

A Tier-Based Model of Syntactic Agreement

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Some (paradoxical) properties of agreement

Usually...

Applies over a distance

Blockers are predictable

Targets the closest visible DP

Probe c-commands goal

One probe \leftrightarrow one goal

but...

Subject to blockers

Vary across dependencies/languages

Which DPs are visible varies

Sometimes reversed

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).

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- 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

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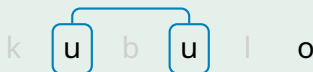
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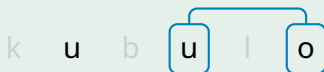
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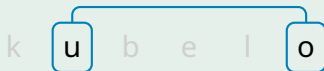
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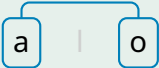
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More about TSL

- 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)

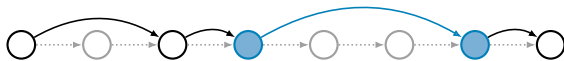


Figure 1: TSL string model with constraint window of size two

See Appendix 1 for another example and a formal definition.

A TSL Model of Agreement

Setup

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- Agreement between elements with initially unvalued features (probes) and elements which provide those values (goals)

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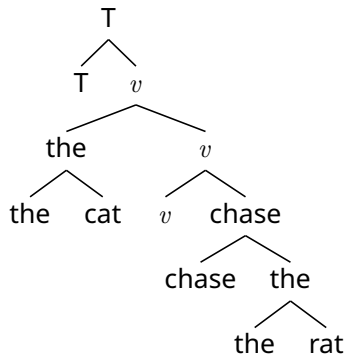
Answer: They are TSL constraints on the search path of the probe.

The search path

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

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

ex. 'The cat chases the rats.'



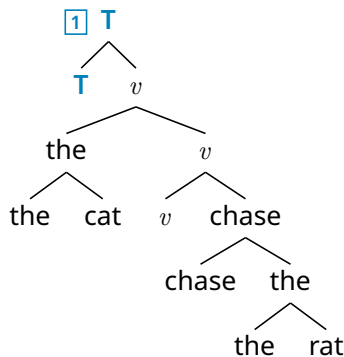
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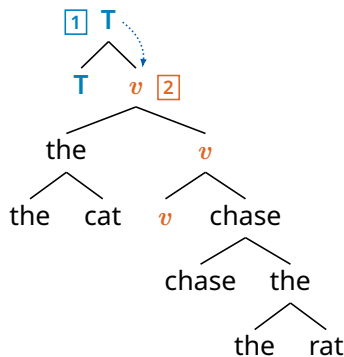
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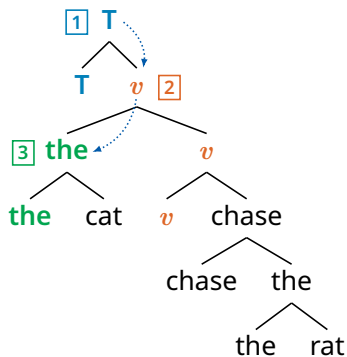
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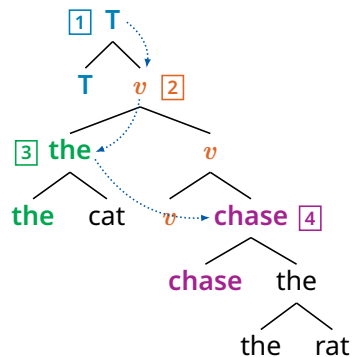
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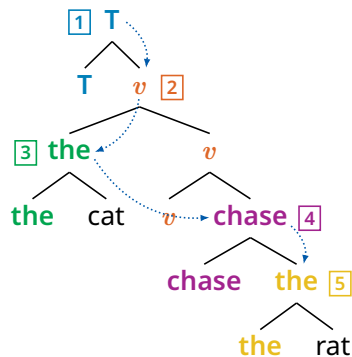
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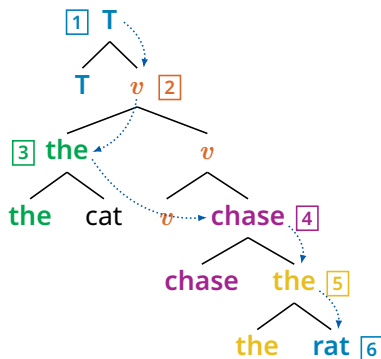
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Example: (canonical) subject-verb agreement

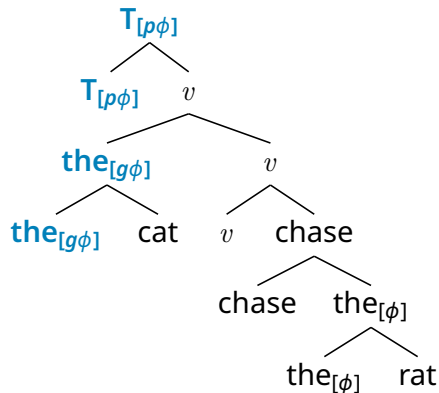
Tier elements: All agreeing elements (T/D) and blockers (C)

Constraints: $*T_{[p\phi]} \cdot D_{[\phi]}$, $*T_{[p\phi]} \cdot C$, $*D \cdot D_{[g\phi]}$, $*D_{[g\phi]} \cdot D_{[g\phi]}$, ...

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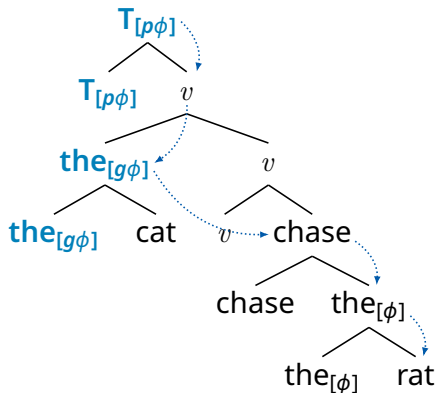


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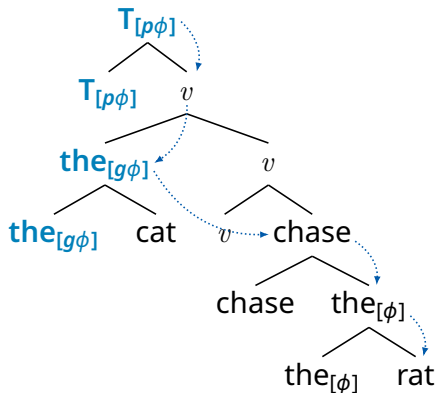
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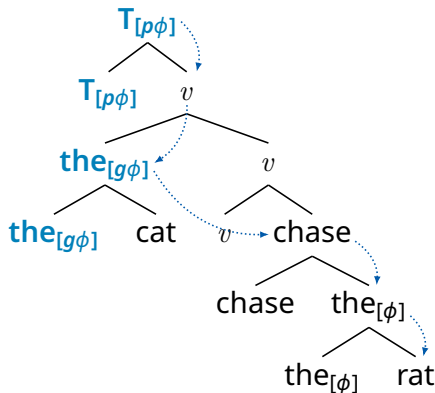
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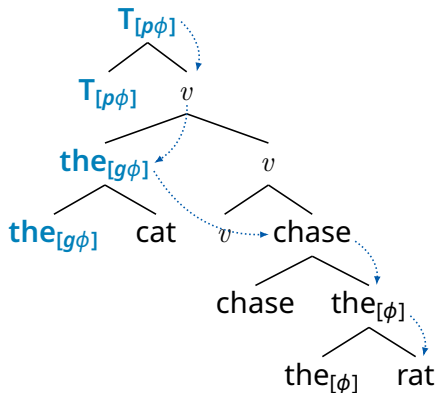
The TSL analysis – example

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

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

Path: $T_{[p\phi]} \cdot v \cdot D_{[g\phi]} \cdot V \cdot D_{[\phi]} \cdot N$

Tier: $T_{[p\phi]} \cdot D_{[g\phi]} \cdot D_{[\phi]}$



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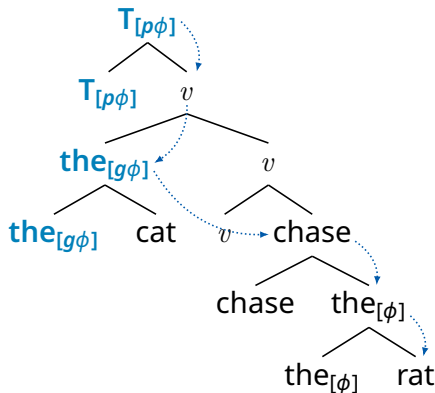
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Tier: $T_{[p\phi]} \cdot D_{[g\phi]} \cdot D_{[\phi]}$

Violations: n/a



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

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

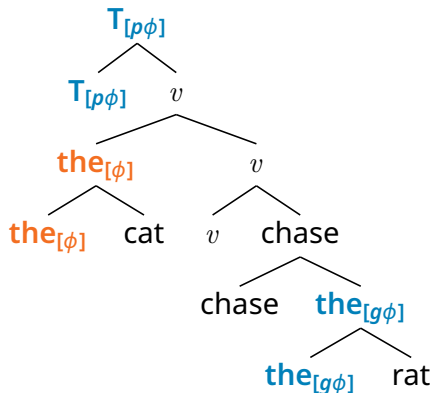
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ex. * The cat **chase** the rats.

Path: $T_{[p\phi]} \cdot v \cdot D_{[\phi]} \cdot V \cdot D_{[g\phi]} \cdot N$

Tier: $T_{[p\phi]} \cdot D_{[\phi]} \cdot D_{[g\phi]}$

Violations: $*T_{[p\phi]} \cdot D_{[\phi]}, *D_{[\phi]} \cdot D_{[g\phi]}$



Invisibility

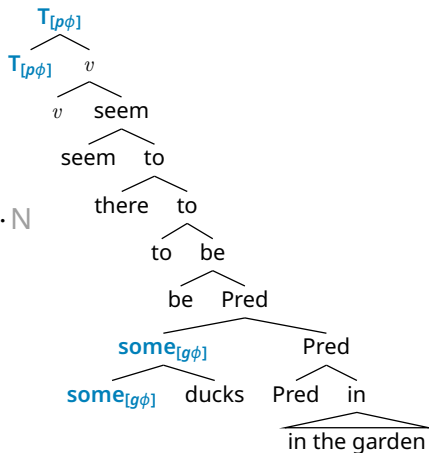
If a DP is omitted from the tier, long-distance agreement is possible.

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

Path: $T_{[p\phi]} \cdot v \cdot V \cdot T \cdot \text{there} \cdot v \cdot D_{[g\phi]} \cdot P \cdot D_{[\phi]} \cdot N$

Tier: $T_{[p\phi]} \cdot D_{[g\phi]} \cdot D_{[\phi]}$

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.

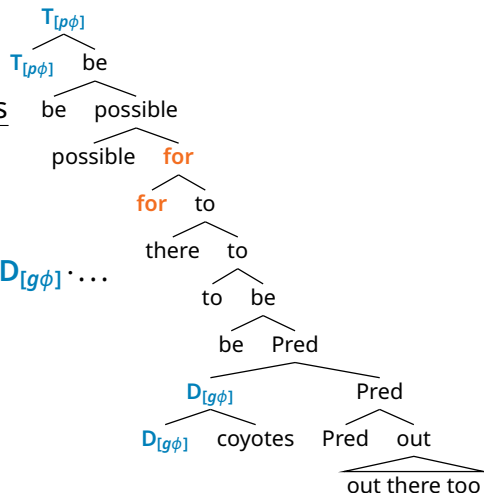
ex. * It **are** possible for there to be coyotes out there too.

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

Path: $T_{[p\phi]} \cdot v \cdot V \cdot C \cdot T \cdot \text{there} \cdot v \cdot \text{Pred} \cdot D_{[g\phi]} \cdot \dots$

Tier: $T_{[p\phi]} \cdot C \cdot D_{[g\phi]}$

Violations: $*T_{[p\phi]} \cdot C, *C \cdot D_{[g\phi]}$




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

$T_{[p\phi]} \dots \mathbf{D}[\phi] \dots D_{[g\phi]}$


- Invisibility: hypothetical goal does not appear on tier

$T_{[p\phi]} \dots \text{there} \dots D_{[g\phi]}$


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

$T_{[p\phi]} \dots \mathbf{C} \dots D_{[g\phi]}$


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 3 and Appendix 4 for details.

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, AB BB, 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).’

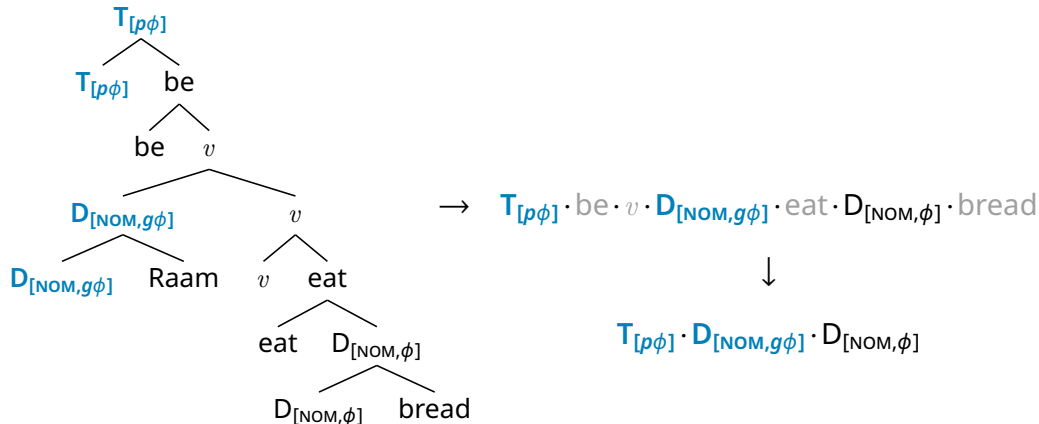
- b. Raam-ne roTii khaayii.
Raam.**M-ERG** bread.**F.NOM** eat.PFV.**F**

‘Raam ate bread.’

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

Case-sensitive agreement (2)

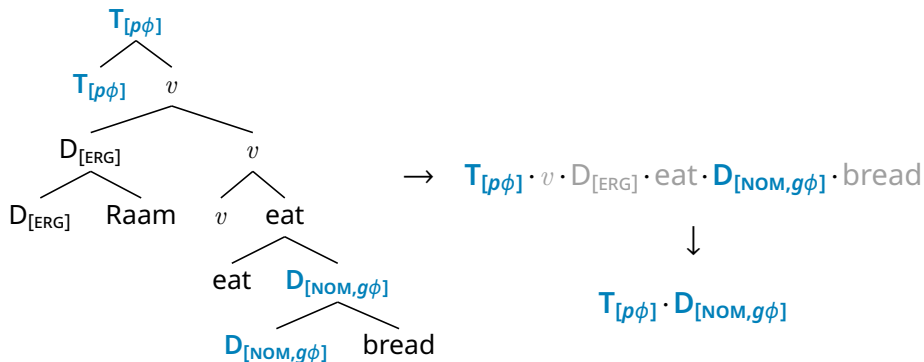
'Raam ate bread (habitually).' (Nominative subject, subject agrees)



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)



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 patrikāā kin-ē.

1SG.ERG DEM store-LOC newspaper.ABS buy-**1SG**

'I bought the newspaper in this store.'

b. Ma thag-i-ē.

1SG.ABS cheat-PASS-**1SG**

'I was cheated.'

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'I bought the newspaper in this store.'

b. Ma thag-i-ē.

1SG.ABS cheat-PASS-**1SG**

'I was cheated.'

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

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 $p\phi \cdot p\phi$.

(4) Gender concord in German

Ich habe [eine hübsche Muschel] gefunden.

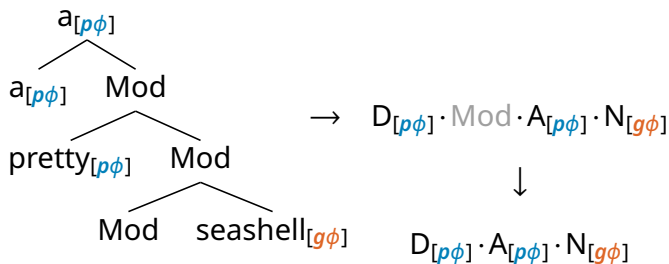
I have [a.F pretty.F seashell.F] found

‘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 $A_{[p\phi]} \cdot A_{[p\phi]}$.



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.

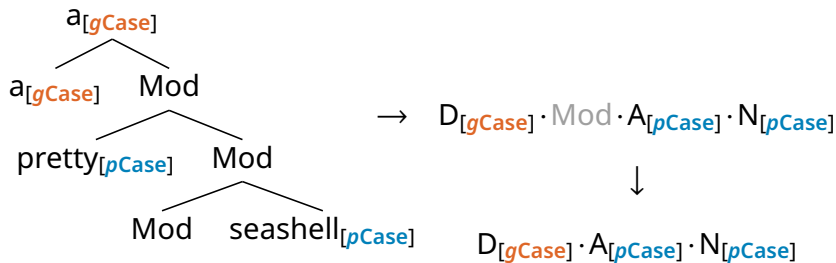
(5) Case concord in German

Ich habe [eine hübsche Muschel] gefunden.
I have [a.ACC pretty.ACC seashell.ACC] found

Analysis: allow $D_{[gCase]} \cdot A_{[pCase]}$ instead of $D_{[pCase]} \cdot A_{[gCase]}$, etc.

Upward agreement (2)

Analysis: allow $D_{[gCase]} \cdot A_{[pCase]}$ instead of $D_{[pCase]} \cdot A_{[gCase]}$, etc.



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
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Typological variation – summary

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(Canonical)	subject-verb agreement	All T/D/C	Strict pairing of $p\phi$ and $g\phi$

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Concord within DP		All D/Adj/N	Allow sequential $p\phi$

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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

Participants

Invisible

Blockers

Directionality

Chaining

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

Parallels with phonology

Parameter	ϕ -agreement
Participants	Probe and most DPs
Invisible	Non-DPs, some DPs
Blockers	Finite C, some DPs
Directionality	Downward/upward
Chaining	Concord/no concord

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

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)

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

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- 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?

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- 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)

Summary

- Agreement patterns in syntax are largely TSL with a window size of 2.

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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?

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- 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.

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- 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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Extras

Even more on TSL

Some formal details

More on locality

Computational considerations

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	✓

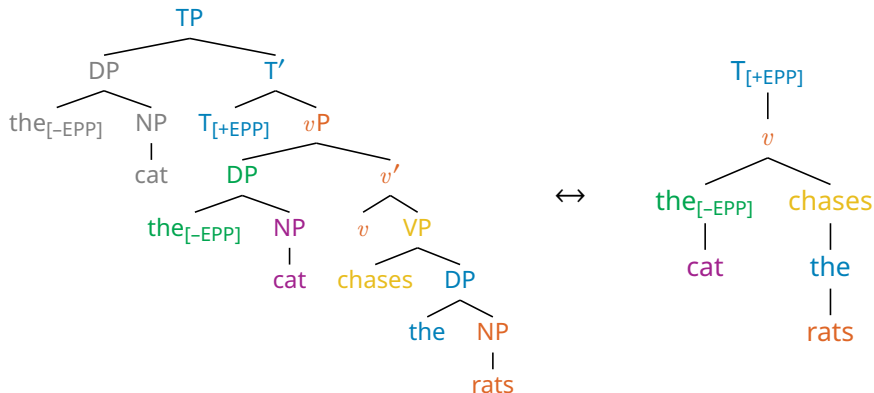
TSL string languages – formal definition

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.

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

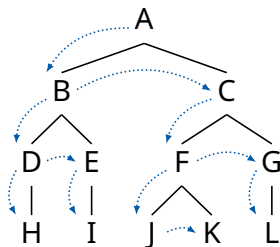
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- There is a c-string from the root to each node.
- Among each head and its arguments: Head < Specifier < Complement.

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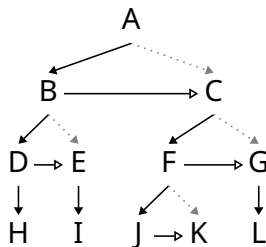
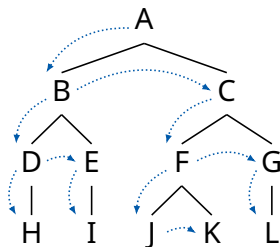


See Graf and Shafiei (2019) for details.

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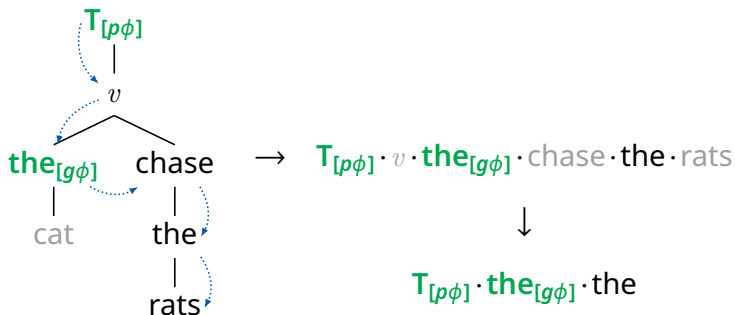
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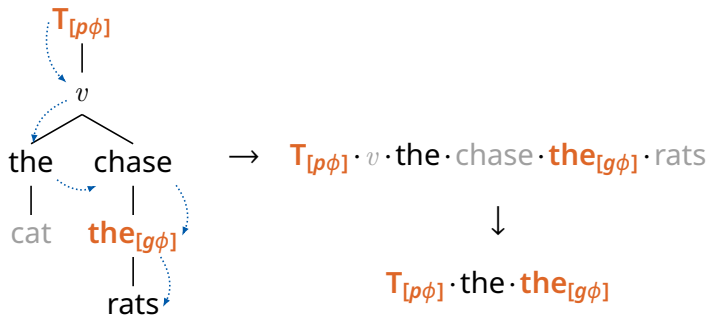
Tiers over command strings

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



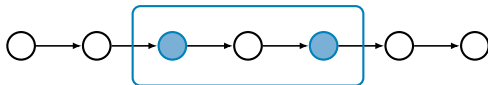
Tiers over command strings (2)

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

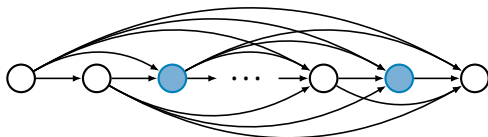


Three models of locality

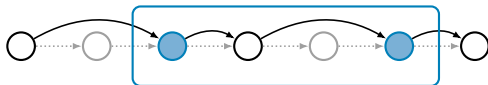
Immediate precedence (SL)



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.

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”

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- 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).