Is there a syntactic processing module?

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1. Introduction

Autonomy of syntactic processing means that the parser (syntactic processor) does not exchange information with the message level processor in the course of sentence reading but simply passes its analysis to the higher message level processor. This is the notion of 'modularity' developed by Forster (1979), which suggests that the initial computation of the syntactic structure of a sentence is not affected by the plausibility given by the meanings of the words or the discourse context. In other words, syntactic preferences initially determine the outcome of on-line parsing process. In this case, plausibility does not influence the interpreter's (reader's) initial analysis, but the processing is slow when the plausible interpretation does not correspond to the initial syntactic analysis.

However, a variety of syntactic constructions which may bring about local ambiguities (garden-path sentences) have been examined to see whether the human parser actually behaves as such an autonomous view claims. In this essay, I want to show that syntactic processing is not always autonomous but semantic information intrinsic to individual words or discoursal context also play a major role in human parsing. Even though it is claimed that there is a syntactic processor or module, it does at least interact with another level processor such as the message level processor, as is claimed in the interactionist view.

2. Processing of PP attachment construction

Rayner et al (1983) found that there was an advantage for sentences like (1), in which the prepositional phrase is ultimately attached to the verb phrase. In contrast, sentences like (2) were processed more slowly since the PP is
ultimately attached to the NP, which violates the ‘principle of minimal attachment’ (Frazier and Fodor, 1978) in which incoming items in on-line processing are attached into the phrase marker being constructed so that the construction should have the fewest nodes:

(1) The spy saw the policeman with the binocular, but...
(2) The spy saw the policeman with the revolver, but...

However, Taraban and McClelland (1988) reported a contradictory result to this. (3) is a minimal attachment structure whereas (4) is not:

(3) The thieves stole all the paintings in the night...
(4) The thieves stole all the paintings in the museum...

They found that (4) was read faster than (3), because, as they argue, the sequence of words in the sentences up to the PPs bias subjects towards the non-minimal attachment structure (i.e., NP-attached NP). Thus, violations of the purely syntactic process of the attachment of words to the structural representation being constructed do not slow down reading, rather violations of expectancies such as semantic process of assigning words to thematic roles in the light of general knowledge do.

Furthermore, MacDonald et al (1994) argue that the frequency of the occurrence of a verb with a certain thematic PP is most attributed to this kind of garden path effect. For instance, the verb see is likely to occur more frequently with PPs modifying the action, whereas admire is likely to occur with PPs modifying the theme of the NP. In fact, as Taraban and McClelland (1988, experiment 1) point out, the materials used by Rayner et al. generally had a bias such that the verbs tended to favor the VP attachment of the PP (e.g., see...with the binoculars). MacDonald et al (1994) suggest that prepositions themselves have a bias of occurring with certain preferable verbs or nouns.

McClelland et al. (1989) show that the finding reported in Rayner et al. (1983) only holds with the VP-attachment-biased materials, and is
reversed with the NP-biased materials. The reading time advantage for the VP-attachment bias in Rayner et al.'s materials turned out to be almost equal or even opposite to the reading time advantage for the NP-attachment-biased materials in the Taraban and McClelland's sentences. Averaging the two types of materials, there was virtually no overall advantage for either type of constructions. Therefore, the McClelland and et al's study suggests that semantic bias rather than syntactic preference appears to determine the initial attachment preference in a syntactic construction of this kind.

There is another evidence that lexical information such as a type of the argument structure of a verb can have an effect on PP attachment preferences. Britt (1994) reports that a verb with optional arguments such as *drop* does not show any reading time advantage for a VP-attached PP over an NP-attached PP whereas a verb with obligatory arguments such as *put* does. Even though the discourse context was biased towards the NP-attachment, lexical information of the verb's argument structure overrides it.

No difference in reading rate for (5) and (6):

(5) He *dropped* the book on the chair before leaving.  
    [VP-attached PP]

(6) He *dropped* the book on the battle onto the chair before leaving.  
    [NP-attached PP]

(8) is harder to read than (7):

(7) He *put* the book on the chair before leaving.  
    [VP-attached PP]

(8) He *put* the book on the battle onto the chair before leaving.  
    [NP-attached PP]

Note that this result indicates somewhat a weaker interactionist position than that proposed by Altmann and Steedman (1988) in that discoursal context does influence the preferable attachment decision but information of the verb may also play a major role in initial interpretation.
3. **Processing of reduced relative clause**

In Britt et al.'s (1992) study, the garden-path effect was found in (10) when the principle of minimal attachment is held; *spilled* in (10) is a past-participle whereas the verb is a simple past tense in (9):

(9) The coffee spilled on the rug and even marked the wallpaper.

(10) The coffee spilled on the rug was difficult for her to conceal.

To try to examine whether a supporting discoursal context will counteract with the minimal attachment preference, they prepared a context biased towards the VP-attached sentence as in (11) and a context biased towards the reduced relative clause as in (12). The results show that there was still a garden-path effect even in a biased context, indicating that context may not affect the minimal attachment parsing.

Context biased towards VP attachment sentence:

*Suzanne had spent a fortune decorating the living room and fitting an expensive new rug. So the night before her friends were invited over, she had a dream that someone spilled coffee all over her new rug. The next day, her friends came over and she really enjoyed showing off her new living room to everyone. Imagine her embarrassment when she tripped over the table with a tray in her hand.*

(11) The coffee spilled on the rug and even marked the wallpaper.  

| 65 msecs. per word |

Context biased towards reduced relative sentence:

*Suzanne didn't know what to say when her parents came home. She had thrown a party and her friends had spilled the coffee on the rug and scratched her mother's new table. She tried to do her best to clean the rug and the table a bit. But she knew it was too late when she heard her parents at the front door. As they entered she tried to distract their attention.*
(12) The coffee spilled on the rug was difficult for her to conceal.

| 80 msecs. per word |

(80 msecs is significantly greater than 65 msecs. The garden-path effect persists even in a supporting context, consistent with the modularity hypothesis.)

Trueswell et al. (1994), however, argue against this view. In their study, they used different sentence subjects in terms of their thematic role. They found that sentence (13) led the reader to a garden-path because the sentence subject in (13) (the workers) may well be initially interpreted as the AGENT of lifted:

(13) The workers lifted by the crane were deposited on the roof.

| 550 |

(14) The bricks lifted by the crane were deposited on the roof.

| 480 |

However, the bricks in (14) cannot usually be interpreted as the AGENT role, and a passive construction is plausible. Thus there found no garden-path effect. An ambiguity of this kind is easily resolved by using the explicit relative clause complementizer that or which.

(15) The workers that were lifted by the crane were deposited....

| 480 |

(16) The bricks that were lifted by the crane were deposited....

| 480 |

Interactionists' (MacDonald et al. (1994) among others) explanations of the mechanisms of this type of human parsing seem to be based mainly upon how often a certain verb is used as the simple past tense or
the past-participle (e.g., lifted), and its preferred thematic role assignment (e.g., AGENT or THEME). Information of a verb's preferred argument structure (e.g., verbs having a bias towards direct objects or verbs having a bias towards a sentential complement) is also powerful in guiding sentence parsing (Britt, 1994; Garnsey et al., 1997) Of course such information is something accumulated through reading experience and based upon human general knowledge.

In summary, comprehension of reduced relatives is not so much autonomous as attributed to the nominal meaning of the sentence subject and the frequency of the function of the verb.

4. Subcategorization information and the Principle of Late Closure

Finally, let us consider sentences (17) and (18) from Mitchell (1987).

(17) After the child had visited the doctor prescribed a course of injections.
(18) After the child had sneezed the doctor prescribed a course of injections.

Readers were garden-pathed by (17), since the parser prefers to assign the doctor as direct object of visited to comply with ‘Late Closure’ (also called ‘Right Association’: if consistent with the rules of the grammar, attach each incoming word into the phrase currently being analyzed (Kimball, 1973)). For example:

Late Closure vs. Minimal Attachment:

(19) Martha will say that it rained yesterday.
     [Low attachment of adverbials: Late Closure]
(20) Martha said that it will rain yesterday.
     [High attachment of adverbials: Minimal Attachment]
However, in (18), the lexical information should tell the parser that *sneezed* cannot take a direct object. Nevertheless, it is reported that subjects were garden-pathed, suggesting that the initial parsing was not guided by the information of the preferred argument structure of the verb. Mitchell also argues that these data indicate that lexical (verb) information does not affect the initial parse, although it might guide the second stage of re-analysis.

5. Discussion

If this is the case, how, then, will interactionists explain these odd results? Why did the readers in Mitchell's (1987) experiment have to be garden-pathed although sneezed cannot take a direct object? I want to discuss some methodological problems which appear in some of the experiments that the autonomous theorists have done so far. I claim that materials in the experiments themselves were odd, to begin with. Those kinds of garden-path effects as we have seen are not likely to occur in normal speech where a pause or pitch changes may well be manifested as sufficient cues to prevent the ambiguity in the first place. In written sentences, instead, there should be a comma where ambiguity is liable to occur, as in between *sneezed* and *the doctor* in (21), or, in another case, an explicit complementizer should be there as in (22):

(21) After the child had sneezed (,) the doctor prescribed a course of injections. [with an appropriate punctuation]

(22) The coffee *that was* spilled on the rug was difficult for her to conceal. [with a complementizer]

In fact, Trueswell et al. (1993) point out that deletion of a complementizer can produce misleading results, and Mitchell and Holmes (1985) report that punctuation such as commas can influence the course of on-line parsing.

I argue that the Mitchell's methodology in which subjects read sentences on a segment-by-segment basis (not on a word-by-word basis) might be affecting the results. It can be said that each presented segment in
his experiment was manipulated so that the garden-path effect would occur. For example:

(23) After the girl had visited the doctor /
    prescribed a course of injection.

(24) After the girl had sneezed the doctor /
    prescribed a course of injection.

In (24), the first segment is gated not after sneezed but after the main clause subject NP the doctor. However, this kind of segmentation seldom occurs in normal text unless it occurs at the end of a line. Besides, his materials do not have any commas in appropriate places. Thus, this methodology has a strong bias towards the garden-path effect and does not represent human's normal reading process.

Furthermore, the number of words processed at one time in normal reading process is also a crucial issue here. As is often discussed in visual word recognition studies (e.g. Rayner and Pollatsek, 1989), the problem of 'eye fixation' and 'eye movements' are also relevant to the Mitchell's materials. If a certain pair or sequence of words tend to be processed at a time in normal reading process, and this process might influences interpretation of written texts, then Mitchell's materials may be ignoring this aspect of reading. Thus it seems that Mitchell simply manipulated his materials so that he could obtain a result which would support his autonomous view of syntactic processing.

Subjects might be actually constructing the transient hypothesis that the doctor was the object of sneezed without full access to the information of the verb's argument structure because they glanced at the NP after the verb and this verb-NP sequence attracted their eyes under the time pressure of the experiment. In this case, a V-NP sequence might be preferably interpreted as 'transitive verb-object' construction whereas a NP-V sequence might be preferably interpreted as 'subject-verb' construction. In fact the latter tendency was manifested in the 'The coffee spilled...' example discussed above.
The above discussion may turn out to support the autonomous view of syntactic processing. Of course we must admit the autonomy of syntactic processing to a certain extent, depending on the text condition in terms of punctuation, presence or absence of commas, where to gate, and so on. However, I claim that it should not always be the case that the human parser first works without any access to other contextual information and representation being constructed during sentence processing. If you don't want to go a garden-path, you must be ready for a bigger cost and watch out for any pitfall; if you don't want to pay a bigger price, you might be lost on a garden-path. The underlying issue may be relevant to the fundamental condition of human cognition, that is, the 'cost-reward balance'. Otherwise we should take the 'wait-and-see' strategy as long as the working memory permits.

6. Conclusion

At present, the autonomous view of syntactic processing appears to rest upon more restricted evidence than the interactive view. In fact, most of their claims can be reanalyzed by the interactionists in terms of parsing guided by semantic considerations such as lexical information or frequency. As MacDonald et al. (1994) articulate, whether any one of source of information can immediately influence processing depends entirely on the combined strength of the opposing cues. In this regard, it seems that evidence for the autonomous position only constitutes the subset of evidence for the interactive position which constitutes the overall, superset picture of the nature of syntactic processing.

Finally, McClelland et al. (1989) predict the nature of sentence comprehension from the connectionist's perspective. They mention that syntactic and conceptual aspects of processing are in fact inextricably intertwined, where syntactic and other constraints are combined in the connection weights, to influence the construction of a single representation reflecting the influences of syntactic, semantic, and lexical constraints. This view appears to posit even stronger interactive accounts than the interactive view does where different levels of processors (including syntactic processor).
interact in initial processing. If this is the case, autonomy of syntactic processor (or module) would be even less plausible.

REFERENCES


