

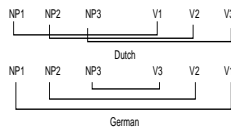
A hypothesis about serial order information in parsing (that yields a novel explanation of center-embedding difficulty)

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The problem

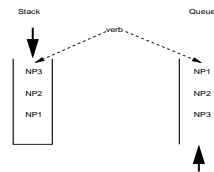
How does the parser decide which noun phrase to assign to which verb?

- (1) a. Jan Piet Marie zag laten zwemmen
Jan Piet Marie saw make swim
'Jan saw Piet make Marie swim.'
- b. ...dass Hans Peter Marie schwimmen lassen sah
that Hans Peter Marie swim make saw
'... that Hans saw Peter make Marie swim.'



Some possible solutions

1. Encoding order via a stack or queue



But this is problematic since *both* strategies would have to be a property of the parsing mechanism (Joshi 1990).

2. Activation decay

Two reasons why this alone will not work in general:

- The most recent item is not always the one to be retrieved (Dutch/German above).
- The less recent item may receive higher activation (due to multiple retrievals, greater initial activation, etc.)

3. Position codes

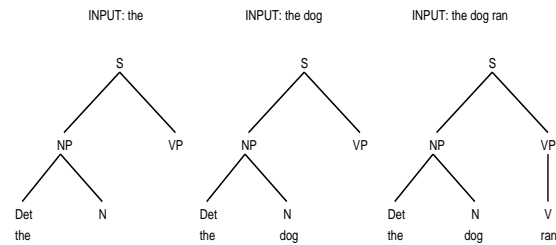
An approach like the Start-End model of Henson (1998) has been used in sentence processing (Lewis and Nakayama 2001). Key idea: Positional cues determine what is retrieved.

Two problems:

- Not generally applicable: Salience of a medially located item could make it easier to retrieve.
- Not the simplest approach to explaining serial order based on associated cue-based retrieval. Ideally, serial order should be derivable from more general principles.

Alternative hypothesis: Three general principles of human parsing combine to eliminate need for serial order representation

Principle 1. Incremental (left-corner) parsing



Principle 2. Associative retrieval of ITEM based information only (not serial position information)

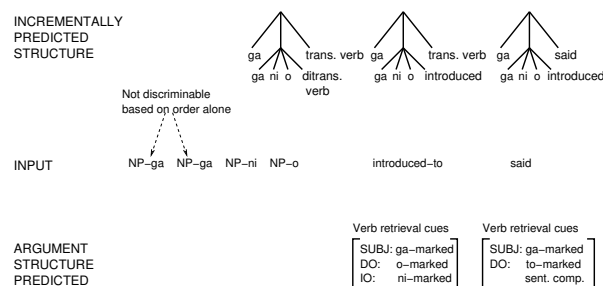
Motivated by the work of McElree and colleagues:

Rapid, parallel access from working memory of item information, but a slow, serial access of relative order information (McElree & Doshier, 1989, 1993).

Principle 3. Independently motivated constraints on retrieval

- Activation fluctuation as a function of usage, delay, and noise.
- Associative retrieval subject to interference.

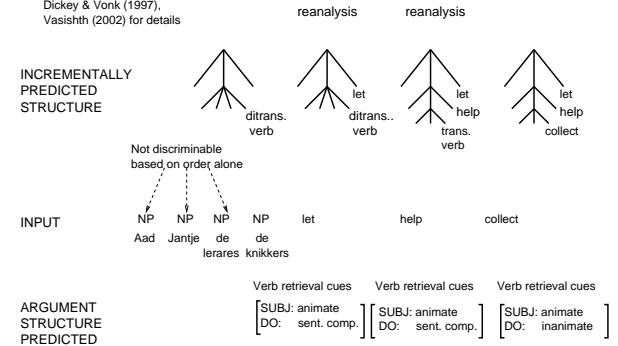
Example: Japanese center embeddings



The sentence processing model (see neighboring poster) incorporates a left-corner parser. The parser incrementally builds structure; in the case of head-final languages, arguments predict the argument structures of upcoming verbs, and in head-initial languages the verbs predict argument structures based on their subcategorization frames. In each case the relevant discriminating cues allow correct retrieval to occur.

Dutch cross-serial center embeddings

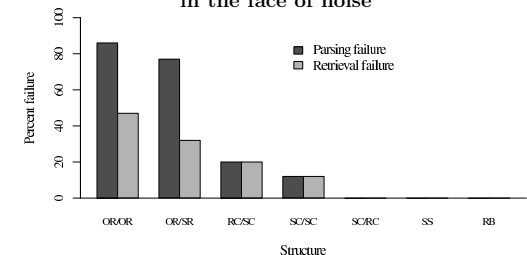
See Kaan & Vasic (2004), Dickey & Vonk (1997), Vasishth (2002) for details



Graded taxonomy of center embeddings (Gibson and Thomas 1997)

- (2) a. **OR/OR** *object relative within object relative*
The editor that the writer that the dog chased scolded supervised the assistants.
- b. **SR/OR** *subject relative within object relative*
The medic who the dog that bit the reporter chased admired the writer.
- c. **RC/SC** *sentential complement within object relative clause*
The reporter who the claim that the editor admired the medic amused sent the gift.
- d. **SC/SC** *sentential complement within sentential complement*
The claim that the reporter who the editor admired sent the gift amused the reporter who the reporter who the editor upstet everyone.
- e. **SC/RC** *object relative within sentential complement*
The claim that the reporter who the editor admired sent the gift amused the writer.
- f. **SS** *object relative within subject sentence*
That the reporter who the editor married liked the medic was surprising.

Monte Carlo simulations of parsing and retrieval failure in the face of noise



Modeling reading time

Attachment time	RC/SC	SC/RC	SC/SC
Verb 1	163	278	163
Verb 2	371	210	211
Verb 3	238	237	211