Reading Group “Issues in Theoretical Linguistics”

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1 Some basics

- Comprehension in Broca’s area?

Few brain areas have been traditionally identified as linguistically relevant areas. The best known are Broca’s and Wernicke’s areas in the left hemisphere, which have been respectively related to production and comprehension. This channel-based model has still strong influences on current research (see Fig. 1). However, during the 70s, several studies on agrammatism claimed that damage in Broca’s area also triggered deficits in comprehension. In some studies, it was postulated that Broca’s area was responsible for syntax and Wernicke’s area for semantics. Yet, the authors of the target article assume Grodzinsky’s hypotheses (1990; 2000), according to which the Broca’s area is responsible for the production and processing of certain syntactic aspects. Furthermore, he claims that evidence from behavioral studies with agrammatic patients shows that the production deficit is dissociated from the comprehension deficit, that is, that the deficit that Broca’s aphasics present in production is not parallel to their comprehension deficit. In this article, Grodzinsky and some colleagues explore the activation of these brain areas when processing structures with and without the syntactic properties that by hypothesis are processed in such areas.

![Figure 1](http://emedia.leeward.hawaii.edu/hurley/Ling102web/mod5_Learning/5mod5.0_intro.htm)

- Why is syntactic movement interesting?

Rizzi, 1990:

(1) a. Could$_i$ they $t_i$ have left? X$_o$-movement

b. It seems that Mary$_i$ is likely $t_i$ to win. A-movement

c. Whom$_i$ did John persuade to visit $t_i$? A’-movement

Grodzinsky, 1990; 2000:

**The Trace-Deletion Hypothesis**  *Traces of XP-movement are deleted from S-Structure level.*
The Default Strategy  If a lexical DP has no theta-role, assign it the theta-role that is canonically associated with the position it occupies.

(2) a. \([\text{DP John}] [\text{VP } t_i \text{ pushed } [\text{DP Bill}]]\].
   \[\text{agent} \quad \text{theme}\]
   \textit{Agrammatic assignment}
b. \([\text{DP John }* ] [\text{VP }* \text{ pushed } [\text{DP Bill}]]\].
   \[* \quad \text{theme}\]
c. \([\text{DP John }* ] [\text{VP }* \text{ pushed } [\text{DP Bill}]]\].
   \[\text{agent} \quad \text{theme}\] \text{above-chance performance}

(3) a. \([\text{DP Bill }] \text{ was } [\text{VP } t_i ] \text{[pushed } t_i [\text{PP by John}]]\].
   \[\text{theme} \quad \text{agent}\]
   \textit{Agrammatic assignment}
b. \([\text{DP Bill }] \text{ was } [\text{VP }* ] \text{[pushed } * [\text{PP by John}]]\].
   \[* \quad \text{agent}\]
c. \([\text{DP Bill }] \text{ was } [\text{VP }* ] \text{[pushed } * [\text{PP by John}]]\].
   \[\text{agent} \quad \text{agent} \quad \text{at-chance performance}\]

2 Introduction [1320-1322]

The TDH is supported by evidence from behavioral and online processing studies. There are few functional neuroimaging studies adressing the issue, but with no conclusive results due to problems with the experimental design (the effect of syntactic movement cannot be clearly distinguished from the effect of other factors).

Ben-Shachar et al., 2003: relative clauses
In the target article, experiment 1: topicalization
In the target article, experiment 2: wh-questions

Goal To find a consistent set of brain regions activated by syntactic movement, across different tasks and various syntactic constructions.

3 Experiment 1 [1322-1328]

3.1 Materials

(4) (a) Baseline: John gave [\text{OD} the red book] [\text{OI} to the professor from Oxford].
(b) Dative shifted: John gave [to the professor from Oxford] [the red book] _. \ A-movement
(c) Topicalized DO: [The red book] John gave _ [to the professor from Oxford]. \ A’-movement
(d) Topicalized IO: [To the professor from Oxford] John gave [the red book] _. 
3.2 ROIs

3.3 Results

**Topicalization effects** [conditions C, D vs. A, B]
- Significant effect in LIFG and LvPCS
- Significant effect in LIFG was significantly larger than the one in LaINS
- Significant effect in pSTS bilateraly

**Dative Shift** [condition B vs. A]
- Nonsignificant effect of dative shift (B > A) in LIFG, LvPCS and bilateral pSTS and HC
- Significant effect in RaINS and RvPCS

4 Experiment 2 [1328-1332]

4.1 Materials

(5) (a) Embedded yes-no Q: The waiter asked if [EMB the tourist ordered salad for lunch].
(b) Embedded subject Q: The waiter asked [which tourist [EMB _ ordered an alcoholic drink in the morning]].
(c) Embedded object Q: The waiter asked [which drink [the fat tourist ordered _ in the morning]].

4.2 Results

**Movement effect** [conditions B, C vs. A]
- Significant effect in LIFG and LvPCS
- Significant effect in LpSTS and marginally significant effect in RpSTS

**Object vs. subject and yes-no Q** [condition C vs. B and condition C vs. B, A]
- No higher activation of object Q than others

5 General discussion [1332-1336]

**Converging evidence** In both experiments, the A’-movement effect has been observed in LIFG, LvPCS and bilateral pSTS. The same activations were found in a previous experiment with object relative clauses (Ben-Shachar et al., 2003). The results are also consistent with data reported in studies using other imaging technologies, syntactic constructions, tasks and languages.

"The combined results of these studies suggest that syntactic movement constitutes a neurally relevant linguistic generalization, processed by this consistent set of brain regions." [p. 1333]
A neurolinguistic generalization The results reported in the article are supporting evidence for

(i) Anatomical specificity: activation in LIFG and pSTS clearly dissociated from adjacent areas (aINS and HC)

(ii) Movement effect: clearly dissociated from other factors, like verbal complexity (Ben-Shachar et al., 2003) or task-related activations in adjacent areas

(iii) Lateralization: significant higher activation in left anterior regions

"The exact division of labor between the regions activated by movement cannot be specified based on this study alone". [p. 1333]

Considering the results exposed above and reported by lesion studies, the authors suggest that anterior regions “could be related to the reactivation of the moved element in an appropriate sentential position, whereas the posterior regions could reflect maintenance of the moved element in memory”.

Diverging evidence LvPCS was not activated in Ben-Shachar et al. (2003) study of object relatives (grammaticality judgment task). The authors suggest that the role of LvPCS could be related to (a) the type of task or (b) semantics, according to previous imaging studies where activation in this region was observed in semantic tests.

“In our movement sentences, LvPCS may have been involved in searching for a semantically appropriate element to be linked, while LIFG was performing a more syntactically guided search for this element.” [p.1333]

Linguistic distinctions in movement-sensitive regions Dative Shift activated right frontal regions, in contrast with topicalizations, embedded questions and object relatives.

(i) This shows that the activation in LIFG and pSTS is highly selective and cannot be attributed to a deviation of the canonical order.

(ii) A distinction has been observed between two different types of syntactic movement: A'-movement (topicalizations, embedded questions and object relatives) and A-movement (dative shift). This distinction is in agreement with a linguistically based approach that postulates different types of movement. However, this dissociation has not been documented by lesion data: agrammatic patients have disrupted comprehension of both A'- and A-movement structures (like passives).

Subject vs. object questions No significant differences between these two conditions were found. The authors suggest that both subject and object movement are processed in movement-sensitive regions (corroborated by online processing studies) and that differences between these two structures are only found when the distance between the moved element and the original position is greater.

6 Topics to be discussed

#1 The use of experimental methods within the field of theoretical linguistics has increased the last decades. The aim of such studies is not only to localize the faculty of language in the brain, but also to provide new evidence for finer-grained linguistic distinctions (like movement vs. nonmovement or A-movement vs. A'-movement). Do you think that this kind of evidence and methodology is useful for theoretical linguistics?

#2 The authors provide evidence for neural correlates of syntactic movement. However, they do not address directly the issue of the faculty of language; do you think that the evidence shown in these articles could tell us something about it?

#3 Neural processes seem to involve several brain loci that are interconnected and that might be multifunctional; yet, there are still some brain regions that play an important role in the processing of certain syntactic properties. In the article, the authors test minimal contrasts that are relevant in theoretical linguistics and show that there is a “movement effect” which suggest a critical role for Broca’s area in the analysis of movement. How is such analysis and interpretation of results influenced by the perspective of the researchers (linguists)?
Here, the traditional conception of language centers—either related to activities (production, comprehension...) or to levels of linguistic description (semantics, syntax...)—in the brain is compromised. The role of Broca’s area in sentence processing had been discussed before and it has been claimed that it is closely related to motor functions, as the monkey homolog of Broca’s area (mirror neurons) seems to suggest. But, could a relationship between the processing of fine grammatical rules in Broca’s area and motor functions attributed to monkey F5 be established?

The authors also exclude more general explanations for these activations, like sensitivity to noncanonical word order or utterance complexity. There are still other general capacities that are claimed to be supported by Broca’s area. For example, it is thought that Broca’s area supports working memory (“the memory required to link a gap to a filler must maintain a limited account of information active over a short (intra-sentential) temporary delay”). According to this account, the variation of distance between a gap and a filler would lead to a linear increase in activation in Broca’s area. Could it explain the data presented in the article?

References


