

#12 – Electrophysiological Findings about Structure-Building

Although we have fairly detailed theories about what distinguishes possible and impossible sentence structures, we are largely lacking any account of the processes by virtue of which humans are able to make judgments about sentences.

The need for such an account is all the more pressing if a single incremental structure-building system is assumed.

Data from electrophysiological studies of language provide a possible source of relevant data.

I. Grammaticality and Processability

(1) “It is straightforward enough to show that sentence parsing and grammaticality judgements are different. There are sentences which are easy to parse but ungrammatical (e.g. *that-trace* effects), and there are sentences which are extremely difficult to parse, but which may be judged grammatical given appropriate time for reflection (e.g. multiply center embedded sentences). This classic argument shows that parsing and grammar are not identical, but it tells us very little about just how much they have in common.” (Phillips 1995, p.37)

- Unrammatical-yet-comprehensible sentences

- (2)
- * Wallace think that Gromit ate the cheese.
 - * The viewers donated PBS the money.
 - * A chicken was resembled by Knuckles.
 - * Who_i did the court think that t_i stole the sheep?
 - * Who_i does his_i dog respect t_i?
 - * That’s the guy I wanna push my sled.

(CBS Winter Olympic Coverage, 2/6/98)

- Ungrammatical, incomprehensible

- (3)
- * What_i did Wallace remember the dog who_j t_j was suspected of t_i?
 - * The news that Wendolene and the likelihood that Preston hated cheese appalled Wallace.
 - * Porridge with covered was windshield the suddenly.

- Grammatical-yet-incomprehensible: overload

- (4)
- # The administrator who the intern who the nurse supervised had bothered lost the medical reports.
 - # The executive who the fact that the employee stole office supplies worried hired the manager.
 - # The Republicans who the senator who the citizens voted for chastised were trying to cut all benefits for veterans.

(from Gibson 1998)

- Grammatical-yet-incomprehensible: garden-paths

- (5)
- # The locomotive raced around the living room contained the art thief.
 - # While Gromit was awakening Wallace fell through the ceiling.
 - # Gromit told the sheep that he met in the kitchen to leave.

- Grammatical-yet-incomprehensible sentences: overload memory resources (4), or led down garden-path by economy conditions.
- Comprehensible-yet-ungrammatical sentences: structure-building system performs an illegal operation in order to proceed (e.g. agreement mismatch), and ‘flags’ the illicit operation.

[cf. notion of *mal-rules* in AI literature: Anderson 1984, Sleeman 1982, Weschedel et al. 1978, McCoy & Pennington 1996; cf. Schneider, in progress, for application of this and notion of *partial unification*]

Conclusion: the distinction between failing to find any analysis for a sentence and failing to find a fully grammatical analysis for a sentence does not entail the existence of separate systems which yield the two types of failures.

II. Varieties of Ungrammaticality/Structure-building Difficulty

Terminology due to Schneider (in progress)

‘Transparent’ Ungrammaticality, easily recoverable Garden Path

- Subject-verb agreement (accommodation of incoming word)
- Dative shift overextensions
- That-trace violations (accommodation of prior structure?)
- Weak islands for object extraction (wh-islands)
- Reflexive w/ antecedent outside GC
- Incorrect case marking (accommodation of earlier word)
- Easily recoverable garden paths

‘Opaque’ Ungrammaticality, unrecoverable Garden Path

- Relative clause islands
- Category expectation violations
- Reflexive not bound by most local antecedent
- (Barely) recoverable garden paths

III. Some ERP Findings involving Sentence Processing (partial survey)

A. Violation of Category Expectation

1. Participle seen when NP required

Der Freund wurde im *besucht*
 ‘The friend was in-the visited.’

- | | | |
|--|------|------|
| a. Friederici, Pfeifer & Hahne (1993) | ELAN | |
| b. Friederici, Hahne & Mecklinger (1996) | ELAN | P600 |

2. Participle seen when NP expected, but participle possible

Das Metall wurde *Veredelung* von einem Goldschmied den man auszeichnete.
'The metal was/became *refinement* of a goldsmith who people honored.'

a. Friederici, Hahne & Mecklinger (1996)

LAN

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[Note that although Friederici et al. interpret the timing difference between (1b) and (2a) in terms of a qualitative difference between processing category information and processing of lexeme specific information, it would be possible to treat the timing difference as reflecting a quantitative difference between the specificity of the syntactic category prediction set up by *im* and *wurde* respectively.]

3. Infinitival *to* seen when NP expected, but acceptable following reanalysis

The broker [hoped/persuaded] *to* sell the stock...

Osterhout & Holcomb (1992)

P600

4. Finite verb seen when either nothing or PP expected; reanalysis required

The broker hoped to sell the stock *was* sent to jail.

Osterhout & Holcomb (1992)

P600

5. Adverb seen when N' expected; no analysis possible, except possibly by inverting words

De echtgenoot schrikt van de emotionele nogal *reactie* van zijn vrouw.
'The husband is-startled by the emotional rather reaction of his wife.'

a. Hagoort, Brown & Groothusen (1993)

P600

b. Hagoort & Brown (199x: same categories, random word choice)

P600

6. Dummy case-marking preposition seen when N' expected

The scientist criticized Max's *of* proof the theorem.
[compared to *of* following *proof*]

Neville, Nicol, Barss, Forster & Garrett 1991

ELAN LAN

P600

7. Finite verb seen when none expected; easy reanalysis of preceding NP required

The judge charged [that] the defendant *was* lying.

a. Osterhout, Holcomb & Swinney (1994)

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P600

The judge [believed/charged] the defendant *was* lying.

b. Osterhout, Holcomb & Swinney (1994) – P600

8. Finite verb seen when none expected; no reanalysis possible

The doctor [hoped/forced] the patient *was* lying.

Osterhout, Holcomb & Swinney (1994) LAN P600

B. Subcategorization Violations

9. Intransitive verb seen when transitive expected:

Der Praesident wurde *gefallen*.
'The president was fallen'

a. Roesler, Friederici et al. (1993) LAN –eos

De zoon van de rijke industrieel pocht de *auto* van zijn vader.
'The son of the rich man boasts the car of his father.'
[repairable by adding *op* 'of' between verb and NP]

b. Hagoort, Brown & Groothusen (1993) – –

C. Case, Agreement, Morphology Violations

[Note that in almost all of these examples the category of the anomalous word is entirely predictable; it is just the choice of grammatical features associated with that category that is inappropriate. According to Friederici's model, therefore, we should not expect to see responses reflecting pure-category anomalies. This is largely confirmed.]

10. Incorrect number agreement on verb

The elected officials *hopes* to succeed.

Het verwende kind [gooit/gooien] het speelgoed op de grond.
'The spoiled child.sg v.sg/pl the toy on the floor.'

a. Hagoort, Brown & Groothusen (1993) P600

b. Osterhout & Mobley (1995) LAN_{sm} P600

c. Munte, Matzke & Johannes (1997) LAN_{sm} P600

[LAN only seen in story-reading, not with judgment task]

Der Kruke ploetzt den Schruck.
'A flurk nerches the minch.'

d. Munte, Matzke & Johannes (1997) LAN –

11. Incorrect number agreement on reflexive

The hungry guests helped *himself* to the food.

Osterhout & Mobley (1995) – P600

12. Incorrect gender agreement on reflexive

The successful woman congratulated *himself* on the promotion.

Osterhout & Mobley (1995) – P600

13. Grammatical but non-bound pronoun

The aunt heard that [she/he] had won the lottery.

Osterhout & Mobley (1995: expt. 2) LAN_{sm} P600
(only subjects who judged sentences bad)

14. Incorrect participle ending on verb

Das Parkett wurde bohner.
'The floor was being polished'

Friederici, Pfeifer & Hahne (1993) LAN P600

15. Incorrect case on pronoun

The plane took *we* to paradise and back.
Ray fell down and skinned *he* knee.

Coulson, King & Kutas (1998) LAN P600

D. Problems Completing Filler-Gap dependencies

16. Encountering wh-word while carrying wh-filler

I wonder which of the staff members the candidate was annoyed when his son was questioned by
—.

McKinnon & Osterhout (1996) – P600

What do you wonder *who* they caught ___ at ___ by accident?

Kluender & Kutas (1993) LAN –

17. Encountering *that* while carrying subject NP without theta-role

The man seems *that* it is likely ___ to win.

McKinnon & Osterhout (1996)

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18. a.k.a. subject-condition violation; encountering gap-verb sequence when expecting NP

What was a proof of *criticized* by the scientist.

Neville, Nicol, Barss, Forster & Garrett (1991)

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P600

19. Specificity condition violation

What did the scientist criticize Max's proof of?

Neville, Nicol, Barss, Forster & Garrett (1991)

LAN

–eos

E. Disambiguation of Subject/Object

20. Number marking on clause-final verb resolves subject/object ambiguity

Das ist die Managerin, die die Arbeiterinnen gesehen [hat/haben]

That is the manager(f.), who the workers(f.) seen [have.sg/pl]

Mecklinger, Schriefers, Steinhauer & Friederici (1995)

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