Dependency networks: A discussion note about Lamb's theory of linguistic structure

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Abstract. Sydney Lamb (2016) presents a theory of linguistic structure that reaches through all levels of linguistic organization (semantics, syntax, morphology, phonology). The network architecture of Lamb's system is analogous to the network of neurons in the brain. Lamb's theory organizes linguistic units in part in terms of *constituencies*. This discussion note explores the possibility of recasting Lamb's theory entirely in terms of *dependencies*. An approach that relies more on dependency as the principle organizing the units of linguistic structure would result in simpler networks, increasing plausibility and thus being more consistent with the network of neurons in the brain.

Keywords: constituency, dependency, dependency grammar, constituency grammar, network, neural network

In his article *Linguistic structure: A plausible theory*, Sydney Lamb (2016) presents an account of linguistic structure that strives to "discover the system that lies behind linguistic productions and is responsible for them". The system Lamb introduces is intended to satisfy three requirements on the theory of linguistic structure: it must be productive, learnable, and consistent with what we know about the brain. Concerning the third requirement, Lamb takes his theory to be analogous to the network of neurons in the brain. The network architecture Lamb advocates regards linguistic units organized at least in part in terms of *constituency*. The purpose of this discussion note is to suggest that a network architecture based entirely on *dependency* would be simpler and thus perhaps more plausible and consistent with the neural network of the brain.

The distinction between dependency and constituency is most prominent in the field of syntax. Lucien Tesnière (1893–1954) is widely viewed as the father of modern dependency
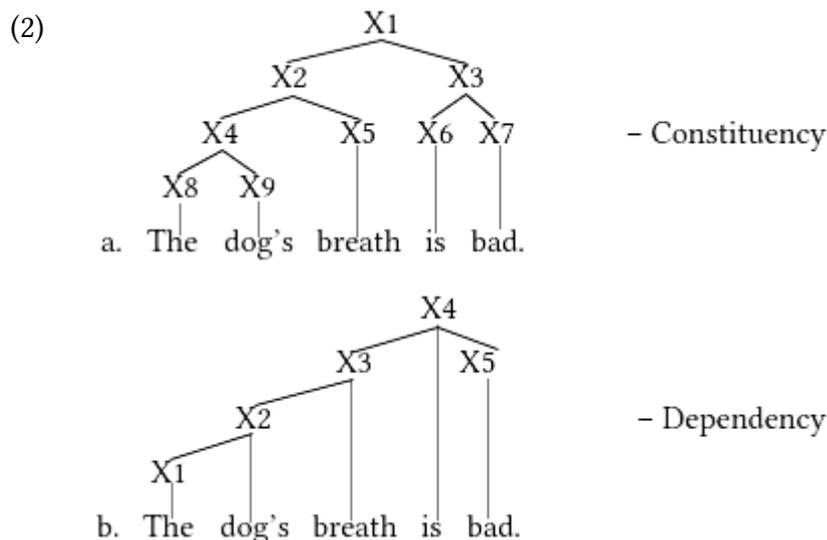
grammar, whereas constituency grammar (phrase structure grammar) is associated above all with the works of Noam Chomsky (1928–). Tesnière's oeuvre *Elements of Structural Syntax* appeared posthumously in 1959, just two years after Chomsky's first prominent publication *Syntactic Structures* in 1957. While the dependency vs. constituency distinction is well-established in the field of syntax (see e.g. Matthews 1981:71–95; Mel'čuk 1988:12–7; Schubert 1987:17–20; Jung 1995:15–27; Heringer 1996:27–9; Uzonyi 2003; Hudson 2010:147–150), it is less known in other fields of linguistics. The point developed here now, however, is that the dependency vs. constituency distinction is applicable to the organization of units at all levels of linguistic structure (semantics, phonology, morphology), and it is hence possible to recast Lamb's theory of linguistic structure entirely in terms of dependency.

Dependency and constituency are competing principles of organization. The units of linguistic structure can be organized in terms of the one or the other, or both are possible at the same time, which means the structures are hybrid. Constituency *combines* units in such a way that a greater unit is created, whereas dependency *attaches* a unit to another unit in such a way that a greater unit is created. To illustrate:

(1)

a. Constituency

b. Dependency

The constituency structure (1a) shows that the atomic units A and B combine to create the greater unit AB; three nodes are present. The dependency structures in (1b), in contrast, show that A attaches to B, or B attaches to A, in such a manner that the two together are connected and thus joined into a greater structure. Crucially, the number of nodes present matches the number of atomic units, two each time.
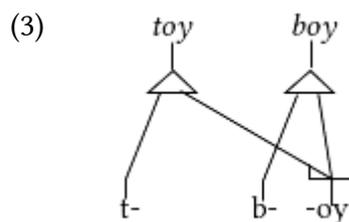
The proponents of dependency as a principle of organizing linguistic units point to the parsimony of dependency in comparison to constituency (e.g. Engel 1994:23, 26; Anderson 2006:48; Hudson 2007:117, 2016). This parsimony is illustrated next by comparing the analyses of a more complex example:

(2)

a. The dog's breath is bad. – Constituency

b. The dog's breath is bad. – Dependency

The constituency analysis shows how the units (words and phrases) *combine* to create larger units (phrases and clause); there are five words presents, yet there are nine nodes assumed. The dependency structure, in contrast, contains just five nodes, one for each word present.

The dependency structures above differ crucially from the constituency structures insofar as they see the relationship that obtains between two linked atomic units as necessarily *directed*. This directedness involves taking one of the atomic units as more prominent than the other in one sense or another. Directedness is usually reflected in the diagram in terms of the vertical ordering dimension. More prominent units are positioned above less prominent ones. In (2b), *is* X4 is the most prominent word, *breath* X3 is more prominent than *The* X1 and *dog's* X2, and *dog's* X2 is more prominent than *The* X1. In comparison, the manner in which constituency allows the units to combine does not necessitate the presence of this directedness. The diagram in (2a) does not reveal whether *The* X8 is more prominent than *dog's* X9, or whether *The dog's* X4 is more prominent than *breath* X5, etc. The traditional terminology that captures this distinction is that of *endo-* and *exocentric* structures. The dependency structures (1b, 2b) are entirely endocentric (headed), whereas the constituency structures (1a, 2a) are entirely exocentric (headless). Labeling conventions can render constituency structures endocentric, such as when heads are identified in terms of the labels VP (verb phrase), NP (noun phrase), etc. For instance, the label NP in the position of X4 above the phrase *The dog's* in (2a) would identify the noun *dog's* as the head of the phrase *The dog's*.[1]
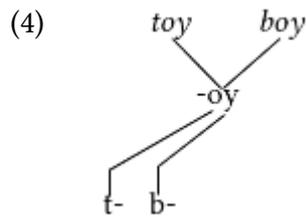
Turning to Lamb's theory of linguistic structure, one sees that it is at least in part conceived of in terms of constituencies, a fact that is visible in the diagrams he produces by the presence of the and nodes, which Lamb gives as small triangles. The first of Lamb's (2016) diagrams shows the phonemic structure of the lexical items *toy* and *boy*. That diagram is reproduced here next:

(3)

The nodes at the top given as *toy* and *boy* represent the semantic content. Below these nodes, though, we see the triangle nodes, each of which is interpreted as marking the combination of the consonant *t-* or *b-* and the syllable nucleus *-oy*. These two combinations are manifestations of constituency.
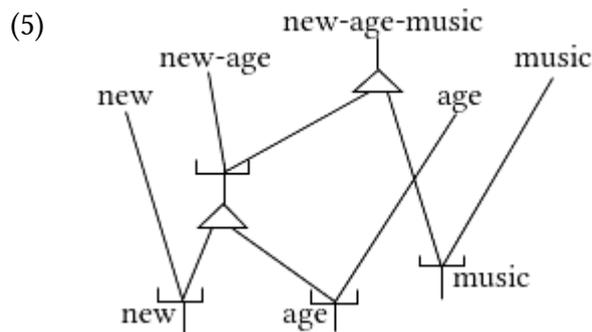
One can reinterpret those two combinations, i.e. *t-* and *-oy* and *b-* and *-oy*, in terms of dependency by granting one of the two sounds in each pair a more prominent status than the other. In these cases, one would certainly choose to position the syllable nucleus *-oy* as the more prominent sound each time. Thus, removing these and nodes and putting the *-oy* in their position, one arrives at the following entirely dependency-based diagram:

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[1] To avoid unnecessary complication of analysis, the status of the clitic *'s* of possession as an independent node in the syntax has been suppressed in this discussion and in the example trees (2a) and (2b). Note as well the nominal groups are deemed here to be noun phrases (NPs) instead of determiner phrases (DP).
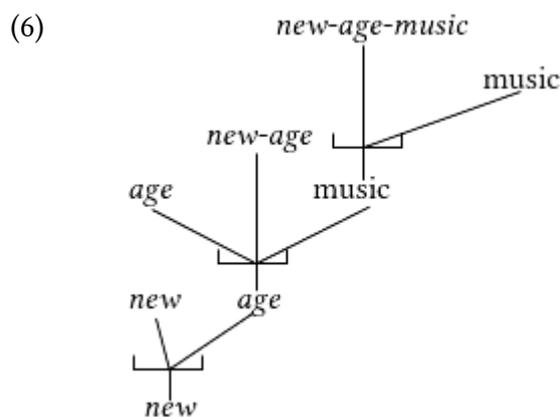
(4)

Counting the number of atomic units and nodes reveals that the number of nodes matches the number of atomic units here; there are five units shown and five nodes in the structure. In contrast, the same five atomic units are assumed in the diagram in (3), yet there are seven nodes posited. The extra two nodes in (3) are manifestations of constituency. Note that the or node in (3), the bracket rotated 90◦, is not necessary in (4) because the intermediate position of *-oy* in the hierarchy allows for no ambiguity as to whether the *-oy* of *toy* or the *-oy* of *boy* is chosen.

Lamb provides the following diagram to illustrate the linguistic structure of the complex lexeme *new age music*:
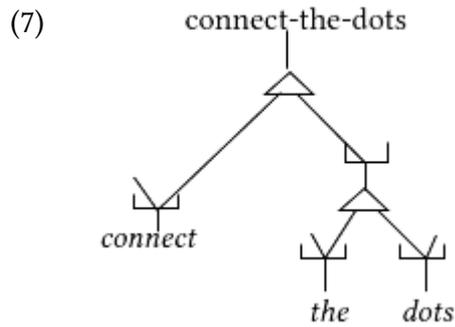
(5)

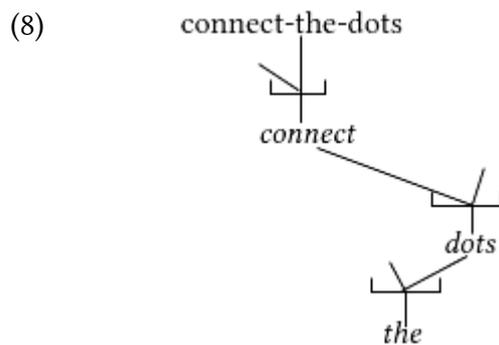Rendering (5) entirely in terms of dependency results in the following diagram:

(6)

The and nodes removed, there are two fewer nodes in (6) than in (5). The removal of the two and nodes involves construing *age* as more prominent than *new* in the compound *new age*, and *music* as more prominent than *age* in the compound *new age music*. Note that the or indicators are necessary here in order to distinguish between the literal meanings of *new* and *age* and their figurative appearance in *new age music*. The figurative meaning of *new age music* as a whole is accommodated in the diagram insofar as there is a path extending down from *new-age-music* through the figurative nodes for *music, age*, and *new*.
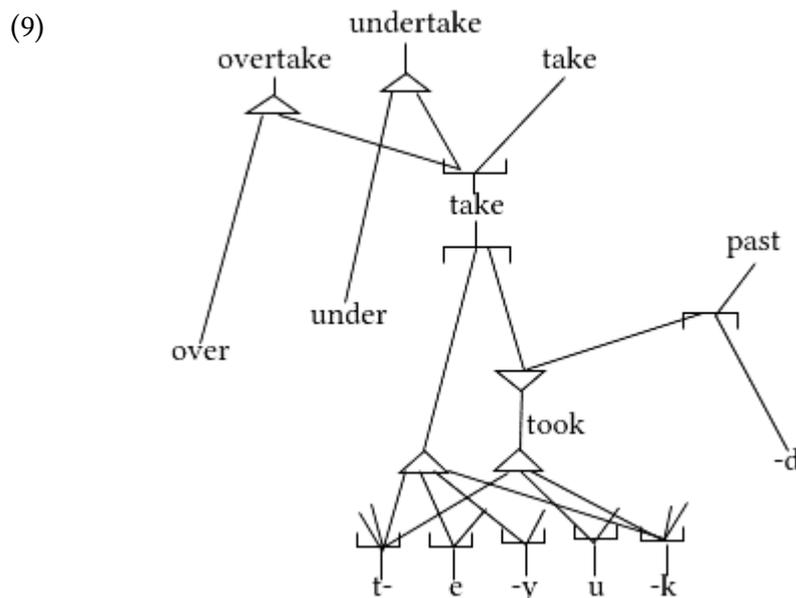
Lamb gives the following diagram for the idiom *connect the dots*:

(7)

Removing the and nodes in order to render the structure entirely in terms of dependency, one arrives at the following diagram:
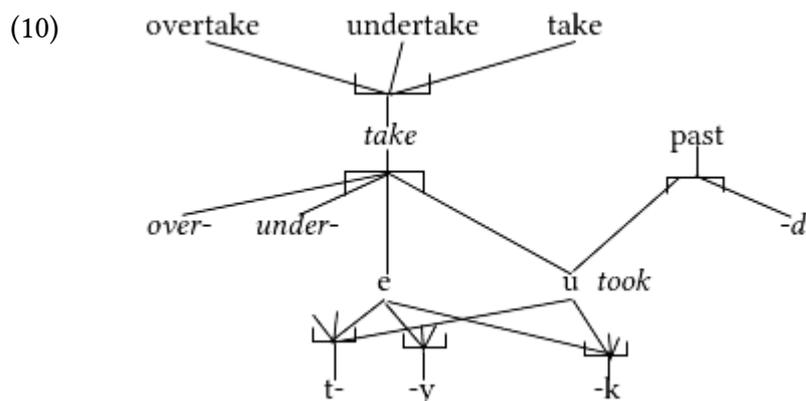
(8)

Changing from (7) to (8) involves viewing *dots* as more prominent than *the* in *the dots*, and *connect* as more prominent than *dots* in *connect the dots*. The number of nodes present is reduced from six to four. The idiomatic meaning of the whole *connect the dots* is again accommodated by the fact that there is a path down from *connect-the-dots* through the figurative nodes corresponding to the non-literal meanings of *connect*, *dots*, and *the*.

(9)

The next example (9) reproduced from Lamb's article is more complex. It reaches from the lexico-morphological level down fully into the phonemic level of structure. It shows the manner in which the past tense of the lexical items *overtake*, *undertake*, and *take* relate to the default past tense *-d* and the idiosyncratic past tense form *took*.

The presence of the triangles bears witness to constituency. Rendering this diagram completely in terms of dependency requires the removal of the triangles and the promotion of one of the lower nodes below each triangle into the position of the triangle:

(10)

At the phonemic level, the sounds *e* and *u* have been 'promoted' into the dominate position over *t-*, *-y*, and *-k*, and at the lexical-morphological level, *-take* has been 'promoted' into the dominate position over *over-* and *under-*. The result is that diagram (10) is simpler than (9) because it contains four fewer nodes.

In conclusion, the relevant question of course concerns the (in)ability of the entirely dependency-based networks above to convey the same information as Lamb's networks, which include a measure of constituency. In the field of syntax, some who do dependency syntax, myself included (cf. Osborne 2005; Osborne et al. 2011; Osborne and Groß 2012, 2016), have argued that constituency is in fact not necessary, the simpler dependency structures accomplish everything that is needed for a coherent and principled theory of syntax, and that constituency actually gets in the way of transparent theory construction.[2] In any event, many grammarians will agree that the dependency vs. constituency distinction reaches through all strata of linguistic structure and that dependency structures are minimal compared to constituency structures.

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[2] This statement is simplified and must be qualified. My view is that constituency is needed for the account of coordination, but dependency alone is all that is necessary for the account of subordination. Coordination is examined from a DG perspective in detail in Osborne and Groß (to appear).

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