A Tier-Based Model of Syntactic Agreement

Keywords: agreement, relativized locality, computational complexity, tier-based strictly local languages

1. Overview Agreement configurations across languages show extensive variation, including (1) which elements agree, (2) which elements may intervene, and (3) whether values are obtained from above or from below. Why should such variation exist, and what are its limits? A wide range of linguistic dependencies, from long-distance phonotactics to syntactic case and movement have been shown to belong to the formal class *tier-based strictly local* (TSL) (Graf 2022). I propose that syntactic agreement is yet another example of a TSL phenomenon. This characterization provides an explanation for the range of variation which is based on independent considerations of computational efficiency (cf. Chomsky 1995; Lambert et al. 2021).

2. Properties of Agreement The present study focuses on agreement for 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 plausible English example is the (optional) long-distance agreement across *there* in (4); see §5. The combination of these three core properties—relativized locality, blocking, and invisibility—form the basis of the claim that agreement is TSL rather than some other formal class.

3. TSL Patterns A TSL pattern is one which can be computed by ignoring irrelevant elements and treating rest as if they are adjacent—a kind of **relativized locality**. (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. This is illustrated in (5). By hypothesis, constraints on long-distance linguistic dependencies require only a window of two elements on a tier, as discussed 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 [$_{CP}$ 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(s) [$_{TP}$ to be some ducks in the garden].

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

(6) [$_{TP}$ T [$_{vP}$ [$_{DP}$ the cat] [$_{v'}$ v [$_{VP}$ chase [$_{DP}$ the rats]]]]]

(7) a. $\mathbf{T}_{p\phi}$ · $\mathbf{the}_{g\phi}$ · v · chase · **the** · rats
  b. *$\mathbf{T}_{p\phi}$ · **the** · v · chase · $\mathbf{the}_{g\phi}$ · rats

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

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

4. Agreement is TSL We can describe the 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. Leaving aside the technical details, we focus on the c-string which represents the search path of a probe at some point in the derivation, which is assumed to follow the complement spine of the tree. As an example, consider the point at which finite T is merged in (1), shown in (6). We visit Spec of vP, then the head, 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 assume bare phrase structure and count each head only once, so no bar-level nodes appear.

The TSL 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, including ergative D in Hindi. Licit agreement configurations are those in which T agrees with an immediately following D on the tier, that is, the closest one; all others are illicit. Thus, the banned substrings on the tier include $\mathrm{T}_{p\phi}$ · D

(where D is not the intended goal) and $T_{p\phi} \cdot C$, among others. Note that in general each type of 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, both the tier elements and constraints may vary across languages, as discussed below.

5. The typology of agreement Variation in agreement patterns fits neatly into the typology predicted for TSL patterns with a window of size 2. First, we predict minimality effects, since even a single intervener on the tier prevents elements on each side from appearing in the same window. At the same time, we predict **variation in which elements participate** in agreement, which are invisible, and which are blockers. 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).

Next, we predict **variation in directionality**. Just as we have progressive and regressive harmony in phonology, we expect syntactic agreement to proceed both upwards and downwards. Concord within the DP, for example, plausibly proceeds upward. We also expect agreement on a single category to display variation. This seems to be true: in some Germanic languages, complementizers agree downward with the embedded subject; in the Bantu language Lubukusu, they agree with a higher subject (Diercks 2013).

Other more complex patterns are also TSL. For example, many speakers allow optional long-distance agreement in sentences like (4). This pattern is TSL under several analyses. One uses the interaction/satisfaction theory of agreement (Deal 2015): the probe is followed by zero or more items that interact but do not satisfy the probe (*there*), then one that satisfies it (other DPs). In general, such patterns can be shown to be TSL. Once again, an analogy can be drawn with phonology, in which harmonizing segments usually allow harmony to continue, while some ("icy targets") do not.

6. On the role of computational efficiency TSL is a highly restrictive formal class; it cannot count violations or implement arbitrary logical statements such as "you can have AB or CD but not both". These properties allow TSL patterns to be learned with simple pattern detection mechanisms and limited memory, contrasting sharply with other superficially similar classes. That so many linguistic patterns are TSL supports the idea that linguistic 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 must be allowed to vary and are therefore best left to be explained by other factors. For example, we might posit that there must be overt differences (such as case marking) which clearly distinguish visible and invisible elements; otherwise there are too many possible tiers to consider. Among the linguistically plausibly tiers, the acquisition theory should explain how the learner navigates this space. This a topic of current research; see Belth (2023) for an example from phonology.

7. Movement, case, and beyond I have drawn particular attention to the parallel between agreement and consonant/vowel harmony. In addition to being TSL, they are exceptionally similar since both are feature-matching phenomena, which is reflected in their tier constraints. If movement is triggered by feature matching (e.g. by Agree), then movement patterns should also be similar; this seems to be broadly correct, though lowering movement is contentious. In contrast, case marking patterns seem rather different, but this is not surprising if case involves a different type of constraint, as in dependent case theory. One obvious next step for the research program is to look more closely at interactions between case, agreement, and movement.

References **Belth, C.** (2023). "Towards a Learning-Based Account of Underlying Forms: A Case Study in Turkish". In: *Proceedings of SCiL 2023*. • **Chomsky, N.** (1995). *The Minimalist Program*. • **Deal, A. R.** (2015). "Interaction and satisfaction in ϕ-agreement". In: *Proceedings of NELS 45*. • **Diercks, M.** (2013). "Indirect agree in Lubukusu complementizer agreement". In: *NLLT* 31.2. • **Graf, T.** (2022). "Subregular linguistics: bridging theoretical linguistics and formal grammar". In: *Theoretical Linguistics* 48.3–4. • **Graf, T. and N. Shafiei** (2019). "C-command dependencies as TSL string constraints". In: *Proceedings of SCiL 2019*. • **Keine, S.** (2019). "Selective Opacity". In: *Linguistic Inquiry* 50.1. • **Lambert, D. et al.** (2021). "Typology emerges from simplicity in representations and learning". In: *Journal of Language Modelling* 9.1. • **Mahajan, A. K.** (1990). "The A/A-bar distinction and movement theory". PhD thesis. MIT. • **McMullin, K. and G. Ó. Hansson** (2016). "Long-Distance Phonotactics as Tier-Based Strictly 2-Local Languages". In: *Proceedings of AMP 2014*.