CONSTRAINING FREE MERGE: LABELING AND THE THETA-CRITERION

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Merge, the ability to recursively combine two elements together, is a core property of human language, and thus it is reasonable to assume that language evolved to make use of Merge. If Merge is essentially a free operation that the language module makes use of, it must be constrained in some ways. I created a computer model of language that implements Free Merge, and I explain how two properties of language, the need for syntactic structures to be labeled (Labeling), and constraints regarding theta assignment (the theta-criterion) can constrain Free Merge. This work suggests that labeling and the theta-criterion play an important role in language generation.

1. Introduction

Chomsky (2005, p. 11) writes that "the human language faculty is … a system of discrete infinity" that is "based on a primitive operation that takes *n* objects already constructed, and constructs from them a new object." This process of combining together linguistic objects is referred to as Merge. Chomsky (2011, p. 52) writes that "unbounded Merge is the sole recursive operation within UG" and that it is "part of the genetic component of the language faculty." If this is correct, human language evolved to make use of recursive Merge.[1]

Chomsky (2001, 2013, 2015) takes the position that Merge is free. Chomsky (2015, p. 14) writes that "[t]he simplest conclusion … would be that Merge applies freely" and "[o]perations can be free, with the outcome evaluated at the phase level for transfer and interpretation at the interfaces." Free Merge would result in an infinite number of possible structures generated for every possible utterance. Thus, Free Merge must be constrained by the language faculty.

[1] Berwick (2011) suggests that non-human primates have lexical items but no Merge, whereas birds have something like Merge (used in songs) but no lexical items. Human language, crucially, makes use of lexical items and Merge.

I utilized a computer model that automatically generates complete derivations of sentences to test the limits of Free Merge. With this model, I was able to constrain Free Merge with two language-related principles utilized in Minimalist work, Labeling and the theta-criterion.

2. Merge

Merge involves combining together syntactic objects (SOs). External Merge refers to selecting a lexical item from a workspace and Merging it with another lexical item or SO, which is an already formed syntactic structure. Internal Merge refers to selecting an element from within an SO and Merging it again with the root of the SO.

There are two types of Merge: set-Merge and pair-Merge. Figure 1a shows set-Merge of the two SOs X and Y. In this case, X is the label. Figure 1b shows Z pair-Merged with an XP; pair-Merge is represented as a dotted arc. Crucially, Z could be considered an adjunct on a separate plane.

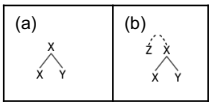

Figure 1. Set-Merge and Pair-Merge

Given Free Merge, it is possible to internally set-Merge an argument freely. In the derivation of *Tom read a book* (Chomsky, 2015), assume that LIs are selected from an input list in (1)a, and that at each stage of a derivation, an LI can be selected from the Input List and externally set-Merged with an already formed SO, or an SO can be internally set-Merged. The desired output is (1)b, following Chomsky's (2015) view that an object internally set-Merges with the verbal root and the verbal root *read* raises to v*. The subject also raises from the v*P to the TP. Note that Free Merge would also produce the ill-formed structures in (1)c-d, in which *a book* is internally set-Merged multiple times, and ends up in positions in which it is not found in actual language, so these types of structures must crash.

(1) (a) Input list: [C, T, Tom, v*, read, a, book]
(b) C Tom T ~~Tom~~ v*+read a book ~~read a book~~. → Tom read a book.
(c) C a book T Tom v*+read a book ~~read a book~~. → *A book Tom read.
(d) C Tom T a book ~~Tom~~ v*+read ~~a book~~ ~~read a book~~. → *Tom a book read.

The verb *think*, as in (2), differs from a transitive verb such as *read* in that it lacks case and doesn't agree with an object. To deal with this, I assume that the intransitive v (cf. Chomsky 2001) Merges with *think* and that v is able to label by itself.[2]

(2) He v thinks that John read the book.

3. Computer Model Output and Free Merge

I tested Free Merge using a computer model (which I constructed primarily in the Python programming language) that selects and Merges together lexical items from an input list, and automatically constructs detailed step-by-step derivations of phrases and sentences. This model incorporates Free Merge so that an argument can be freely internally set-Merged. This model also incorporates other core notions of Labeling Theory, such as feature transmission; a phase head (C or v*) passes unchecked phi-features to a complement and these unchecked phi-features need to form an Agree relation and be checked.

3.2 Labeling

In Labeling Theory (Chomsky, 2013, 2015), a label refers to the ability to interpret a phrase, e.g., as a VP, NP, etc. If a phrase cannot be labeled, then it cannot be properly interpreted. Murphy (2015) writes that "Label constitutes the evolutionary novelty which distinguishes the human cognome from non-human cognomes (7)", where the human cognome is "the finite set of operations available to the human brain (2)." Whether or not labeling is the core element that distinguishes human language from other animal communication systems remains an open question, but labeling appears to be crucial for human language.

The basic assumptions of Labeling Theory are that in an {H, XP} configuration in which H is a head and XP is a phrase, H can label (if it is strong enough to label). In an {XP, YP} configuration, if the heads of the XP and YP share prominent features, the shared feature(s) can label, or if one of the phrases moves out (undergoes internal Merge), the head of the remaining phrase can label

[2] Epstein, Kitahara, and Seely (2016) propose that *think* and v* are externally pair-Merged together, resulting in <think, v*>, where v* is the pair-Merged element. External pair-Merge of v* with *think* results in the uPhi, as well as the phasehood, of v* disappearing. This external pair-Merge analysis is one way to account for verbs such as *think*. However, permitting external pair-Merge greatly increases the possibilities for Free Merge. It also isn't entirely clear how phasehood and uPhi of a phase head can disappear under pair-Merge.

(if that head is strong enough to label).[3] In addition, Chomsky proposes that the English T and verbal roots are inherently too weak to label by themselves. However, when they Agree with an XP in an {XP, YP} structure, shared features strengthen them so that they can label.[4]

Consider the derivation of *Tom will read a book*, shown in Figure 2, which is successfully generated in my model. The object *a book*[5] internally set-Merges with the SO headed by *read*. This results in an {XP, YP} structure that is labeled via shared phi-features, indicated as <ϕ, ϕ>, resulting from Agree between *read* and *a book*. Similarly, the subject *Tom* internally set-Merges with the TP, resulting in a labelable {XP, YP} structure, resulting from the shared phi-features of the subject and T. Note that I follow Chomsky's (2015) view that the verbal root *read* moves to v*, producing <v*,read>, with v* the pair-Merged element. In addition, *will* moves to T forming <Tpres, will>. This "head-movement" is implemented as internal pair-Merge.

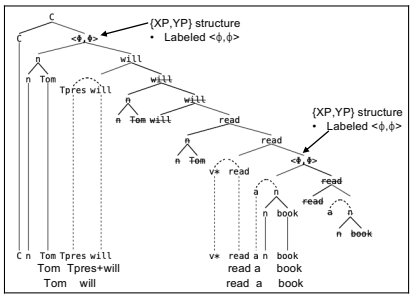

Figure 2. Successful derivation of *Tom will read a book*

[3] An anonymous reviewer asks about cases in which both elements in an {XP, YP} structure move out, such as in a French v*P where the subject and verb supposedly move. Movement of the verb is head movement. How exactly to deal with head movement is an open question. Chomsky (2001) suggests that head movement is a phonological operation. If head movement occurs at PF (phonological form), then head movement of the verb does not influence the syntax and will not influence labeling. In my model, the head is visible for labeling in its base position even after it has undergone movement, which I have implemented as internal pair-Merge.

[4] Murphy & Shim (2020) argue that T can label by itself. If uPhi are responsible for blocking labeling (cf. Mizuguchi 2017 for a proposal that heads without unvalued features can label), then it is possible that finite T (which has uPhi) cannot label by itself, whereas non-finite T (which lacks uPhi) is able to label. Murphy & Shim also note potential problems for permitting shared features to label, and they propose that only categorial heads label. Although these issues are worthy of further analysis, I assume the standard Labeling view that shared prominent features can label.

[5] Note that I assume that *a book* is an NP, with the determiner being a pair-Merged adjunct, a view that has been suggested by Chomsky (2007), as well as Oishi (2015). See Bruening (2020), among others, for support for the view that arguments are NPs and not DPs. Whether or not an argument is treated as an NP or a DP is not crucial for the examples discussed in this paper.

My model implements Free Merge of arguments, which can result in derivations that crash. In Figure 3, the subject *Tom* remains within the v*P and does not move to the specifier of TP. Since Merge is free, nothing forces the subject to move. However, this derivation crashes because of labeling failures, shown in Figure 3b. In the v*P, there is an {XP,YP} structure in which the subject and the v*P do not share phi-features, so labeling is not possible. In addition, assuming that English T is too weak to label by itself (following Chomsky 2015), T, represented as <Tpres, will>, is unable to label since it has no subject with which it shares phi-features. In another unsuccessful derivation shown in Figure 4, the object, *a book*, undergoes internal set-Merge with the TP, and the underlying subject *Tom* remains in-situ. This results in the labeling failures shown in Figure 4b. Although *a book* and <Tpres, will> are able to form a labelable {XP, YP} structure due to phi-feature agreement, the v*P-internal subject and the v*P form an unlabelable {XP, YP} structure, due to a lack of shared phi-features. Furthermore, the root *read* is also unlabeleable, since the object *the book* has moved out and the root *read* cannot be strengthened by shared phi-features.

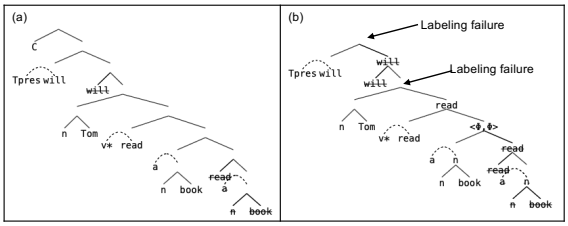

Figure 3. Labeling failure: unsuccessful derivation of *Tom will read a book*

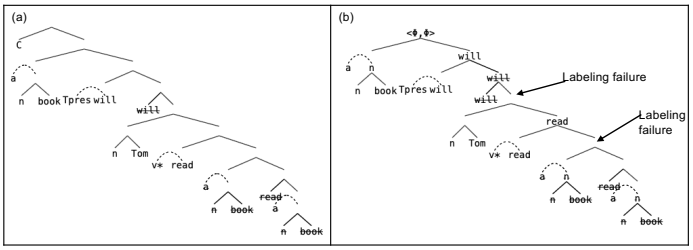

Figure 4. Labeling failure: another unsuccessful derivation of *Tom will read a book*

The sentence *He thinks that John read the book* has the successful derivation shown in Figure 5, which contains v that Merges with *think*, and v is able to label.

Free Merge also permits derivations such as that in Figure 6, in which the subject remains in-situ. This will crash because the matrix subject is in an

unlabeleable {XP, YP} configuration with the vP and because T is not strengthened. Thus, this ill-formed derivation is ruled out by Labeling.

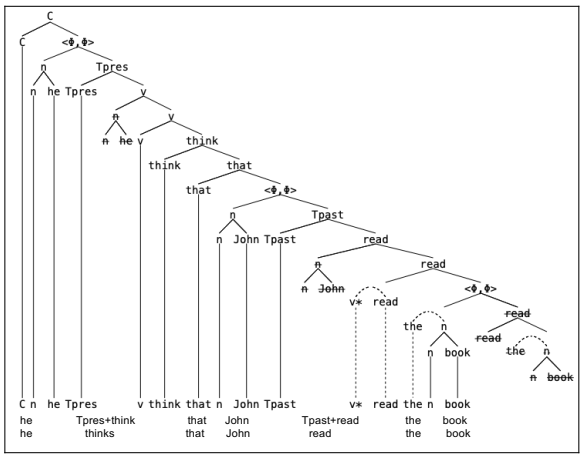

Figure 5. Successful derivation of *He thinks that John read the book*

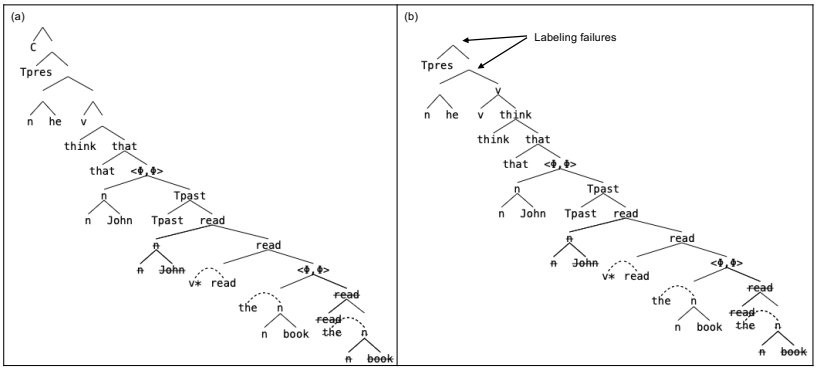

Figure 6. Labeling failure in *He thinks that John read the book*

3.3 Theta-Criterion

The theta-criterion is the notion that "[e]ach argument bears one and only one θ-role, and each θ-role is assigned to one and only one argument (Chomsky, 1981, p. 36)." The theta-criterion plays an important part in constraining Free Merge.

Figure 7 below shows an unsuccessful portion of a derivation, automatically generated by my model, of *Tom will read a book* (compare with the successful

Figure 2 above). The object *a book* is externally set-Merged with *read*, where it obtains a theta-role. The object then internally set-Merges with *read* and again with <v*, read> - this is the traditional specifier of v*P subject position. Since Merge is free, this operation is permitted. However, the transitive <v*, read> has a subject theta-role to assign. Thus, *a book* will get a second theta-role. This violates the theta-criterion, so this derivation crashes.

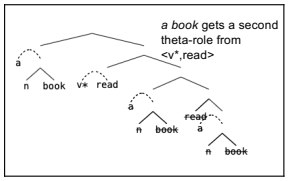

Figure 7. Theta-criterion violation: Unsuccessful derivation of *Tom will read a book*

4. Conclusion

I have discussed the derivations of 2 simple sentences and attempted to show how Labeling and the theta-criterion are sufficient for constraining Free Merge. The number of crashed and successful derivations[6] for these 2 sentences are summarized in Table 1. All of the crashes are caused by labeling failures or violations of the theta-criterion. Thus, labeling and the theta-criterion (in some form or other) seem to be core properties of language, and accounts of language evolution likely need to explain these properties.

Table 1. Crashes and successful derivations

	Sentence	# of Crashes	# of Successful Derivations
(a)	*Tom will read a book.*	14	2
(b)	*He thinks that John read the book.*	22	1

5. Supplementary Materials

The complete derivations for the target examples discussed in this paper can be found at: http://www.osaka-kyoiku.ac.jp/~jginsbur/JCole22Appendix

[6] In some cases, my model predicts that there can be more than 1 convergent derivation for a single sentence, as with *Tom will read a book* (which differ with respect to the number of times that the subject *Tom* undergoes internal set-Merge). This raises the question of whether a single well-formed sentence can have multiple possible structures resulting in the same interpretation.

Acknowledgements

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