# Can the Syntactic Burden on Working Memory Account for Island Constraints?

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The prevailing account of filler-gap dependencies in the psycholinguistic literature posits a limited workspace of memory for processing utterances, called working memory (Just & Carpenter, 1992; although see MacDonald & Christiansen, 2002, for the connectionist account). Such an account correlates the limitedness of working memory to processing difficulties; processing difficulties arise as an individual's working memory capacity fills up—sometimes filling up to the point that information is shunted from working memory (Dickey, 1996).

For example, in filler-gap dependencies, greater distances[1] from filler to gap require a filler to be held in working memory longer while intervening words (with their syntactic nodes) are processed. As things pile up in working memory, processing slows. The distance between filler and gap is demonstrated in (1) below.

1) a. *The pole*$_1$ *that* Ø$_1$ *struck Sydney...*
   distance: n syntactic nodes
   b. *The pole*$_1$ *that Sydney hit* Ø$_1$...
   distance: n + ≥10 syntactic nodes
   c. *The pole*$_1$ *that Sydney walked the dog into* Ø$_1$...
   distance: n + ≥18 syntactic nodes

The greater distances associated with the filler-gap dependency in (1 b.) predicts that it will be more difficult to process than (1 a.) (see King & Just, 1991).

An increased syntactic burden on working memory can also account for the distinction among (2-4).

2) **The child that the dog that the man owned bit cried.*
   **The child*$_1$ [ *that the dog*$_2$ [ *that the man owned* Ø$_2$ ]$_{R\text{-}CL2}$ *bit* Ø$_1$ ]$_{R\text{-}CL1}$ *cried.*
   greatest distance: n + ≥45 syntactic nodes
3) *The child that the dog bit cried.*
   *The child*$_1$ [ *that the dog bit* Ø$_1$ ]$_{R\text{-}CL1}$ *cried.*

[1] Distance can alternately be defined as the number of words between filler and gap (often called just "distance") or as the number of relevant syntactic nodes separating a filler from its gap (often called "depth"). Although distance and depth often happen to correspond, evidence suggests that depth has a stronger correlation to processing load (e.g. McKee & McDaniel, 2001; O'Grady, Lee, & Choo, 2003; also Dickey, 1996). I use "distance" to mean only the number of intervening syntactic nodes (i.e. "depth").

greatest distance: n + ≥10 syntactic nodes

4) *I saw the man that owned the dog that bit the child that cried.*

*I saw the man*$_1$ [ *that* Ø$_1$ *owned the dog*$_2$ [ *that* Ø$_2$ *bit the child*$_3$ [ *that* Ø$_3$ *cried* ]$_{R\text{-}CL3}$ ]$_{R\text{-}CL2}$ ]$_{R\text{-}CL1}$.

greatest distance: n syntactic nodes

Consider, first, the difference in filler-gap distance associated with the fillers in (2) and the fillers in (3-4). As I demonstrate in Diagram 2 (Appendix 1), the first filler (*the child*) in (2) is separated from its gap by a much greater distance than any of the fillers in (3-4). In fact, *the child* is separated from its gap by at least twice as many syntactic nodes as the other fillers.

In addition to the greater distance associated with its filler-gap dependency, (2) also requires multiple fillers to be held in working memory simultaneously. For example, *the dog* must be held in working memory until after *owned* is processed; *the child that the dog that the man owned* must be held in working until after *bit* is processed. Both of these fillers will be held in working memory at the same time until at least *that the man owned* is finished being processed (see Figure 1 below).

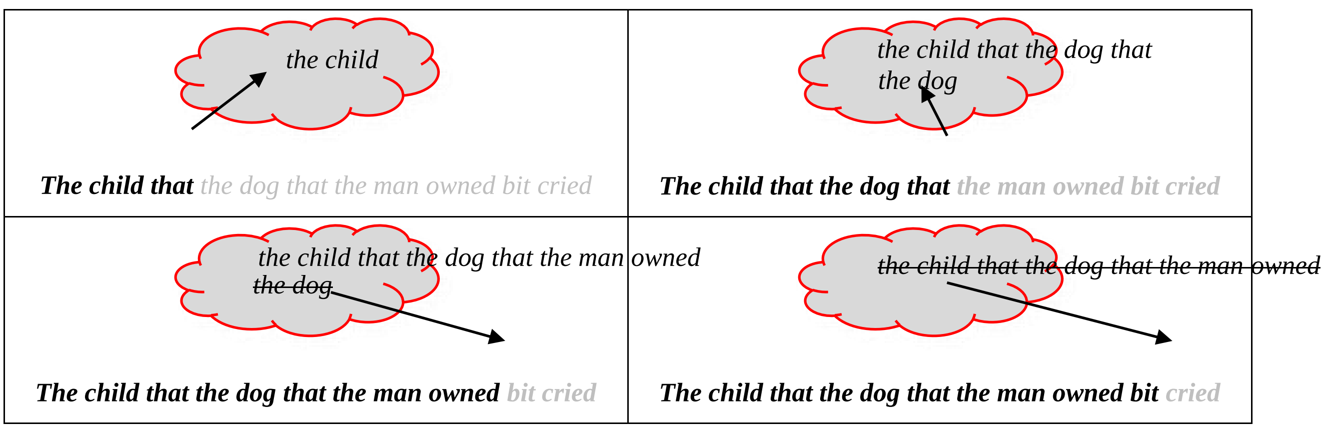


Figure 1. The processing of (2) demonstrating how two fillers must be held in working memory. (Bold text has been processed by the parser, and the gray cloud represents working memory.)

Contrastingly for both (3-4), only one filler is ever kept in working memory at any given time. Thus, two factors might together overload working memory and cause the unacceptability of (2):

factor one—greater distances between filler and gap;

factor two—multiple fillers held in working memory simultaneously.

Such syntactic burdens on working memory can account for the processing difficulty and even unacceptability associated with filler-gap dependencies like those,[2] but can they also account for the unacceptability of island constraints? Consider Ross' (1967) Complex Noun Phrase Constraint demonstrated by (5) below (borrowed from Hofmeister & Sag, 2010).

5) **What did he know someone that has?*
   **What did he know someone*$_1$ [ *that has* Ø$_1$ ]$_{R\text{-}CL1}$*?*
   greatest distance: n + ≥

Here again, the first filler (*what*) is separated from its gap by a distance analogous to the tremendous distance associated with the filler-gap dependency in (2) above. Moreover, *what* and the second filler (*someone*) are both simultaneously held in working memory at least until *has* has been processed. In other words, island filler-gap dependencies seem to always be associated with the same two syntactic factors that are associated with the potential overload on working memory in (2) above.

Of course, these factors parallel nicely with Chomksy's Subjaceny Condition. That is, Subjacency prohibits movement across two cyclical nodes (DPs and CPs). The syntactic burden of crossing two such nodes is equated with a tremendous distance between the filler and gap as well as, at some point, two fillers being held in working memory simultaneously. Moreover, Chomsky's Barriers account seems to further support the effect of these two syntactic factors on working memory. That is, Barriers suggests that an increase in the number of barriers crossed will decrease the acceptability of a filler-gap dependency or, in terms used here, an increase in the syntactic distance increases the burden on working memory thereby degrading acceptability.

The effect of these syntactic burdens on working memory during processing of center embedding, *wh*-islands, and similarly difficult filler-gap dependencies seems to cover similar

[2] Of course, this is not to suggest that other accounts cannot also explain the differences associated with (2-4).

empirical ground as generative constraints, and the working-memory account outlined here need not be mutually exclusive to a generative account. In fact, this account seems to be simply a variant on the generative constraints for filler-gap dependencies, a variant that adopts psycholinguistic terminology to address processing data. For example, the effect of syntactic distance on working memory might better explain the gradations of processing speeds and even acceptability judgments for many speakers. That is, while Barriers can only count to 1, syntactic distance presents a potentially infinite gradation of distinction, which might account for any levels of acceptability beyond good, marginal, or bad—should there turn out to be more than these three levels (see Hofmeister & Sag, 2010).

## Appendix 1

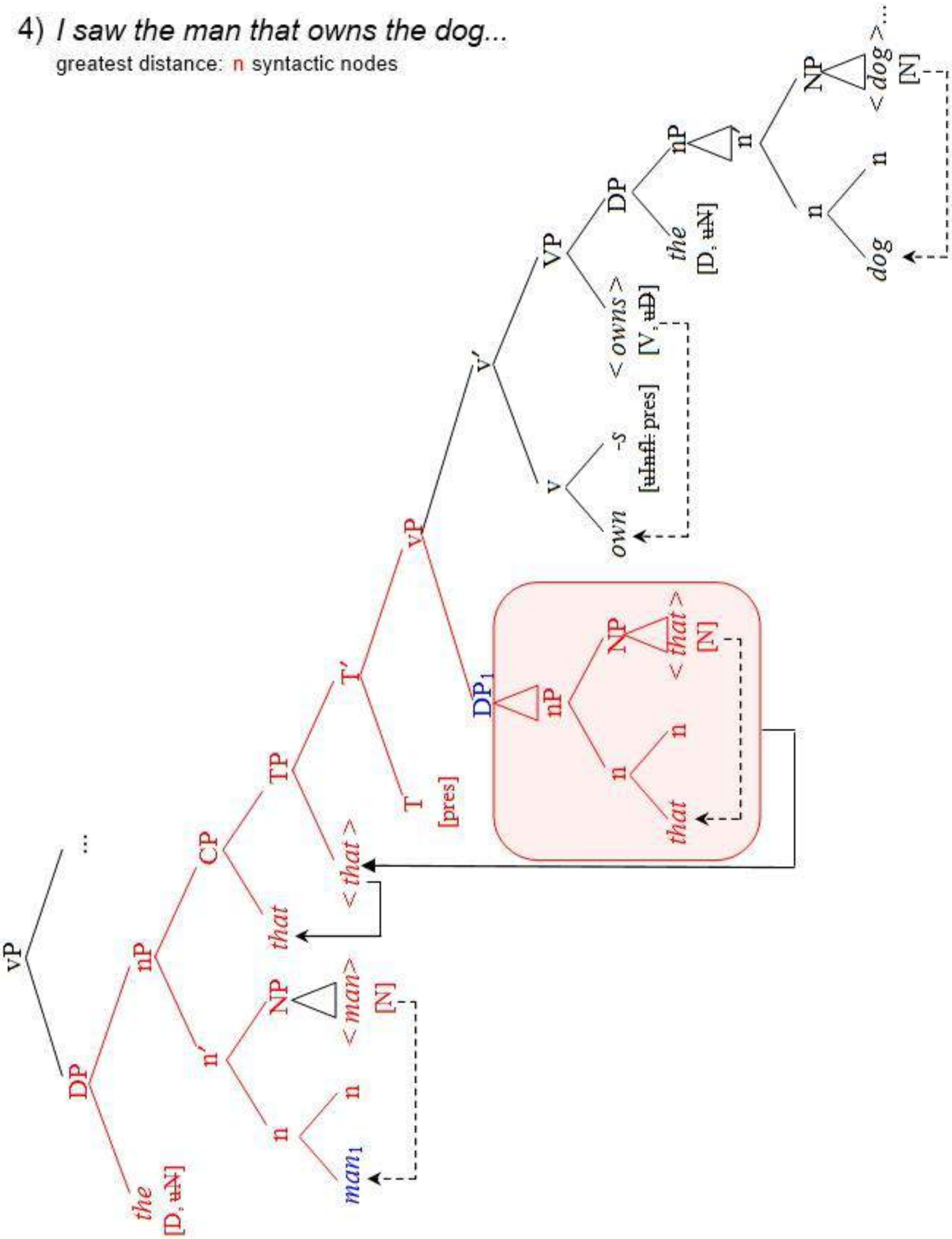


**Diagram 1. Diagram for example (4) above. Distance from filler (*the man*) to gap in red; greatest distance = n.**

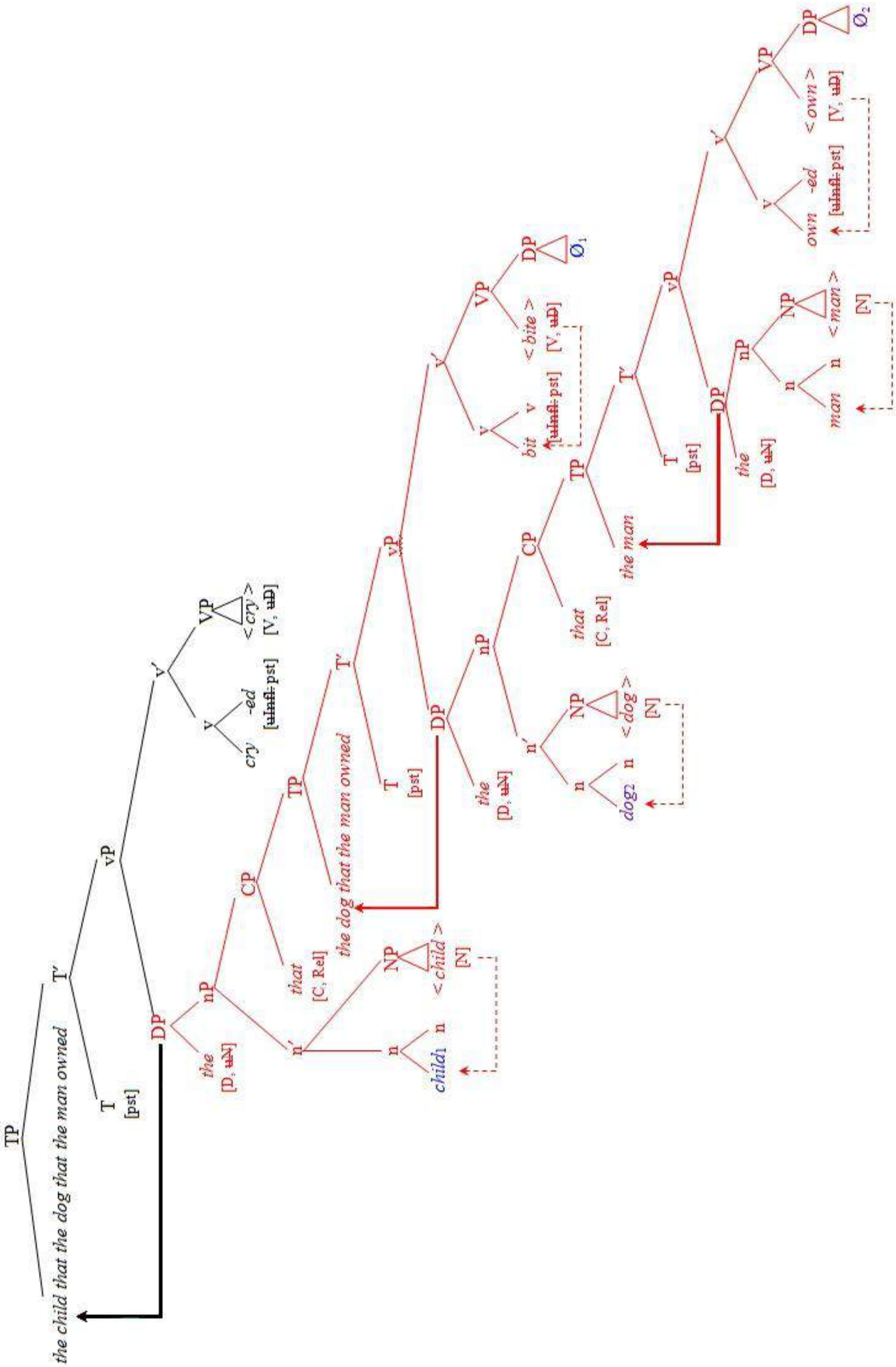


**Diagram 2. Diagram for example (2) above. Distance from first filler (*the child*) to gap in red; greatest distance = n ≥45.**

References

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