

A dependency look at the reality of constituency

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Recently, Nelson et al have addressed the fundamental problem of the neurophysiological support for complex syntactic operations of theoretical computational models (1). They interpret their compelling results as *supporting the neural reality of phrase structure*. Such a conclusion opens various questions.

First, constituency is not the only possible reality for the syntactic structure of sentences. An alternative is dependency, where the structure of a sentence is defined by word pairwise dependencies (Fig. 1). From that perspective, phrase structure is regarded as an epiphenomenon of word-word dependencies and constituency (in a classical sense as that of X-bar theory) has been argued to not exist (2). Furthermore, constituency may not be universal and thus its suitability may depend on the language (3). Dependency is a stronger alternative for its simplicity, its close relationship with merge (4), its compatibility with recent cognitive observations (5) and its success over phrase structure in computational linguistics, where it has become predominant (6).

Second, the authors admit that *a parser of the sentence might transiently conclude that “ten sad students”... is a phrase consistently with a transient decrease in activity* (1st paragraph of p. 4). Unfortunately, their parser does not account for that as shown by the counts in Fig. 2 A of (1). In contrast, a standard dependency parser would because at that point it would close the dependencies opened by “ten” and “sad” (Fig. 1). This raises the question of whether the conclusions depend on the choice X-bar and particular parser as

a model of phrase structure. The conclusions in (1) may suffer from circularity, namely the positive support for a particular X-bar model could be due to the fact that the source was a toy artificial X-bar grammar. Future analyses would benefit from the use of natural sentences, sentences with realistic probabilities that are also longer and more complex (sentence length does not exceed 10 in (1)).

Third, dependency shows the limits of comparing phrase structure models against n -gram models with $n = 2$, because only about 50% of adjacent words are linked (7,8), thus a bigram model misses 50% of the dependencies. Bigrams are a weak baseline, as the common practice in computational linguistics is using at least smoothed trigram models, and often 5-gram models, to obtain meaningful predictions (9). A higher-order lexical n -gram model would strengthen the current results. The authors also employ more sophisticated n -gram models. One is an unbounded model based on part-of-speech categories, implying a dramatic loss of information with respect to the original words which might explain its poor performance. The other is a syntactic n -gram, but not enough information is provided about its definition and implementation. Regardless, since the model is obtained from a corpus derived from a toy grammar and lexicon, its probabilities are likely to be unrealistic and thus it is problematic.

In sum, dependency offers a better approach to the syntactic complexity of languages and merge. n -gram models of higher complexity should be the subject of future research involving realistic sentences.

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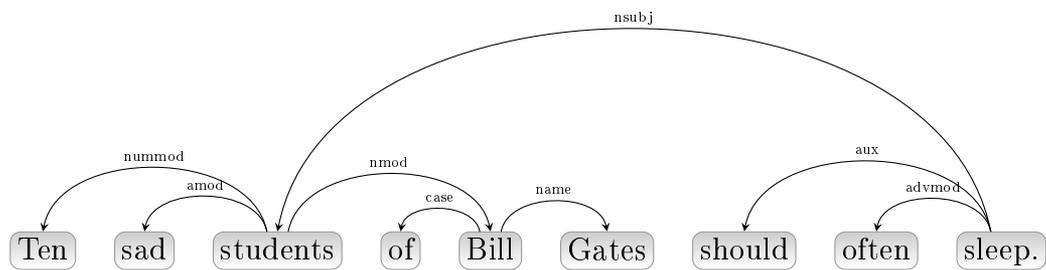


Fig. 1. Syntactic dependency structure of the sentence in Fig 2 A of (1) according to Universal Dependencies (10).