

# Two interesting hypotheses

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How Broca's aphasia and syntactic theory meet.

# Main sources:

- Friedmann, N. and Y. Grodzinsky (1997). "Tense and agreement in agrammatic production: pruning the syntactic tree." Brain and Language **56**: 397-425.
- Grodzinsky, Y. (2000). "The neurology of syntax: Language use without Broca's area." Behavioral and Brain Sciences **23**: 1-71.
- Grodzinsky, Y. (2004). Variation in Broca's region: preliminary cross-methodological comparisons (Chapter 8). Variation and Universals in Bilingualism. L. Jenkins (Ed). Amsterdam, Elsevier: 171-193.
- Grodzinsky, Y. and K. Amunts (Eds.) (2006). Broca's Region. New York, Oxford University Press.
- Grodzinsky, Y. (2006). A blueprint for a brain map of syntax. In Broca's Region. Y. Grodzinsky and K. Amunts (Eds).
- Friedmann, N. (2006). Speech production in Broca's agrammatic aphasia: Syntactic Tree Pruning. In Broca's Region. Y. Grodzinsky and K. Amunts (Eds.).

# 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)
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# Zooming onto Broca's area lesions

- Grodzinsky's TDH<sub>1</sub> (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:  $\theta$ -conflict
- Somehow, the patient is receiving thematic information that both NPs in the sentence have the same  $\theta$ -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  $\theta$ -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)

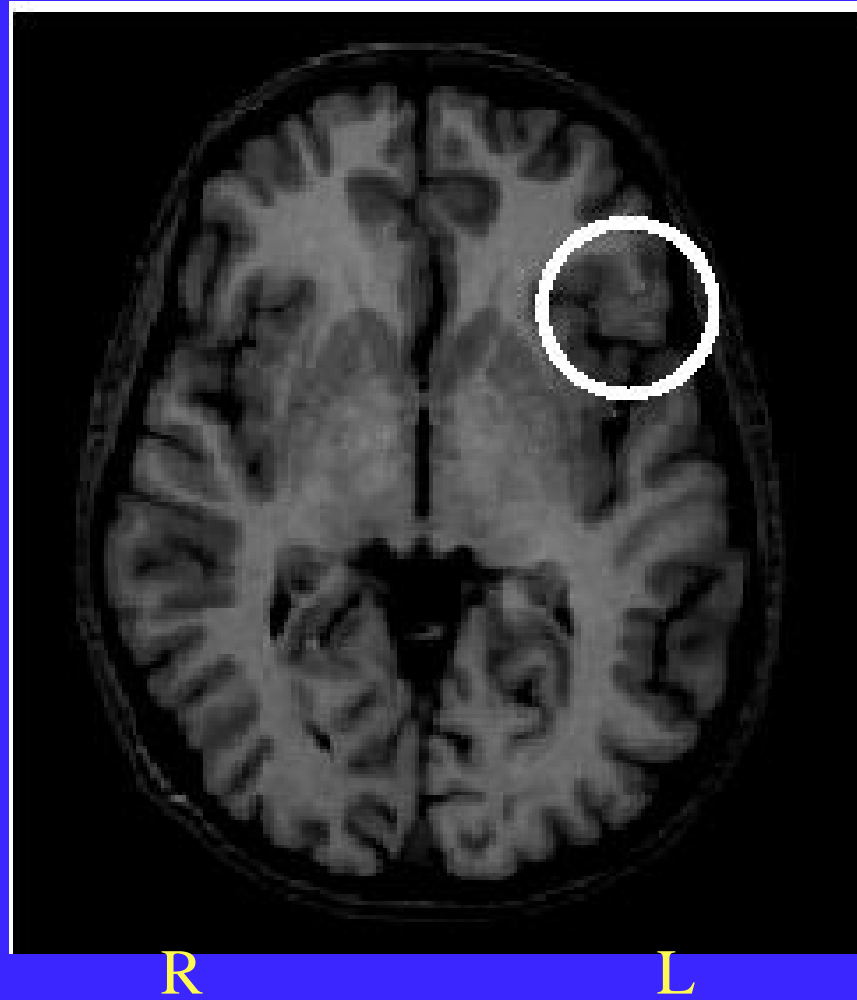
# Scrambling in Japanese: Minimal pairs

- 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 OS $t$ V 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)



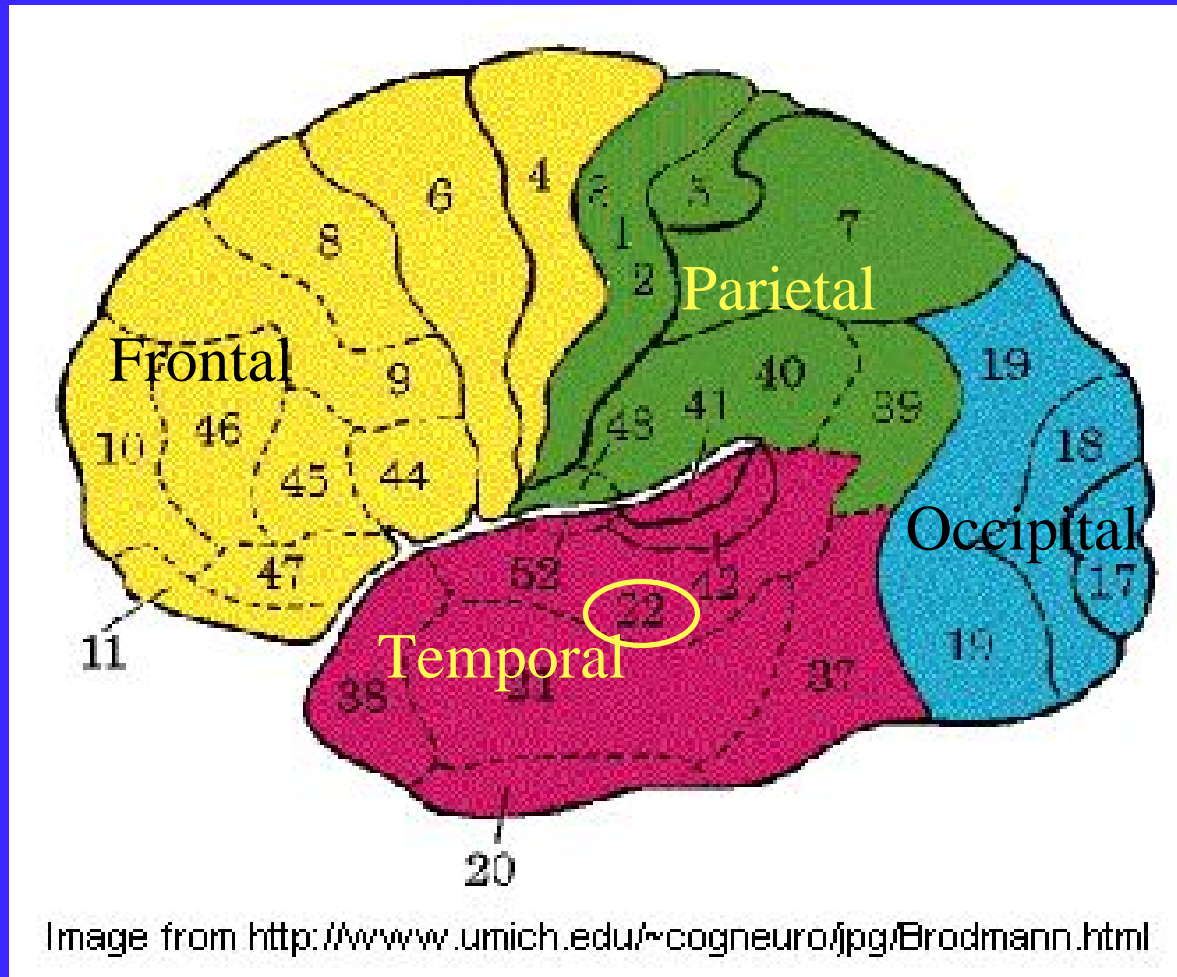
# fMRI Results:

- 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 Hershli'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 t t 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**

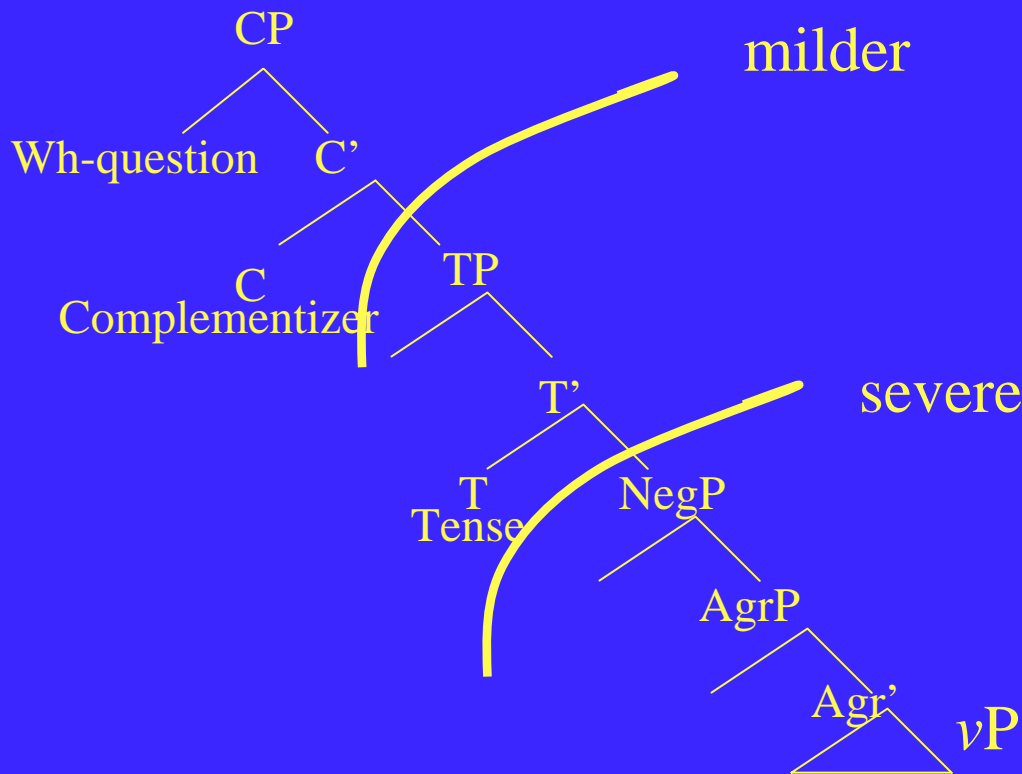
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- **A** Subject pronouns              **NA** Object pronouns
- **A** Relatives                      **NA** Reduced relatives
- **A** Wh-questions                  **NA** yes/no questions
- **A** Subordination conjunctions
- **NA** Coordination conjunctions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

(Friedmann, 1998, 1999, 2006; Friedmann and Grodzinsky, 1997, 2000; Friedman 2006)

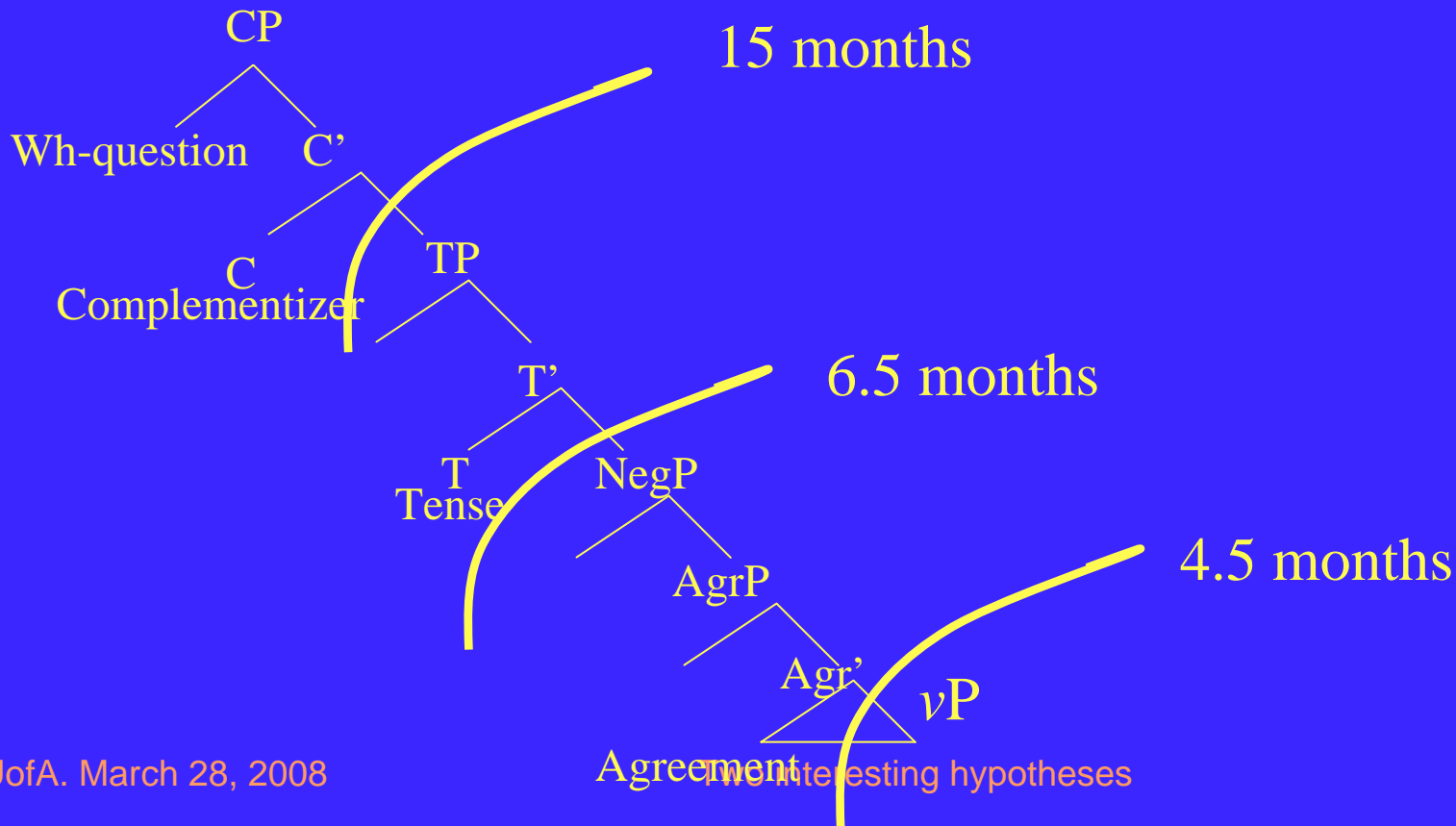
- In essence: The highest functional nodes in the syntactic tree are selectively affected



# The Tree Pruning Hypothesis (TPH)

(Friedmann, 1998, 1999, 2006; Friedmann and Grodzinsky, 1997, 2000)

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



# Objections

- Caramazza, A. (1986). "On drawing inferences about the structure of normal cognitive systems from the analysis of patterns of impaired performance: the case for single-patient studies." Brain and Cognition 5: 41-66.
- Each patient is a unique case: categorizations are misleading
- TDH is a desperate attempt to save a falsified hypothesis
  
- Caplan 1995, 2001, 2007
  
- 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, D. and Y. Grodzinsky (2006). "The variability debate: More statistics, more linguistics." **Brain and Language** **96** (2): 157-170.
- David Caplan, Gayle DeDe and Hiram Brownell *Effects of syntactic features on sentence–picture matching in Broca's aphasics: A reply to Drai and Grodzinsky (2006)* • DISCUSSION **Brain and Language**, Volume 96, Issue 2, February 2006, Pages 129-134
  
- 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
- Grillo, N. (2005). Minimality effects in agrammatic comprehension. Proceedings of ConSOLE XIII: 107-120.
- Grillo, N. (2007). Fast decay of morphosyntactic features activation inducing RM effects in agrammatic aphasia. Ms, University of Siena & Utrecht Institute of Linguistics OTS.