

## Recursion and GP 2.0

**Introduction.** Common wisdom holds that “[phonological] structures, though hierarchical, are not recursive, in that, unlike syntactic structures, they cannot be embedded indefinitely deeply in other structures of the same type. [...] For example, a rhyme cannot be subordinate to a syllable that is in turn subordinate to another rhyme.” (Jackendoff 2007: 39) I argue that this quote, though certainly the mainstream view, cannot be taken at face value.

Firstly, it presupposes that mainstream assumptions about constituency are correct. Work in Government Phonology (GP; Kaye, Lowenstamm & Vergnaud 1985, 1990, Kaye 1990) has shown repeatedly that certain phonological constituents cannot be maintained, including the syllable and (to some extent) the rhyme. The power of Jackendoff’s quote rests on the reliability of the notions involved.

Secondly, explanatory adequacy is an issue. Minimalist Syntax (Chomsky 1995) focuses on what drives a derivation (e.g. uninterpretable features). A similar concern has been central in GP, where the Non-Arbitrariness Principle (NAP) demands a connection between target and trigger, a requirement not met in rewrite rules ( $A \rightarrow B/C\_D$ ). Such concerns are central for an explanatory account in either domain. In contrast, Neeleman & van de Koot (2006) offer a detailed argument for fundamental *differences* between syntax and phonology, but treat phonology (unlike syntax) as a random assembly of unmotivated rules where anything goes. Under such a distorted view of phonology the flat, string-based model they propose seems sufficient, but it ignores much in phonology that actually argues for hierarchy.

Lastly, the notion of recursion itself is tricky. Minimalist syntax (Chomsky 1995), limits itself to one structure building operation, merge, taking two syntactic objects  $\alpha$  and  $\beta$ , and building a set  $\{\alpha, \beta\}$  out of them. Merge is recursive, as it can take its own output and reapply to it to build e.g.  $\{\gamma, \{\alpha, \beta\}\}$ ; but crucially, merge as an operation is category-neutral. (The label of the output is another issue and debated/-able, cf. Cecchetto & Donati (2005).) Given such category-neutrality, a DP contained in a  $\nu P$  is created by a recursive operation, a fact easily concealed by the labels. Recursion is often equated with self-embedding, but those two are not identical (Nevins, Pesetsky & Rodrigues 2009).

**Asymmetries.** As Neeleman & van de Koot (2006) correctly point out, the fact that trees *can* be used in phonology does not imply that trees *must* be used. We have to ask what phenomena can *only* be explained by trees, instead of just *also* be explained. The central reason why syntax employs trees is that they allow for the expression of asymmetries, which could not be handled by flat structures. GP 2.0 (Pöchtrager 2006, Pöchtrager & Kaye 2013), an offspring of GP, argues that the same is true for phonology. In the following I will look at some examples; first hierarchy in general, then asymmetries.

**GP 2.0 and hierarchy.** In GP 2.0, many melodic properties are reinterpreted as structural, e.g. the old stop element **ʔ** (Jensen 1994) as well as the voicelessness element **H** (cf. Pöchtrager 2006 for arguments on both). Each of them are interpreted as more structure, raising the question of how this “more of structure” can be differentiated. The x-bar schema (Fig. 1) provides the means to express this

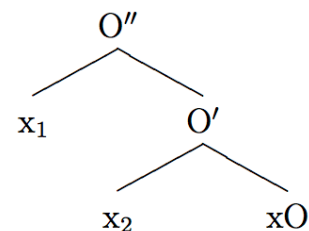


Fig. 1

difference while keeping both cases separate: The complement represents stopness, the specifier voicelessness. As a result, we have model that meets the category-free definition of recursion.

Similar arguments applied to the element **A** (“non-high/coronal”) which also interacted with structure in such a way that it seemed wiser to make it structure right away (Pöchtrager 2009, 2010, 2013ab, 2015). Vowel reduction (Pöchtrager 2018) provides various clues how to go about this. In a nutshell, vowel height has to do with size. The more open a vowel is, the bigger it is structurally. (More precisely: the more empty positions it has.) Vowel reduction, as e.g. in Brazilian Portuguese, simply involves the removal of successive layers of structure. Mid-open [ɛ] is only open in stressed position; the further removed a vowel is from stress, the more it reduces (Fig. 2). This captures the scalar nature of vowel height and makes clear that we are again dealing with a recursive system.

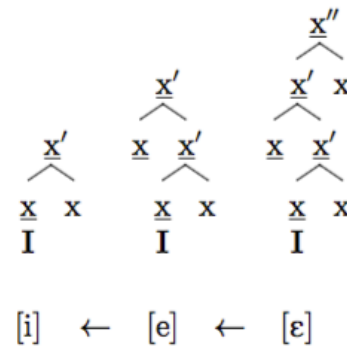


Fig. 2

With three elements gone, structure has to shoulder a heavier burden than before. But this is more than a simple redistribution of work; the shift is motivated by the NAP. To the extent that **ʔ**, **H**, and **A** show interaction with structure they must be given structural interpretation themselves in order to even express that interaction. The resulting structures are much more complex than what is usually understood when talking about constituent structure in phonology. Only hierarchical structure seems to provide the means to capture such fine-grained distinctions. At the same time they provide the backdrop for the expression of asymmetries.

**GP 2.0 and asymmetries.** The clearest evidence for asymmetries in phonology comes from differences between the elements **I** (“palatality”) and **U** (“labiality”), which seem distributed in asymmetric fashion in the tree structures of GP 2.0. For example, English allows *oi* (*boy*, *void*) but not *\*eu*. The difference lies in the positions of **I** and **U**, cf. fig. 3 (the triangle represents the structure replacing **A**).

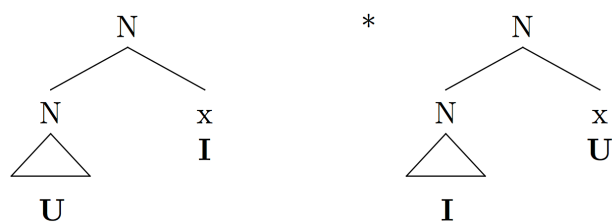


Fig. 3: *oi* vs. *\*e*

The details of this are formalised in Phonological Binding Theory, which demands that **U** must not c-command **I** (simplifying), while the reverse is possible, cf. Pöchtrager (2009, 2015), Živanović & Pöchtrager (2010). It is particularly encouraging that the same restrictions apply to Putonghua (Mandarin) and Japanese. In fact, **I/U** asymmetries go well beyond that, e.g. in vowel harmony: Presence of **U**-harmony in a language typically implies **I**-harmony and the former is always subject to more restrictions than the latter (Kaun 1995). Some restrictions follow from Binding: High front rounded *ü* contains **I** and **U**. In harmony, such a combination could arise by **I** spreading onto *u* or **U** spreading onto *i*. While the

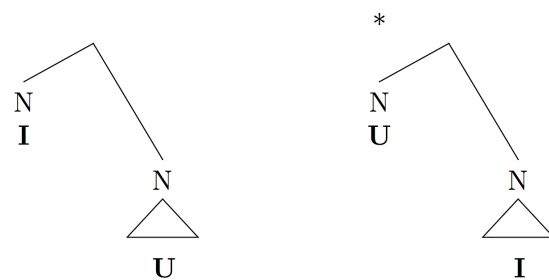


Fig. 4

former is attested (Finnish, Hungarian), the latter is not. U spreading onto *i*, the unattested case, would require an U to make its way into an expression that already contains I, cf. fig. 4. Under the assumption that the “entry point” is on top of I, i.e. that an U would come to c-command an I, we immediately rule out the unattested case as it would lead to a binding violation.

**GP 2.0 and metrical structure.** The structures that GP 2.0 uses do involve self-embedding. Fig. 5a gives the structure of a bi-“syllabic” word with initial stress, i.e. a trochee, following Pöchtrager (2006). It consists of two onset-nucleus (ON) pairs where the second pair is embedded in the first (cf. van der Hulst 2010, Smith 1999, García-Bellido 2005 and Golston 2016 for similar proposals). Fig. 5b gives the more mainstream, “flat” representation where both syllables are sisters within the foot.

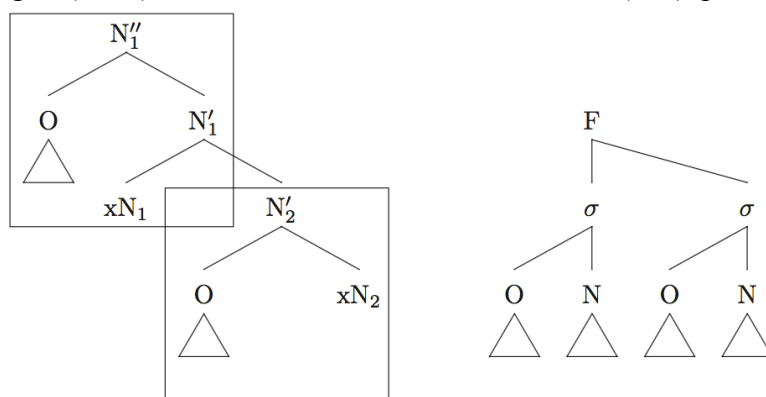


Fig. 5: (a) foot in GP 2.0 – (b) traditional foot

Fig. 5a & 5b make different predic-

tions for various phonological phenomena. 5a predicts that there is a constituent break between the initial onset and the rest of the foot. This defines the complementary environments where English allows [h] (in the initial onset) and [ŋ] (exactly not in the initial onset, but as part of its sister constituent.) The same break is exploited in various rhyme schemes: Alliteration pays attention to the initial onset (pre-stress), while end rhyme goes by the complement.

5a also encodes metrical prominence: The weaker nucleus (rather, a projection thereof) is embedded in the stronger one. Instead of relying on labeled branches, prosodic strength is encoded in the tree itself. Such a solution avoids one problem that labeled branches face; as Anderson & Ewen (1987: 101) point out, there is no reason why there should be exactly one “strong” branch. On the other hand, in a structure like the one in (13a), there will be one and only one nucleus that is not selected by another nucleus, and that will be the metrically strongest one. Hayes’ (1995) property of culminativity comes for free.

Furthermore, nuclei have a strong relationship with each other (stress, vowel harmony etc.), and thus is encoded as well: a nuclear head (or its projection) selects (the projection of) another nuclear head, and that one in turn can select the next etc. This is quite different from onset phrases, which are selected by the nucleus but do not select themselves.

**Limits of recursion.** Allowing for recursive structures raises the question what the limits are, if any. While there is work on the minimal size of phonological domains, there is virtually none on the maximal size, or on the question of whether there even is one. Nasukawa (2016: 235–236), allowing for large-scale recursion, simply cites performance as the limiting factor. Yet this does not immediately explain why *monomorphemic* phonological objects are not particularly long. Similarly, van der Hulst (2010) allows for infinitely deep embedding, but with a clean-up mechanism that then breaks the structures apart and flattens them out. It seems desirable not to

have a need for such clean-up in the first place. Several potential answers are worth considering.

Firstly, Arsenijević & Hinzen (2010, 2012), based on arguments on the conceptual-intentional interface, propose that in syntax, there is *no* self-embedding within the same phase. If recursion beyond a certain degree is dependent on semantic factors, as they argue, and if phonology lacks semantics (in the sense of interfacing with the conceptual-intentional interface), then the (potential) lack of infinite recursion could be derived. A recursive system can, but does not need to provide infinite recursion, cf. also Nevins, Pesetsky & Rodrigues (2009).

Secondly, the answer might lie in one of the functions of phonology, i.e. as an addressing system for the mental lexicon (Kaye 1995; Jensen 2000; Ploch 1996, 1999). If the lexicon needs to be populated with e.g. 10,000 addresses/morphemes, then that will be possible without overly complex phonological structures. A system of 20 consonants, 5 vowels and a CVCV morpheme structure constraint would already reach that target ( $20 \times 5 \times 20 \times 5 = 10\,000$ ), and many phonological systems are of course considerably more complex than that, despite the counterbalancing effect of various phonotactic restrictions.

Thirdly, there is the parallel to morphology, which commonly relies on hierarchical structure. Yet, recursion reaches its limits fairly soon outside of compounding: Inflectional morphology often terminates a morphological construction, but also in derivation it is very unclear whether recursion is allowed (Dressler 1989, Scalise 1994), especially of the self-embedding type: *great-great-great-great-grandfather* and *re-re-re-write* are possible, though their successful interpretation probably requires extralinguistic skills such as counting. Likewise, *nationalisation* is certainly fine, but *?nationalisationalise* less so, with each cycle adding to the unacceptability (*?nationalisationalisationalise*).

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