The Computational Basis of Locality in Syntactic Agreement

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1. Overview This work takes a computational approach to the study of syntactic locality, analyzing such patterns as **tier-based strictly 2-local** (TSL-2) languages. A wide range of linguistic dependencies, from long-distance phonotactics to syntactic case and movement have been shown to belong to either the TSL languages or their tree-based equivalent (Graf 2022). Here, I focus on **syntactic agreement**, which shows strong parallels to long-distance harmony in phonology, also predominantly TSL-2 (McMullin and Hansson 2016). It is shown that relativized minimality follows from the assumption that the search path of a syntactic probe obeys a TSL-2 language, as do other instances of syntactic blocking. In essence, myopia in syntax results from a narrow **moving window of visibility** for the relevant computations. The model also predicts **variation** in visibility and directionality, and allows for chain-licensing.

2. Properties of Agreement For concreteness, we model agreement in ϕ-features between a functional head such as T or C, which are initially unvalued, and a DP which provides that value. The canonical example is subject-verb agreement. This relation obeys **relativized minimality**: in general, finite T must agree with the closest DP in its c-command domain, usually the subject, as in (1). Next, certain elements **block agreement** even though they do not participate; the lack of agreement across finite C in English (2) can be analyzed in this way (cf. Keine 2019). Furthermore, in many languages certain DPs are **invisible for agreement**. For example, in Hindi perfective clauses the ergative subject is invisible, and the nominative object agrees instead, as in (3). A simple English example is long-distance agreement across *there* in (4).

3. TSL Patterns A TSL pattern can be computed by ignoring irrelevant elements and treating the rest as if they are adjacent. (This notion of a tier is related though conceptually distinct from the tiers of autosegmental phonology.) A simple example is (symmetric) sibilant harmony, in which sibilants must agree in anteriority. For example, words like ‘sasaksa’ and ‘ʃaʃakʃa’ would be licit, but not ‘sasakʃa’ or ‘saʃaksa’. In this case, we ignore all non-sibilants. The string made up of the remaining elements is called a **tier projection**—a visual metaphor for treating them as adjacent. On the tier, we **ban the substrings** sʃ and ʃs, as illustrated in (5).

(1) Minimality in subject-verb agreement
  a. The cat chases the rats.
  b. *The cat chase the rats.

(2) Finite C blocks agreement
  *It seem [$_{\text{CP}}$ that we have a problem].

(3) Hindi case-sensitive agreement (Mahajan 1990)
  Raam-ne roTii khaayii.
  Raam.M-ERG bread.F.NOM eat.PFV.F
  ‘Raam ate bread.’

(4) There seem [$_{\text{TP}}$ to be some ducks in the garden].

(5) sasaksa → sss → ✓ sasakʃa → ssʃ → ✗
  ʃaʃakʃa → ʃʃʃ → ✓ saʃaksa → sʃs → ✗

4. The Finite Window TSL languages allow distant elements to be treated as if local, but they also require each constraint to be stated within a finite window on the tier, ruling out the vast majority of possible constraints. By hypothesis, long-distance linguistic dependencies require only a **window of size two**; see McMullin and Hansson (2016) regarding long-distance harmony and Graf (2022) for examples from syntax. Although not yet treated explicitly in the TSL literature, relativized minimality also derives from this assumption, as shown below.

5. Agreement is TSL-2 We can describe many constraints on syntactic dependencies using a derivational ordering of nodes called a **command string** or c-string (Graf and Shafiei 2019), which is approximately the order obtained from asymmetric c-command. For ease of exposition, I omit the formal details and discuss the strings in terms of Minimalist derivations.

Consider the point in the derivation at which finite T is merged in (1), as shown in (6). The c-string which represents the **search path of the probe** is assumed to follow the complement spine of the tree. We visit Spec of vP, then the head v, then the complement VP, and so on. The c-strings for (1–3) are given in (7–9), with diacritics showing the probe and the intended goal. Note that we count each unique head only once.

(6) $[_{\mathrm{TP}}\,\mathrm{T}\,[_{v\mathrm{P}}\,[\text{the cat}]\,[\,v\,[_{\mathrm{VP}}\,\text{chase}\,[\text{the rats}]\,]\,]\,]\,]$

(7) a. $\mathbf{T}_{p\phi} \cdot \mathbf{the}_{g\phi} \cdot v \cdot \text{chase} \cdot \mathbf{the} \cdot \text{rats}$

b. $*\mathbf{T}_{p\phi} \cdot \mathbf{the} \cdot v \cdot \text{chase} \cdot \mathbf{the}_{g\phi} \cdot \text{rats}$

(8) $*\mathbf{T}_{p\phi} \cdot \text{seem} \cdot \mathbf{that} \cdot \mathbf{we}_{g\phi} \cdot \text{have} \cdot \mathbf{a} \cdot \text{problem}$

(9) $\mathbf{T}_{p\phi} \cdot \mathrm{D}_{\mathrm{ERG}} \cdot v \cdot \text{eat} \cdot \mathbf{D}_{\mathbf{NOM},\,g\phi} \cdot \text{bread}$

The **TSL-2 analysis** is as follows. All potential agreeing elements are projected on the tier (T and D), as are blockers (C). These elements are highlighted in (7–9). Invisible elements are not projected, such as ergative D in Hindi. Licit agreement configurations are those in which T agrees with an immediately following D on the tier; all others are illicit. Thus, the banned substrings on the tier include $\mathrm{T}_{p\phi} \cdot \mathrm{D}$ (where D is not the intended goal) and $\mathrm{T}_{p\phi} \cdot \mathrm{C}$, among others. This model **predicts minimality effects**, since even a single intervener on the tier prevents elements on each side from appearing in the same window, ruling out structures like (7b). Though not usually considered minimality violations, **other locality violations** such as (8) are ruled out **for the same reason**; there is no distinction from a computational perspective.

6. The typology of agreement In general, each type of syntactic probe has its own tier and constraints; *wh*-movement, for example, is not sensitive to non-*wh* DPs. This is in accord with recent theories of Agree in which locality restrictions are relativized to individual probes (cf. Deal 2015; Keine 2019). Also, the contents of a tier may **vary across languages**. If an element is omitted from a tier, it is invisible; if a non-agreeing element does appear, it is a blocker. In this respect, syntactic agreement is completely parallel to long-distance consonant/vowel harmony, in which non-agreeing segments may be invisible or blockers (cf. McMullin and Hansson 2016).

The tier constraints may also vary, predicting **variation in directionality** if the constraints are mirrored. Just as we have progressive and regressive harmony in phonology, we expect both upward and downward agreement; concord within the DP, for example, plausibly proceeds upward. Recent theories of Agree disagree on such matters (e.g. for Zeijlstra 2012, it is always upward), making the computational perspective especially insightful. Furthermore, by allowing multiple probes in sequence, we can model chain agreement; by analogy with phonology, harmonizing segments usually allow harmony to continue, while some ("icy targets") do not.

7. Computation, learning, substance That so many linguistic patterns are TSL(-2) supports the idea that typology within and across domains derives in part from the common computational machinery underlying them (cf. Lambert et al. 2021). However, the formalism says nothing about the set of possible tiers or constraints, which are best explained by other factors. For example, the acquisition theory should explain how the learner identifies tiers; see Belth (2023) for an example from phonology. Substance also has a role to play. I have drawn attention to the parallel between agreement and consonant/vowel harmony, which are feature-matching phenomena. In contrast, case patterns seem rather different, but this is not surprising if case involves a different type of constraint; once again, TSL-2 seems to be enough (Hanson 2023).

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