?

■ Takeaways ■

- Computational approaches to linguistic analysis reveal insights that might otherwise not be obvious.
- In other cases, they provide independent support to conclusions reached in other ways (e.g. visibility is parameterized).
- A clear understanding of the formal patterns can help us understand other aspects of linguistic structure.

■ Acknowledgments ■

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A Extras

A.1 Even more on TSL

■ Extra example: Sibilant harmony ■

Sibilants match in anteriority, *t* blocks harmony, other C's transparent

(based on Slovenian)

All elements:	{s, ʃ, t, k, a}
Tier elements:	{s, ʃ, t}
Constraints:	{*sʃ, *ʃs}

Word	Tier	
s a s a s a	s s s	✓
s a s a ʃ a	s s ʃ	✗
s a k a s a	s s	✓
s a k a ʃ a	s ʃ	✗
s a t a s a	s t s	✓
s a t a ʃ a	s t ʃ	✓

■ TSL string languages – formal definition ■

In a **tier-based strictly k-local (TSL-k)** language, a string is well-formed iff its **tier projection** does not contain any forbidden substrings of some length k.

- Σ = "alphabet" = set of all symbols
- T = "tier alphabet" = set of visible symbols
- G = "grammar" = forbidden substrings
- The tier projection is obtained by deleting all non-tier elements and concatenating the remaining elements.

Example: vowel harmony (redux)

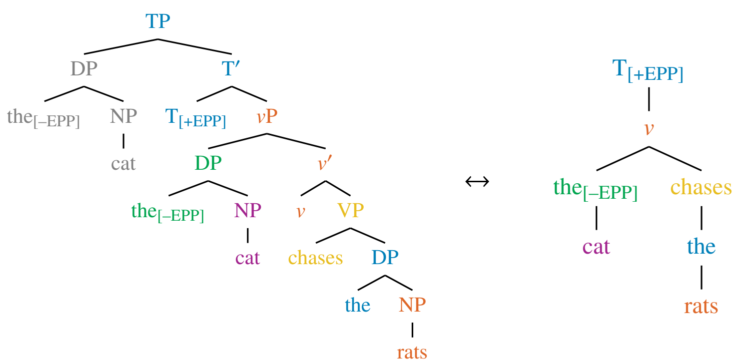
$\Sigma = \{k, b, l, i, e, u, o, a\}$
$T = \{i, u, o, a\}$
$k = 2$
$G = \{iu, {*}ui, {*}io, {*}oi\}$

String	Tier projection	Substrings	
kubulo	uuo	{uu,uo}	✓
kibilo	iio	{ii,**io**}	✗
kubelo	uo	{uo}	✓
kibelo	io	{**io**}	✗
kubalo	uao	{ua,ao}	✓
kibalo	iao	{ia,ao}	✓

A.2 Some formal details

■ MG derivation trees ■

- All nodes appear in base position.
- The rightmost child of a node is its complement; others are specifiers.
- Movement is indicated using feature diacritics.

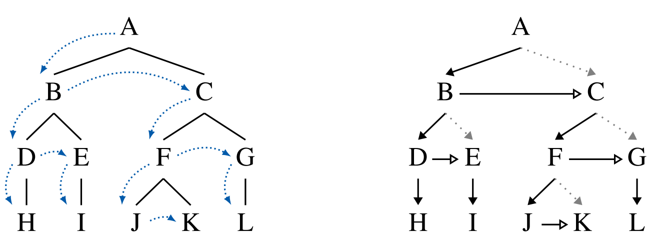


See Graf and Kostyszyn (2021) for a formal definition. Related: Brody (2000).

■ Command strings ■

A **command string** (c-string) is a derivational ordering of nodes.

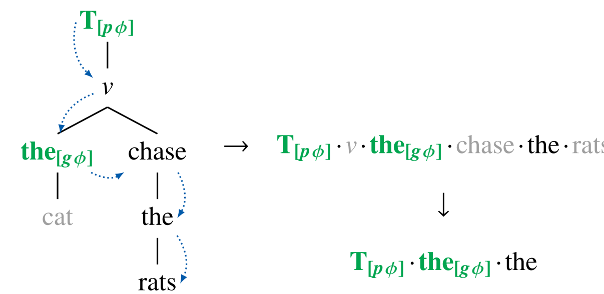
- There is a c-string from the root to each node.
- Among each head and its arguments: Head < Specifier < Complement.



See Graf and Shafiei (2019) for details.

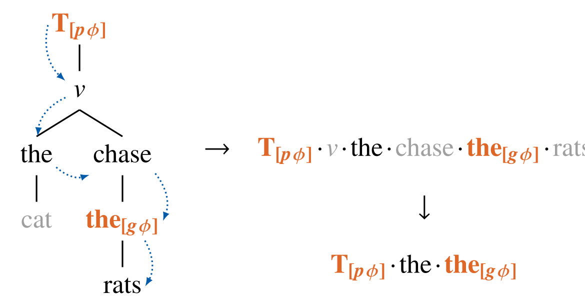
■ Tiers over command strings ■

✓ The cat **chases** the rats. (subject agreement)



■ Tiers over command strings (2) ■

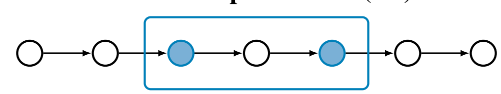
✗ The cat **chase** the rats. (object agreement)



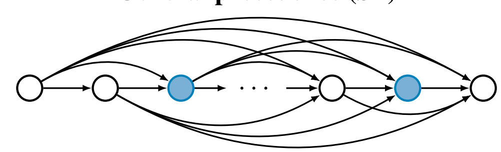
A.3 More on locality

■ Three models of locality ■

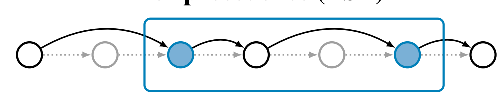
Immediate precedence (SL)



General precedence (SP)



Tier precedence (TSL)



■ **Three models of locality (2)** ■

- The immediate precedence (SL) model can handle local spreading.
- The general precedence (SP) model can handle unbounded processes, but can't handle blockers.
- Only the tier precedence (TSL) model can handle unbounded processes with blocking.

A.4 Computational considerations

■ **Limits on structural configurations** ■

TSL computations can relate elements at a distance, but are otherwise severely restricted in what they can do.

- No arbitrary logic — "a DP can A-move out of a finite CP, but only if there is A′-movement within some (other) CP in the sentence"
- No counting — "up to three reflexive pronouns may occur in a sentence if each obeys the Binding Theory"

These characteristics derive from the restriction that all constraints must be stated within the moving window.

■ **Conditions for efficient learning** ■

- The restrictions on TSL patterns help to make them efficiently learnable by limiting the amount of memory needed (Lambert et al. 2021).
- But there are too many possible tiers to test them all individually.
- We also need to consider other aspects of language acquisition such as the Tolerance Principle (see eg. Belth 2023; Hanson 2024b).