The sentence processing model

"Sentence processing is skilled memory-retrieval modulated by similarity-based interference and fluctuating activation."

Linguistic representations are chunks in declarative memory

The contents of the lexicon are stored in declarative memory.

Chunk The minimal representational element that enters into relations with other chunks (Miller, 1957). Represents a maximal projection, encoded as FEATURE:VALUE pairs. Relational features for SPEC, COMP, HEAD.

$$\begin{bmatrix} \text{IS-A} & XP-chunk \\ \text{CAT} & : X \\ \text{SPEC} & : \\ \text{COMP} & : \\ \text{HEAD} & : \\ \text{NUM} & : \\ \text{CASE} & : \\ \text{NEXT-GOAL} & : \end{bmatrix}$$

- *Elimination of stack info:* A feature NEXT-GOAL encodes the goal that should be pursued when the current constituent is complete.

Grammatical knowledge compiled from production rules

The grammar, *e.g.* parsing skill, is encoded as procedural knowledge as CONDITION:ACTION pairs.

	Retrieval production		Attachment rule
IF	goal category is...	IF	lexical entry has features...
	and lexical entry has features...		and retrieved constituent has features
THEN	set retrieval cues to...	THEN	create new constituent
			and attach it

The model implements a *left-corner*[1], *repair* parser.

1. Lexical access proceeds via ordered access modulated by frequency and context, with competition effects.

2. Structural ambiguity is resolved probabilistically via a combination of working-memory factors (such as recency) and ACT-R's rational production choice rule.

3. A single structural interpretation is pursued, although multiple possibilities are locally generated in parallel. Retrieval interference mitigates against maintaining multiple similar structures.

4. Limited, opportunistic recovery from misanalyses via reactivation of discarded structures; completed by simple repair.

A
├ B
│ ├ D
│ └ E
│   ├ H
│   │ ├ [1] J
│   │ └ K
│   └ I
└ C
  ├ F
  └ G

[1] DBEAC.JHKEI.FCG
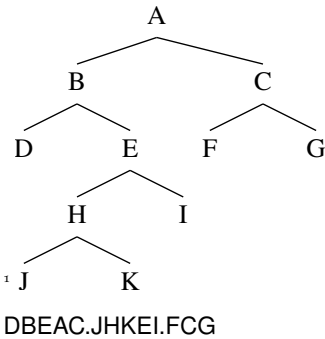
SP1	*Declarative mem. for long-term lexical & novel linguistic structure.*
SP2	*Extremely limited working-memory focus.*
SP3	*Activation fluctuation as a function of usage and delay.*
SP4	*Associative retrieval subject to interference.*
SP5	*Efficient parsing skill in a procedural memory of production rules.*

Core assumptions from ACT-R

The subsymbolic component

All chunks have an activation level[2], a notion of representational strength.

[2]
$$A_i = B_i + \sum_j W_j S_{ji}$$

- Base level activation[3] is a function of usage history and decay. Intended to track the log odds a chunk will need to be retrieved.

[3]
$$B_i = ln\left(\sum_{j=1}^{n} t_j^{-d}\right)$$

- "Associative retrieval interference arises because the strength of association from a cue is reduced as a function of the number of items associated with the cue[4]... which reduces the maximum associative strength S by the log of the "fan" of item j, that is, the number of items associated with j."

[4]
$$S_{ji} = S - ln(fan_j)$$

- The latency of retrieval is a function of the chunk's activation[5]; F = scaling constant; set to 0.14

[5]
$$T_i = Fe^{A_i}$$

A1   *Declarative memory of chunks.*
A2   *Focused buffers holding single chunks.*
A3   *Activation fluctuation as a function of usage and delay.*
A4   *Associative retrieval subject to interference.*
A5   *Procedural memory of production rules with a least-commitment, run-time control structure.*

References

Miller, George A. (1957). "The magic number seven, plus or minus two". In: *The Psychological Review* 63, pp. 81–97.