Two interesting hypotheses

How Broca’s aphasia and syntactic theory meet.
Main sources:


Broca’s aphasics have no problem understanding:

- Basic syntactic trees (repeat basic) and violations of basic phrase-structure rules
- Lexical meanings and their interface with syntax (violations of sub-categorizations are easily detected by them)
- Argument structure (when movement and traces are not involved)
- (Full interpretation is unaffected)
- Basic inter-sentential dependencies (relatives, subordinates etc. When no movement and traces are involved)
- Case assignment (esp. in languages that have overt case, such as Serbo-Croat)
- Binding and anaphoric relations (with some exceptions)
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Zooming onto Broca’s area lesions

- Grodzinsky’s TDH$_1$ (Trace Deletion Hypothesis first version): Broca’s aphasics have an impairment in comprehension only when confronted with sentences that present movement and traces, but not otherwise.
- A “particularly influential hypothesis” (said by an opponent: Alfonso Caramazza)
- Methods: Picture selection task upon presentation of sentences, truth judgments, and detection of non-grammaticality
- Reminder: They cannot “produce” such sentences
- Above-chance (often 100%) correct performance signals absence of a comprehension impairment
- Chance performance signals a comprehension impairment
What’s being ruled out:

- Generic “working memory” impairment
- Generic “linking” impairment
- Generic impairment with “inversions” (extending to non-linguistic domains, see Grodzinsky’s 2000 BBS paper)
- Generic impairment with “complex” syntactic constructions of all kinds
- A problem confined to lexical knowledge
- And/or to “encyclopedic” knowledge
- *The spoon ate the table* is understood perfectly, in spite of its semantic implausibility
- Selectional restrictions (verbs subcategorizations) are not a problem
Typical data: Minimal pairs (AC=above chance, C=chance)

- **Active versus passive**
  - *The woman is chasing the man*  AC
  - *The man is chased by the woman*  C

- **Subject relative versus object relative**
  - *The woman who is chasing the man is tall*  AC
  - *The man that the woman is chasing is tall*  C

- **Subject-gap versus object-gap**
  - *Show me the woman who is chasing the man*  AC
  - *Show me the man who the woman is chasing*  C

- **Subject cleft versus object cleft**
  - *It is the woman that is chasing the man*  AC
  - *It is the man that the woman is chasing*  C
Notice:

- Object relatives, object clefts and object gaps are a special problem for younger normal children and for Williams Syndrome subjects (Andrea Zukowski 2003, 2005)
- There is something “special” about these constructions
Other data

- No impairment with head-movement as such.
- Grammaticality judgments are perfect for:
  - Could they have left town?
  - *Have they could leave town?
  - John did not sit.
  - *John sat not.
- OK with full interpretation
  - Who did John see?
  - *Who did John see Joe?
  - *Mary ate the bread that I baked a cake.
- OK with selectional restrictions on transitive complements and object deletion
  - The children sang.
  - *The children sang the ball over the fence.
  - *The children threw.
  - The children threw the ball over the fence.
Refining the hypothesis

- Broca’s area as “neural home to receptive mechanisms involved in the computation of the relation between transformationally moved phrasal constituents and their extraction sites” (Grodzinsky, 2000, BBS)
- But those patients perform successfully in constructions that involve movement of the VP-internal subject to [Spec, IP] (Hickok, 1992)
- A better hypothesis: θ-conflict
- Somehow, the patient is receiving thematic information that both NPs in the sentence have the same θ-role, and that, therefore, any one of them can be matched to the agent and the patient argument in the sentence.
- The performance is, thus, 50% (chance)
A specific hypothesis

- The TDH hypothesis does not bear upon the mere syntactic “complexity” of the sentence
- Nor upon the “first” versus “second” position of the NPs and the traces
- Nor upon the “left” versus “right” position
- It bears upon the standard position of θ-roles and arguments in the patient’s language, whatever that standard position is.
- In fact, in Chinese (an otherwise SVO language like English) the heads of the relative clauses follow the relative, contrary to English
- Similar results in Hebrew, Spanish, Korean and German (see Grodzinsky’s papers for biblio)
Scrambling in Japanese: Minimal pairs

- 2 possible configurations, with different results in Broca’s aphasics (Hagiwara and Caplan, 1990)

(a) *Taro-ga Hanako-o nagutta* AC
Taro hit Hanako
Subject Object Verb

(b) *Hanako-o Taro-ga t nagutta* C
Object Subject t Verb

SOV is the basic order, while OSfV is the “scrambled” (secondary) order (Hale, 1983; Saito, 1985; Miyagawa, 1997)

In (b) *Hanako* must c-command the VP, so it must have moved to adjoin a higher projection than that of the subject (*Taro*)

(See many details in the BBS paper)
The $\theta$-conflict hypothesis

- There should also be cases of **systematic inversion** (that is, **below** chance performance)
- In fact there are (Grodzinsky, 1995, 2000)
- with *psych* verbs (*admire, love, adore, fear*, etc.) (Belletti and Rizzi, 1988; Pesetsky, 1995)
- The syntactic subject is not really an “agent”, it’s rather an “experiencer”, and the “object” is really a “theme”
- Normal assignment in yellow, Broca’s aphasic’s assignment in blue:
  - Theme Experiencer
  - *The girl*$_i$ was *t’j admired*$_i$ by *the boy*$_j$
  - Agent Experiencer
  - No conflict here. The inversion is **systematic**
  - No problem with the active counterpart
  - *The boy admired the girl*
fMRI Results:

- More intense signal in the left inferior frontal gyrus (Broca’s area) for the sentences that involve movement and trace
- In agreement with the data on Broca’s aphasics
- Also Hershl’s gyri (Brodmann area 22) are activated bi-laterally (temporal lobes)
From Ben-Schachar et al. (in Grodzinsky’s 2000 paper)
Herschl’s gyrus

Areas 22 are also activated bi-laterally. Syntax is not all in the left hemisphere.
Similar fMRI data for scrambling

- Activation of the same areas (Broca’s left, and Herschl’s bilaterally) is observed for scrambled embedded double-object verbs in German (Röder et al, 2002)

- Jetzt wird der Astronaut dem Forscher den Mond beschreiben
  Now will the astronaut [to] the scientist the moon describe

- Jetzt wird dem Forscher den Mond der Astronaut beschreiben
Broca’s aphasia revisited (Friedmann 2006)

- *Who did the cat chase?* AC
- *Which dog did the cat chase?* C
- WHO is a pure operator, while WHICH is discourse-dependent and therefore computationally “more costly” (Hickok and Avrutin 1995; Tait 1995; Avrutin 2006)
- Strong asymmetry between tense and subject-verb agreement inflection (tested in many languages)
- Subject-verb agr. 65% correct or more
- Tense is at chance level
Broca’s aphasia revisited (Friedmann 2006)

- **A** = affected
- **NA** = not affected

- **A** Subject pronouns
- **NA** Object pronouns
- **A** Relatives
- **NA** Reduced relatives
- **A** Wh-questions
- **NA** yes/no questions
- **A** Subordination conjunctions
- **NA** Coordination conjunctions

Language variability:

- **A** yes/no questions in Dutch, English and German
- **NA** yes/no questions in Hebrew and Arabic
- Parametric differences in NegP?
The Tree Pruning Hypothesis (TPH)

- In essence: The highest functional nodes in the syntactic tree are selectively affected.
The Tree Pruning Hypothesis (TPH)

- Recovery of S.B., a 20 years-old Hebrew speaker with traumatic brain injury (Friedmann, 2005, 2006)

Diagram:
- CP
- Wh-question
- C'
- Complementizer
- TP
- C
- T'
- Tense
- NegP
- AgrP
- Agr'
- 
- Agreement
- 15 months
- 6.5 months
- 4.5 months
Objections


- Each patient is a unique case: categorizations are misleading

- TDH is a desperate attempt to save a falsified hypothesis


- Different levels have been conflated into the C and AC classification

- Different data for English (worse understanding of passives) versus Dutch and German (better understanding of passives)

- Better understanding with overt passive morphology (mood) than without

- Nestedness (complex branching without movement) also creates comprehension problems

- Picture choice is not the same as syntactic judgment
The debate:

- Dan Drai and Yosef Grodzinsky *A new empirical angle on the variability debate: Quantitative neurosyntactic analyses of a large data set from Broca’s Aphasia* Brain and Language, Volume 96, Issue 2, February 2006, Pages 117-128


- Drai and Grodzinsky’s punch line: “Performance variation within a group of patients in itself does not preclude the existence of structure in their deficit. Thus in aphasia the data may present inter-patient variability, but the challenge for us is to try and discover commonalities at the group level in the face of this variability”.

Conclusions:

- Movement is the correct distinction in the realm of relative clauses (subject vs. object gap), while “complexity” (branching type) and “mood” (overt passive morphology) are not.
- Syntactic movement sets types of active sentences apart from one another (i.e., base actives vs. scrambled or topicalized ones),
- Comprehension scores of German/Dutch Broca’s aphasic patients on passive sentences are significantly higher than those of their English counterparts (Scope Freezing versus allowed scope ambiguity)
An interesting development:

- Relativized Minimality à la Rizzi can explain the data and do justice to TDH (Nino Grillo 2005, 2007)

- Blocking the formation of a chain over an intervening element whenever it cannot ‘see’ any difference in the internal structures of the elements involved

- movement of an NP over another one (or the establishment of a long distance relationship over an intervening NP) poses special computational problems to Broca’s aphasics